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Research paper



Design of Student Worksheets based on Learning Cycle 5E Learning Model for VIII Junior High School Students in Indonesia

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Abstract

The ability of a mathematical connection is one of the skills that must be possessed by students in the learning process of mathematics. Connecting mathematical concepts to gain a meaningful learning. Learning cycle 5E is one of the learning models that could improve students' mathematical connection ability. Student worksheet is a teaching material which is in the form of papers containing a summary of the materials, a guide for independent studying that refers to the basic competencies needed to be achieved. This article aims to develop a student worksheet design that provides an opportunity for students to optimize students' mathematical connection ability in the independent learning process based on the 5E learning cycle model. This research is for the development of the ADDIE model which consists of four stages, which are: analysis, design, development, implementation, and evaluation. This research is only up to the design stage. The subjects of the study are the students of SMP IT-Abu Bakar and MTs Mu'allimat Muhammadiyah Yogyakarta Indonesia. The instruments of the data collecting included interview sheets, document sheets, and description sheets. Interview sheets for retrieving curriculum data and student characteristics, document sheets for evaluating teaching materials, and description sheets for determining students' mathematical connection ability. Data analysis techniques uses qualitative data analysis. This research resulted in the design of student worksheets that fit the characteristics of students, curriculum, and teaching materials as well as packaging it based on the LC 5E model to provide a meaningful learning experience. Student worksheets are designed to facilitate students in learning activities and provide opportunities for students to optimize mathematical connection capabilities that are integrated into the learning model LC 5E.

Keywords: *ADDIE; Learning cycle 5E; Mathematical connection.*

1. Introduction

The ability of mathematical connection is the ability of students in connecting mathematical ideas. The standard process on the aspect of mathematical connection ability is connecting mathematical ideas between topics, context related to other subjects, and the correlation of mathematical ideas in real life. Students do not only learn mathematics in their interests and experiences, but also getting to know the usefulness of mathematics [1]. On the other hand [2], explaination to students whether or not they have the ability to reflect and see if they could dig problems, and try to find solutions by using math ideas to solve the problem. Mathematical connections are greatly needed by students, especially for solving problems that require a relationship between mathematical concepts with other concepts in mathematics and other disciplines, or in everyday life [3]. The ability in mathematical connection is crucial for the perception of students to see those mathematics as an unified whole, and the developer of capability in mathematical connection is by problem-solving [4]. The ability of mathematical connections have been widely researched by [3]–[10], and the results of ability mathematical connection is still relatively low. The same thing is also found by [5], [11] that students still view the mathematical concept as fragmentary. Students have difficulty in connecting mathematical concepts, mathematical concepts with other disciplines and mathematical concepts in everyday life.

The Learning Cycle 5E (LC 5E) model is a theory-based learning of constructivism that require students to discover and link prior knowledge with new concepts [12]. Stages LC 5E consists of engagement, exploration, explanation, elaboration, and evaluation. Researchers [13]–[18] made mathematical learning by using an effective LC 5E model. On the other hand [19], [20] using the LC 5E model is used to understand students in electrical concepts and elasticity. Answering the concerns of the 21st century, the 5E learning cycle provides a coherent contribution between teachers and students in the knowledge-sense perspective [21]. To implement LC 5E, it requires instructional learning materials that supports the capability in mathematical connections. However, based on the observation of the researcher, worksheets that are oriented on the ability of mathematical connections are generally not available for school students.

The student worksheet is a teaching material that consists of sheets of material summaries and self-directed work instructions referring to the basic competencies needed to be achieved [22] [23]. While the student's activity book is a collection of papers that contains activities of understanding, knowledge, and attitude of students. Student worksheets could also improve their achievements [24]. In the student worksheet, there are other disciplines that instructional design could do effectively [25], [26]. Student worksheets could also be a means to inculcate mathematical concepts. This article proposes LC 5E-based mathematics worksheet design revolving around students' mathematical connection ability.

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2. Method

This research is a development design research, which is designing development of student worksheet based on LC 5E. This research model uses the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation).

