Development of E-Worksheet of Integration Technique Rational Functions Different Linear Factors to Improve Mathematical Creative Thinking Skills

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***Abstract*—The research aims to develop an e-worksheet technique to integrate an integral rational function of the factors of linear differences on integral calculus learning. The development of the e-worksheet is done using the model ADDIE. The subject in this research is the 3rd-semester students of Study Program of Mathematics Education, Faculty of Teacher Training and Science Straight of the Universitas Riau as many as 15 people. The data collection instrument for the research is questionnaire validation experts, students' questionnaire responses, and tests mathematical creative thinking ability. The Data obtained were analyzed by using quantitative descriptive analysis and qualitative. Based on the validity test results, the e-worksheet is valid and feasible to use the student on integral calculus. Judging from the results of the test of the practicality of e-worksheet, the average percentage of the value of the practicality of 83.89 and is in the category of very practical. Refer to the test results effectiveness of e-worksheet, the average n-gain the ability of creative thinking mathematically student of 0.54 and is located in the medium category. Because the e-worksheet technique is the integration of an integral rational function of the factors of different linear meets the criteria for validity, practicality, and effectiveness, it can be said that the e-worksheet technique is the integration of an integral rational function of the factors of linear different can be developed to improve the ability of creative mathematical thinking of students on the subject of integral calculus.**

Keywords—creative, development, e-worksheet, integral, thinking

I. INTRODUCTION

The emergence of the revolution of industry 4.0 influences the learning activities, whether it be from the way of learning, mindset, how to act, and the capabilities that need to be owned by the students after studying the material. Education aims to make the students understand the material being studied and learn to reason, think critically, creatively, and be literate. Moreover, in the field of mathematics, the application is very tightly with everyday life. Students who study mathematics must understand the material studied and should be able to apply the theory mathematically, mindset mathematically, and the ability mathematically as the ability of creative mathematical thinking. According to the statement [1], math can be used to develop creative thinking abilities, logic, systematic, cooperation, and discipline required to compete in today's modern world. When they study mathematics, students will know the correlation and pattern generalization of experience, so the effect on the increase creativity and awareness of students following the development of social culture [1].

Creative thinking can look at a problem from different angles to produce many alternatives to solve the problem. The ability to think creatively is a skill that can be trained and improved. The development of creative thinking skills needs to be done early to face various problems in real life [2]. In learning in the classroom, students can think creatively different, so the lecturer is expected to develop creative thinking skills through teaching and learning activities.

The importance of the ability to creative thinking mathematically was not in line with the reality that occurred. Score the ability of creative thinking mathematically achieved students on the material three-variable linear equation system that 53% were not creative category, 42% were less creative category, 2% were quite creative category, 3% were creative category, and no one in very creative category [3]. Kulsum, Hidayat, Wijaya, & Kumala obtain similar results, i.e., all of indicator of mathematical creative thinking skills on the sets material is in the low category [4]. Students capable of medium and low have not yet mastered all aspects of creative mathematical thinking.

From the results of such research, and to answer the challenges of the industrial revolution, the need for actions taken to develop the ability to think creatively. One of the tools that can facilitate the development of the ability of creative mathematical thinking is that worksheet. A worksheet is part of the learning device and can facilitate the achievement of creative mathematical thinking.

Use the worksheet can support the learning activities of students. A worksheet is one of the teaching materials, which contains instructions for implementing the learning task to be done by students, can help students to discover concepts and participate actively [5]. In line with this opinion, the use of the worksheet has several benefits, among others such as (a) create a learning process that is active for the students, (b) facilitate the students to develop the concept, (c) find and develop the teaching and learning process, (d) assist faculty in the preparation of the lesson, (e)

to be a reference for lecturers and students in teaching and learning activities, (f) to perform activities on the worksheet, the student will obtain records related to the studied material, (g) learning activities systematically on the worksheet also enrich the students with information related to the concept of the material studied [6].

Based on such benefits, lecturers need to develop a worksheet to facilitate their capabilities thoroughly on various aspects of learning such as aspects of self-regulated learning, aspects of reasoning, aspects of the investigation, aspects of creativity, and aspects of problem-solving, in accordance with the statement of the Umriani, Suparman, Hairun, & Sari that the worksheet can be designed to improve the ability of creative mathematical thinking [7]. This opinion is also in line with the statement of Agustina, Rahayu, & Yuliani that student worksheets based on STEM (Science, Technology, Engineering, Mathematics) are effective to improve student's creative thinking skills [8].