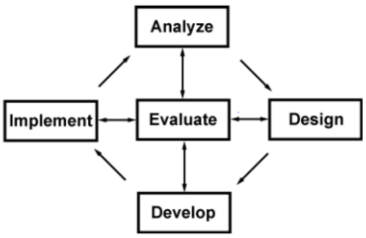

Fig. 1: ADDIE model [27]

The development procedure includes analyzing, designing, developing, implementing, and evaluating. This research is limited only to the stage of designing to determine the mathematics worksheet design based on LC 5E subject to build a flat side room. This research was conducted in Junior High School SMP IT-Abu Bakar Muhammadiyah and MTs Mu'allimat Muhammadiyah Yogyakarta Indonesia. The object of the study includes curriculum, student characteristics, and the evaluation of teaching materials. The instruments for data collecting includes interview sheets, document sheets, and description sheet. Interview sheets to retrieve curriculum data, student characteristics, document sheets to evaluate teaching materials, and description sheets to determine students' mathematical connection ability. Data analysis techniques used are qualitative data analysis consisting of data reduction, data display, and conclusion. Data obtained from observations and interviews conducted in schools are then summarized and concluded. From the results of the analysis, things that are needed in the development of student worksheets are obtained.

3. Results and Discussion

The stage of data analyzing is done by data analysis in a theoretical manner as well as empirically to get to know students' characteristic, curriculum, and teaching materials. The observational results of learning an interview with the teacher of SMP IT-Abu Bakar and MTs Mu'allimat Muhammadiyah Yogyakarta Indonesia; the learning process is still centered on the teacher, the students tend to be passive therefore students' mathematical connection ability has not been used maximally. Furthermore, the aspects of mathematical connection ability could be seen from the work of the students; concluding that students who weren't able to solve it were due to the imprecise use of mathematical formulas, students did not understand the prerequisite materials, students have not understood the relationship of mathematics in daily life and understanding of the problem which is related to other knowledge is still lacking, these findings were revealed by the previous researchers [4]–[8], [15], [28]. Student worksheets that were previously used did not include all competency indicators, and were presented in a non-sequential manner. While the student worksheets with the LC 5E model refers to the indicators of competence and consists of structured learning steps that involve students actively so that students can interact with the given material, train their independence of learning, improve the mastery of the materials, and facilitate teachers in assigning tasks [29]. Moreover, the student worksheets with the LC 5E model provides an opportunity for students to optimize students' mathematical connection ability in the learning process independently [30]. Therefore, at the design stage, the preparation of core competencies, basic competencies, graduation competency standards, student materials, test standards, media selection in accordance with the characteristics, and the choice of teaching materials format in the form of student worksheets used by using model LC 5E oriented on the students' ability of mathematical connections. The benefits of this student worksheet is to facilitate students in learning activities where students can arouse interest and curiosity by linking illustrations into math problems, exploring ideas in group discussions, presenting discussion results using their own sentences in clarifying the findings, reworking the concepts gained by working on individual problems, evaluating answers and summarizing learning outcomes [19], [29], [30].

The design of the LC 5E student worksheet is an initial draft which is then validated by an expert. Expert validation is performed by one media expert and one material expert who aims to obtain data on the validity of the student worksheet. In the development of tests, legibility and field tests are carried out. The legality test is performed by one teacher to assess the readability of the student worksheet before it is used in the field test, and also to six students with high, moderate, and low ability to assess student worksheets. After the further examination is conducted, field test aims to obtain data about the feasibility of student worksheets regarding students' mathematical connection ability. The initial draft of student worksheet that has been designed:

3.1. Student worksheet cover

The student worksheet cover is made attractive so that students are interested in working on student worksheets. Figure 2 is the design of the student worksheet cover.

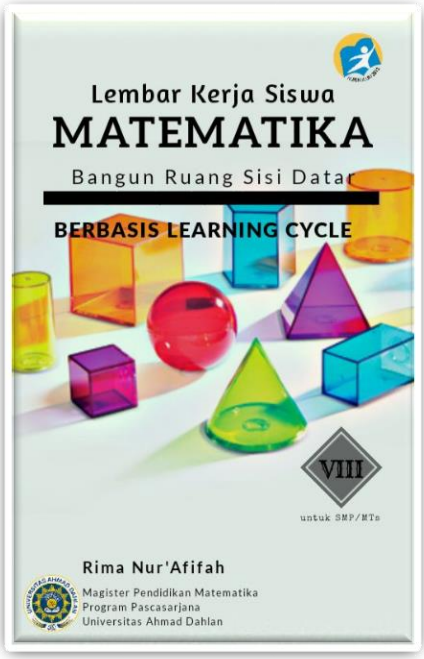

Fig. 2: Cover

3.2. Preface

Writing that contains the author's gratitude for having completed the student worksheet design. Figure 3 is the design of the preface.

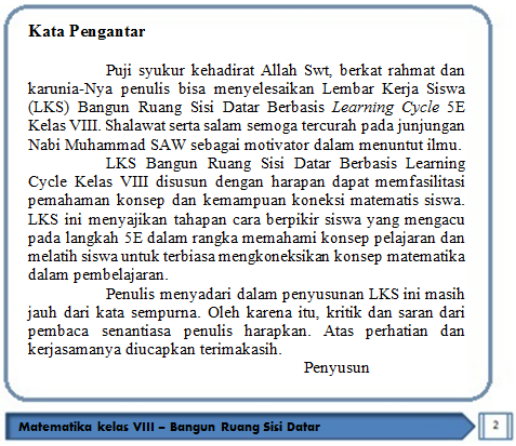

Fig. 3: Preface

3.3. Quality instructions

Figure 4 contains the steps to use the student worksheet.

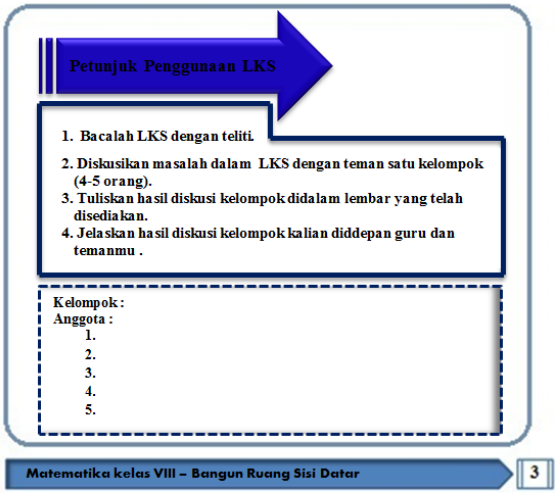

Fig. 4: Craft instructions

3.4. Lesson analysis

Lesson analysis is designed to determine core competencies, and essential competencies. It aims to acknowledge the content delivered. Figure 5 is the essential competencies, indicators, objectives and learning activities.

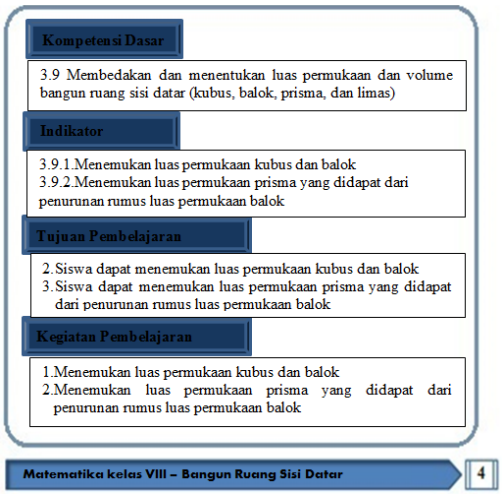

Fig. 5: Are the essential competencies, indicators, objectives and learning activities

3.5. Material and questions

The materials and questions in the student worksheet are packaged in accordance with the LC 5E model. LC 5E learning model is chosen because it contains the meaningful learning theory of Ausubel and Vygotsky learning theory, it is an important aspect that must be possessed by the students that are connecting new knowledge and understanding the cognitive framework already possessed by the students, moreover, the students gain a meaningful learning [12]. This step consists of;

3.5.1. Phase engagement

In this phase, students are expected to connect the illustrations of daily life problems with mathematical concepts presented in a topic, it aims to generate and explore the initial knowledge, ideas, interests, and curiosity of students [14],



Fig. 6: Phase engagement

3.5.2. Phase exploration

Students are given the opportunity to work together to resolve the problems presented in small groups of 3-5 students. In the phase, there are three activities that students carry out with student worksheets; a. Prerequisite knowledge activities where students are asked to recall the concept that had been studied, b. Finding the concept activities, which is armed knowledge of the students' prerequisite to find the concept, c. Concluding activities, after students recall and have found the concept of the next step, students then conclude the concept that has been obtained afterwards. It aims to provide student-centered learning. In this phase, students actively convey ideas and those that involve personal experience in everyday life, as shown in Figure 7, 8, 9, and 10.