The above description means e-worksheet is one of the learning tools that require the design the better. The activity of designing a worksheet to develop the ability of creative thinking mathematically has been done by other researchers. As research conducted by Zulyadaini obtained the result that the students' worksheet based on contextual teaching and learning according to the validation of the expert is of good quality. Meanwhile, from the students; responses, it was found that the e-worksheet was practical. Therefore, the e-worksheet is suitable for use in factorization material algebra [9]. Other researchers developing worksheets, namely Kurniawati & Suparman. From the research, obtained mathematics worksheets uses RME approach to improve communication meet the criterion for a valid [10]. The difference between these studies with a research study done is that worksheet is developed for a worksheet that can be accessed online. In addition, the development of e-worksheet will be focused on facilitating the ability of creative mathematical thinking. Therefore, researchers are interested in developing convenient online learning in e-worksheet to facilitate students' creative thinking skills on Integral Calculus.

II. Literature Review

Learning tools are tools or equipment to carry out a process that allows educators and learners to learn activities [11]. Learning plans can be designed through RPS and SAP. While planning, the learning can be done by setting up the media, learning resources, assessment tools, and the worksheet.

Worksheet Students is also one of the learning tools that can support learning activities. A worksheet is one of the teaching materials, which contains instructions for implementing the learning task to be done by students, can help students to discover concepts and participate actively [5]. Based on this opinion, then the use of the worksheet has several advantages, such as (a) enable students in the learning process, (b) assist students in developing the concept, (c) training students to find and develop the teaching and learning process, (d) assist faculty in preparing the lesson, (e) as a guideline for lecturers and students in carrying out the learning process, (f) help students obtain the notes about the material learned through learning activities, (g) help students to add information about the concepts learned through the learning activities in a systematic [6].

Learning tools developed in this research are online learning to improve the ability of creative mathematical thinking. According to Guilford, thinking creative as the ability to see a variety of possible resolutions to a problem [12]. Meanwhile, according to [13], the ability of creative thinking is the belief and intuition of a person related to the mathematical ideas prepared to develop strategies for solving mathematical problems. The traits of the skills of creative thinking is as follows: 1) fluency, 2) flexibility, 3) originality, 4) elaboration [14].

According to [15], creativity is required of students and is considered important to increase students' capacity and academic achievement. Therefore, it needs a strategy for learning mathematics oriented on the activities of forming students ' creativity. According to Davis, there are six reasons why learning math is need to emphasize creativity, namely: (1) Mathematics is so complex and extensive to be taught by rote, (2) Students can find the solutions of the original (*the original*) while solving problems, (3) Teachers need to respond to the contributions to the students the original and surprise (*surprised*), (4) mathematics Learning by rote and the routine problem will make the students motivated and reduce its ability, (5) Authenticity is something that needs to be taught, like making proof of the original from theorem, (6) everyday real Life require mathematical and requires creativity in getting it done [16].

Efforts to develop creative thinking skills can be made by assigning the form of the questions non-routine, so students will be trained to cultivate the ability to think creatively [17]. Questions are non-routine that the student can do with the help of the learning group. The effort to develop the ability to think creatively can be packed in a worksheet. Related worksheet developed and the creative aspect that has been mentioned. In this study, the worksheet is developed e-worksheet to facilitate creative thinking mathematically related aspects of fluency, flexibility, and originality.

III. Methods

This research was conducted in the Study Program of Mathematics Education, Faculty of Teacher Training and Education, Universitas Riau. The research conducted is a type of research development. The development online learning uses a model ADDIE with five stages, namely Analysis, Design, Development, Implementation, and Evaluation [18].

Tahap *Analysis* is the stage to find the problems that occur in the learning process. Based on the problems encountered, namely the need to facilitate the development of mathematical creative thinking abilities of students, researchers decided to learn tools that fit the needs of the students are learning tools online that can optimize the ability of creative mathematical thinking. Learning tools online that will be created in this study is the e-worksheet. At the design stage, the design process e-worksheet with the option to set the learning material chosen is the technique of integration of an integral rational function of the factors of linear difference and the format of the e-worksheet. The next stage of *development*, the draft e-worksheet embodied in the e-worksheet according to the format defined previously. E-Worksheet has been made and then rated by two-person validator experts. Data analysis of the validation results is done by determining the average score of the

aspects of the e-worksheet to facilitate the ability of creative mathematical thinking.

The determination of the e-worksheet validity category referring to the e-worksheet validity category proposed by [19]. If the average validity score is from 1 to 1.75, then the category is less valid. If the average validity score is more than 1.75 to 2.5, then the category is quite valid. If the average validity score is more than 2.5 to 3.25, then the category is valid. If the average validity score is more than 3.25 to 4, then the category is very valid.