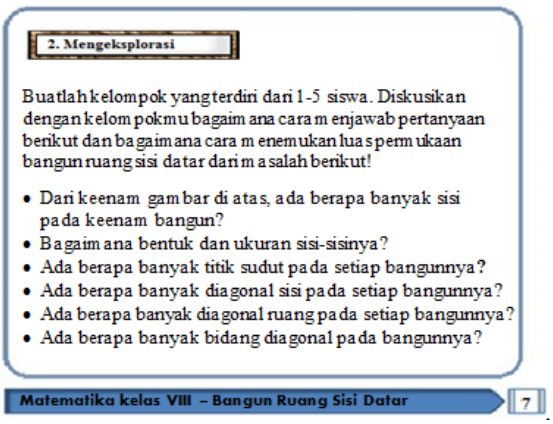

Fig. 7: Phase exploration

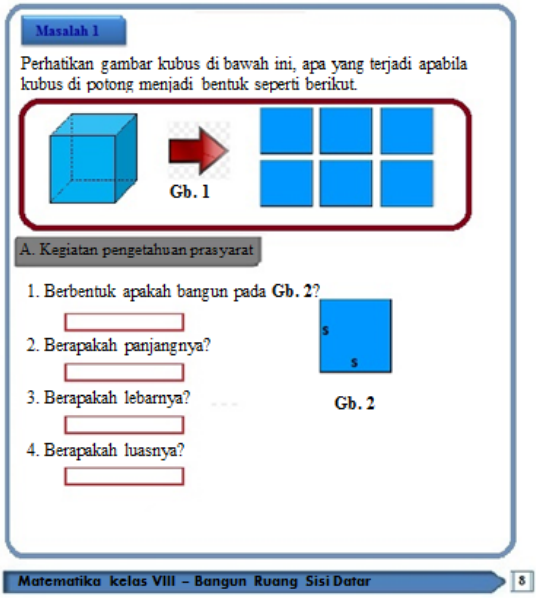

Fig. 8: Phase exploration (knowledge prerequisite activities)

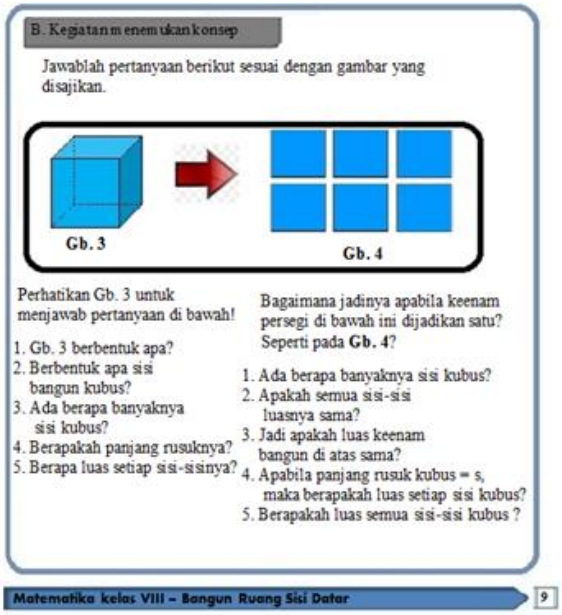

Fig. 9: Fase exploration (activities to find concepts)

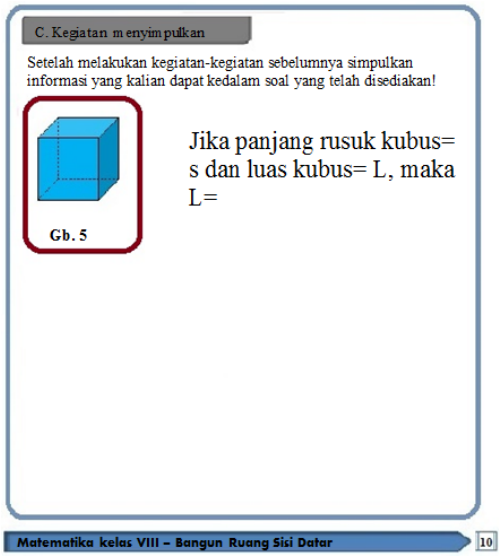

Fig. 10: Phase exploration (activities concluded)

3.5.3. Phase explanation

Students clarify their findings in the exploration phase by explaining the concepts obtained at the time of discussion with the students' own sentences, and critically listens to each other's explanations between students or teachers, as shown in Figure 11.

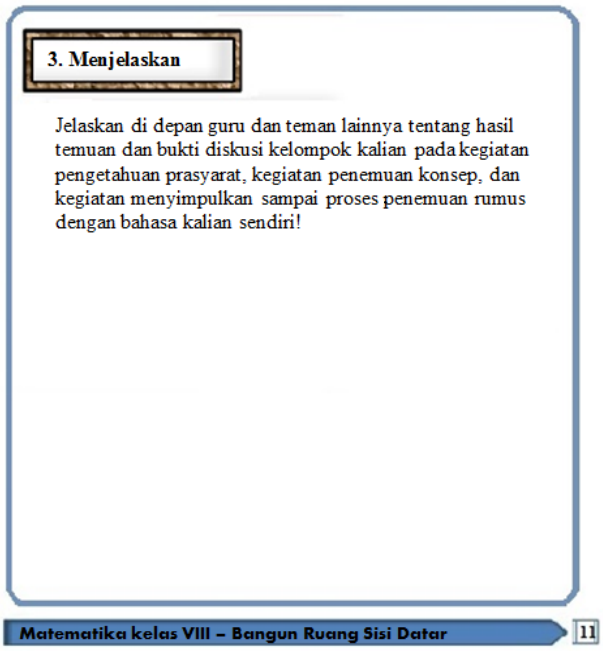

Fig. 11: Phase explanation

3.5.4. Phase elaboration

Students apply the concepts and skills learned in the new context in the form of questions that have been prepared so that students individually blend. This problem is a matter of mathematical connections that link the concepts that have been learned to be brought into the solution of the problem so that students will remember the concept that were previously learned [6], as shown in Figure 12.

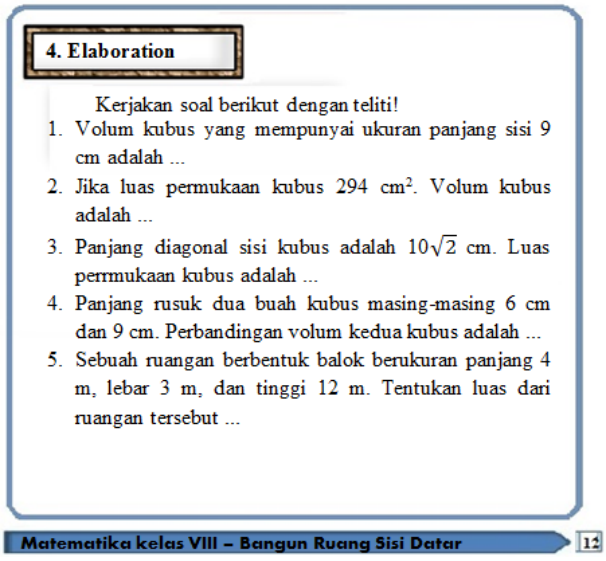

Fig. 12: Phase elaboration

3.5.5. Phase evaluation

Students are guided by teachers to conduct self-evaluation by doing the evaluation questions based on indicators of mathematical connection ability so that students understand the shortcomings and advantages in the learning process and teachers could

draw conclusions on the competencies that have been studied. This is done so that the next learning process is better. This issue provides a meaningful learning experience so that the material learned would be remembered in memory. The problem in the evaluation phase could be used as an evaluation in implementing the use of LC 5E student worksheet, as shown in Figure 13.