Ratings, suggestions, and improvement of both the validator used to improve the e-worksheet. Furthermore, the e-worksheet that has been fixed according to the advice validator was tested in small groups of 5 students. Students are given an e-worksheet and asked to fill out a questionnaire response against the use of e-worksheet. Based on the results of a small group trial, I obtained suggestions for improving the e-worksheet. Then, the e-worksheet was repaired according to the advice given to students.

On the *Implementation*, the researcher did the test e-worksheet to a large group of 15 students. Before giving the e-worksheet to students, researchers gave about the ability of creative mathematical thinking to the student to know the level of mathematical creative thinking abilities of students. Researchers then calculate the pretest score obtained by each student. Next, the researchers gave the e-worksheet to 15 students to learn. The researcher asked the students to fill in their questionnaire responses based on their experience learning to use e-worksheet.

Next, the researcher gave a post-test to the students to measure mathematical creative thinking ability achievement after using the e-worksheet. Next is the evaluation. Stage *Evaluation* is the process to analyze the results of experiments performed on the stage of *Implementation*. The results of this analysis obtained the size of the practicality and effectiveness of the e-worksheet. To determine the practicality of the e-worksheet, the scores obtained from students' questionnaire responses transformed into the form of a percentage regarding the [20]. The formula used is as follows in:

$$p = \frac{t}{m} \times 100\%, \quad (1)$$

where t is the total score of the students' answers, and m is the total score of a maximum of hope. Results the percentage is then classified into the criteria of the practicality of e-worksheet, referring to [20]. If the practicality proportion is from 0 to 20, then the practicality level is very impractical. If the proportion of practicality is more than 20 to 40, then the practicality level is impractical. If the proportion of practicality is more than 40 to 60, then the practicality level is less practical. If the proportion of practicality is more than 60 to 80, then the practicality level is practical. If the proportion of practicality is more than 80 to 100, then the practicality level is very practical.

The effectiveness of the e-worksheet was obtained from a score of n-gain using the following formula.

$$g = \frac{score\ posttest - pretest\ score}{maximum\ score - pretest\ score}. \quad (2)$$

After getting the magnitude of the n-gain, determined the levels of n-gain of students. The level of high and low n-gain are grouped based on the following criteria. If the n-gain is less than 0.3, then the n-gain is in the low category. If the n-gain is more than or equal to 0.3 and less than 0.7, then the n-gain is in the medium category. If the n-gain is more than or equal to 0.7 then the n-gain is in the high category.

Data collection was performed by administering a questionnaire to the validator and students. Based on the stages of research, the research instrument used is validation form by the validator, test the ability of creative mathematical thinking, and questionnaire responses of students.

IV. Results And Discussion

E-Worksheet technique integrates an integral rational function of factors linear contrast can be seen feasibility of the elements of validity, practicality, and effectiveness. The results of the validation e-worksheet by two experts can be seen in the following Table I.

Based on Table I, from 18 of the statement, 12 of the statement category is valid, whereas six are very valid. Viewed from the aspect to measure the validity of the e-worksheet, from 6 aspects three aspects belong to the category of valid, while the three aspects longer have the category of very valid. The overall mean e-worksheet technique is the integration of an integral rational function of the factors of linear difference is valid and can be used to the students in the course of integral calculus.

After the validator considers the questionnaire, the questionnaire is piloted to a small group of 5 students. From small groups, the researchers obtain suggestions for improvement related to typing errors on the e-worksheet. Researchers then fix the e-worksheet according to the advice of the student. Next, the e-worksheet that has been fixed is tested in a large group consisting of 15 students. Before the e-worksheet is given to students, researchers first test the ability of creative mathematical thinking to 15 students. After obtaining a pretest score, the e-worksheet is then given to the students to learn and do along with the questionnaire responses of the use of the e-worksheet. The score of the students ' answers on the questionnaire was used to measure the practicality of the e-worksheet. The results of the response of the students can be seen in the following Table II.

Based on the score of students' questionnaire responses towards e-worksheet, it is seen that from a 12-item assessment of the practicality, 2 grain belongs to the category of practical. In comparison, ten other grain belongs to the category of very practical. Overall, the assessment of the practicality of e-worksheet value 50.33 with a percentage of 83.89% belongs to the very practical category. Therefore, it can be said e-worksheet developed already meets the criteria of practicality.