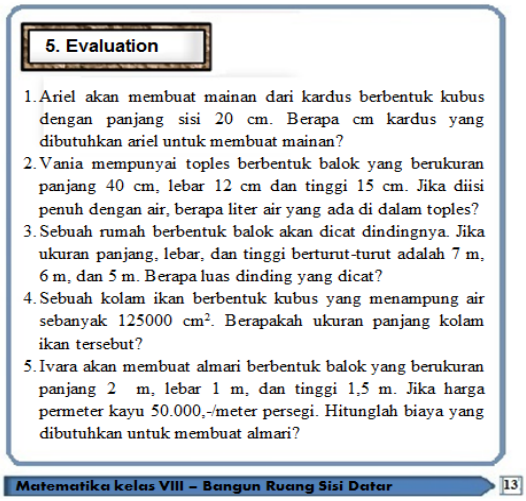

Fig. 13: Phase evaluation

4. Conclusion

The results of the analysis; obtainment of student worksheet covering the core competencies, basic competencies, graduation competency standards and mathematics materials were packaged based on the LC 5E model to provide a meaningful learning experience due to learning LC 5E there are structured learning steps that involve students actively so that the materials learned would be remembered in memory. The selected materials woke up a flat side room because many students only memorized the formula alone without knowing the origin of the formula [12]. The uses of student worksheets are to facilitate students in learning activities and provide opportunities for students to optimize the ability of integrated mathematical connections in the learning model LC 5E. From the result of the research, it can be concluded that the development of the mathematics student worksheet based on LC 5E learning model is up to the design stage. For the next stage, the researcher will proceed with the development, implementation and evaluation stage.

References

[1] NCTM, "Executive Summary Principles and Standards for School Mathematics Overview," 2000.

[2] Yan Wang KT & Jari Lavonen (2018), Aims for Learning 21st Century Competencies in National Primary Science Curricula in China and Finland. *EURASIA J. Math. Sci. Tech. Edu.* 14(6), pp. 2081–2095.

[3] Rohendi D (2012), Developing E-Learning Based on Animation Content for Improving Mathematical Connection Abilities in High School Students. *IJCSI Int. J. Comput. Sci* 9(4), pp. 1–5.

[4] Raja Maisyarah ES (2017), Mathematical Relation (Connecting Mathematical Ability) Students in Solving Mathematical Problems. *Int. J. Sci. Basic Appl. Res.*, December.

[5] Nenta Dumalia Siregar ES (2017), Analysis of Students' Junior High School Mathematical Connection Ability Analysis of Students' Junior High School Mathematical Connection Ability. *Int. J. Sci. Basic Appl. Res.* 33, pp. 309–320.

[6] Haji S, Abdullah MI, & Syafdi Maizora Y (2017), Developing Students' Ability Of Mathematical Connection Through Using Outdoor Mathematics Learning. *J. Math. Educ. Infin.* 6(1), pp. 11–20.

[7] Rustam GW & Bambang Sri Anggoro (2017), Influence of Anxiety Mathematically, Mathematical Connection Capabilities, and Independence Learning Against Math Learning Outcomes for PSTEP Students at Open University. *J. Educ. Pract.* 8(20), pp. 52–60.

[8] Rohendi D & Dulpaja J (2013), Connected Mathematics Project (CMP) Model Based on Presentation Media to the Mathematical Connection Ability of Junior High School Student. *J. Educ. Pract.* 4(4), pp. 17–22.

[9] García FJ & Bosch M (2006), Mathematical modelling as a tool for the connection of school mathematics. *Zdn* 38(3), pp. 226–246.

[10] Hendriana H, Slamet UR, & Sumarmo U (2014), Mathematical connection ability and self-confidence (an experiment on Hunior High School students through Contextual Teaching and learning with Mathematical Manipulative). *Int. J. Educ.* 8(1), pp. 1–11.

[11] Rusmini ES (2017), The Effect of Contextual Learning Approach to Mathematical Connection Ability and Student Self- Confidence Grade Viii Smp Negeri 8 Medan. *Int. J. Sci. Basic Appl. Res.*, 35(September), pp. 249–262.

[12] Asist. Prof. Dr. Abdulkadir TUNA PDAK (2013), The Effect Of 5e Learning Cycle Model In Teaching Trigonometry On Students' Academic Achievement And The Permanence Of Their Knowledge.

[13] Murat Tezer MC (2017), Mathematics through the 5E Instructional Model and Mathematical Modelling : The Geometrical Objects. *EURASIA J. Math. Sci. Technol. Educ.*, 8223(8), pp. 4789–4804.

[14] Liu T, Peng H, Wu W, and Lin M (2009), The Effects of Mobile Natural-science Learning Based on the 5E Learning Cycle : A Case Study. 12, pp. 344–358.

[15] Abdi A (2014), The Effect of Inquiry-based Learning Method on Students' Academic Achievement in Science Course. *Univers. J. Educ. Res.* 2(1), pp. 37–41.

[16] Runisah, Herman T & Dahlan JA (2017), Using the 5E learning cycle with metacognitive technique to enhance students' mathematical critical thinking skills. *Int. J. Emerg. Math. Educ.* 1(1), pp. 87–98.

[17] Sarı U, Hajiomer A, Güven K, & Faruk Ö (2017), Effects of the 5E Teaching Model Using Interactive Simulation on Achievement and Attitude in Physics Education. *Int. J. Innov. Sci. Math. Educ.* 25(3), pp. 20–35.

[18] Patrick OEB, Ajaja O & Urhievwejire (2012), Effects of 5E learning cycle on students' achievement in biology and chemistry. *Cypriot J. Educ. Sci.* 7(3), pp. 244–262.

[19] Madu BCPDACC (2012), Effect of Five-Step Learning Cycle Model on Students' Understanding of Concepts Related To Elasticity. *J. Educ. Pract.* 3(9), pp. 173–181.

[20] Hülya YILMAZ1 PHÇ (2006), The Effect Of The 4-E Learning Cycle Method On Students' Understanding Of Electricity. *J. TURKISH Sci. Educ.* 3(1), pp. 3–6.

[21] Bybee RW (2009), *THE BSCS 5E INSTRUCTIONAL MODEL AND 21ST CENTURY SKILLS*, January.

[22] Merdekawati S & Lestari HP (2011), Developing Student Worksheet In English Based On Constructivism Using Problem Solving Approach For Mathematics Learning On The Topic Of Social Arithmetics. *Int. Semin. Fourth Natl. Conf. Math. Educ. 2011 Dep. Math. Educ. Yogyakarta State Univ.*, pp. 978–979.

[23] SP and Susanti TTLB (2018), Validity of worksheet-based guided inquiry and mind mapping for training students ' creative thinking skills Validity of worksheet-based guided inquiry and mind mapping for training students ' creative thinking skills. *J. Phys. Conf. Ser. Pap.*

[24] Zulyadaini MP (2017), Development of Student Worksheets Based Realistic Mathematics Education (RME). *Int. J. Eng. Res. Dev.*, 13(9), pp. 1–14.

[25] Hill M & Sharma M (2015), Research-based worksheets on using multiple representations in science classrooms. *J. Aust. Sci. Teach. Assoc.* 61(3).

[26] Saragih S, Napitupulu EE, & Fauzi A (2017), Developing Learning Model Based on Local Culture and Instrument for Mathematical Higher Order Thinking Ability. *Int. Educ. Stud.* 10(6), pp. 114.

[27] Jones BA (2007), Instructional Design in a Business English Context, 1, pp. 683–696.

[28] Runtyani Irjayanti Putri RHS (2015), Keefektifan Strategi React Ditinjau Dari Prestasi Belajar,Kemampuan Penyelesaian Masalah, Koneksi Matematis, Self Efficacy. *J. Ris. Pendidik. Mat.* 2(November), pp. 262–272.

[29] Balci S, Cakiroglu J, & Tekkaya C (2006), Engagement, Exploration, Explanation, Extension, and Evaluation (5E). *Biochem. Mol. Biol. Educ.* 34(3), pp. 199–203.

[30] Science OST & Would T (1996), Implementing the Learning Cycle.