TABLE I. THE RESULTS OF THE VALIDATION E- WORKSHEET TECHNIQUES OF INTEGRATION

Item Assessment	Value of the Validator		Average	Description
	V1	*V2*		
Contents				
The Suitability of the e-worksheet with the Learning Outcomes of course (CPMK)	4	3	3.5	Very Valid
E-worksheet under the learning objectives to be achieved	4	3	3.5	Very Valid
E-worksheet under the substance of the material	3	3	3	Valid
E-worksheet following the needs of students	3	3	3	Valid
Average Aspect 1			3.25	Valid
Learning				
E-worksheet put the student as a subject	4	4	4	Very Valid
E-worksheet participatory	3	3	3	Valid
E-worksheet are interactive for students	3	3	3	Valid
Average Aspect 2			3.33	Very Valid
Mathematical Creative Thinking Abilities				
Work Procedures to support the achievement of the ability to think creatively	3	3	3	Valid
Practice problems support the achievement of the ability to think creatively	3	3	3	Valid
Average Aspects 3			3	Valid
Physical Appearance				
the Appearance of the e-worksheet interesting	3	4	3.5	Very Valid
The form and size of the font is easy to read	4	3	3.5	Very Valid
Form and size of the font that is used consistently	4	4	4	Very Valid
Average Aspect to the-4			3.67	Very Valid
Linguistic				
The structure of the sentences used clear	3	3	3	Valid
Language used communicative	3	3	3	Valid
The language used under the EYD	3	3	3	Valid
Average Aspect 5			3	Valid
Layout				
Layout the contents of the e-worksheet consistent	3	4	3.5	Very Valid
content layout e-worksheet harmony	3	3	3	Valid
Composition and the selection of attractive colors	3	4	3.5	Very Valid
Average Aspect 6			3.33	Very Valid

TABLE II. THE RESULTS OF THE RESPONSE OF STUDENTS TOWARDS THE USE OF E-WORKSHEET

No	Statement	Total NK	p (%)	Category
1	E-worksheet that use interesting	51	85	Very Practical
2	E- worksheet used can enhance the spirit of learning	48	80	Practical
3	The Shape and size of the letters on the e- worksheet easy-to-read	51	85	Very Practical
4	E-worksheet include time allocation	50	83.33	Very Practical
5	The material covered on the e-worksheet appropriate learning objectives	52	86.67	Very Practical
6	E- worksheet help me to master the material integration techniques	52	86.67	Very Practical
7	Questions in the e-worksheet challenging to do	52	86.67	Very Practical
8	e- worksheet facilitates the ability of creative thinking mathematically	52	86.67	Very Practical
9	I don't feel any difficulty in using e- worksheet is	42	70	Practical
10	The use of an e-worksheet adds to the learning experience I	53	88.33	Very Practical
11	E- worksheet help me to achieve the learning objectives in the material studied	52	86.67	Very Practical
12	The language used in the e-worksheet is clear, coherent, and easy to understand	49	81.67	Very Practical
Average		50.33	83.89	Very Practical

TABLE III. THE ACQUISITION OF THE SCORE OF THE MATHEMATICAL CREATIVE THINKING ABILITY

The Students	Score				Category
	Pretest	*Posttest*	*Gain*	*N-Gain*	
M1	5	9	4	0.57	Medium
M2	0	5	5	0.42	Medium
M3	6	12	6	1.00	High
M4	4	8	4	0.50	Medium
M5	0	7	7	0.58	Medium
M6	2	10	8	0.80	High
M7	1	4	3	0.27	Low
M8	3	7	4	0.44	Medium
M9	2	5	3	0.30	Medium
M10	6	8	2	0.33	Medium
M11	5	11	6	0.86	High
M12	1	5	4	0.36	Medium
M13	0	4	4	0.33	Medium
M14	3	8	5	0.56	Medium
M15	3	10	7	0.78	High
Average	**2.73**	**7.53**	**4.8**	**0.54**	**Medium**

Testing effectiveness of e-worksheet seen from the increase in the ability of creative mathematical thinking of students after the given e-worksheet technique is the integration of an integral rational function of the factors of linear different, compared to before the given e-worksheet. Furthermore, to view the increased categories, a large n-gain compared with the criteria of n-gain is predetermined. The results of the calculations related to the scores of mathematical creative thinking abilities of students can be seen in the following Table III.

Based on Table III, it is seen that the five-fifteen students have increased their mathematical creative thinking ability. Category improvement of mathematical creative thinking abilities of the students is in the category of the low, medium, and high. Overall, the average score of pretest 15 students amounted to 2.73, while the average post-test score was 7.53. This means an increase in the average score of the pretest to the posttest is 4.8. Based on the calculation of n-gain, the obtained n-gain of 0.54 with medium category. This means that the ability of creative thinking of

students from before the given e-worksheet with after the given e-worksheet increased with the medium category.

Referring to the results of this study, the mean e-worksheet integration techniques are developed to be used and can improve the ability of creative mathematical thinking of students. This is by research results that have been obtained by previous researchers, namely the developed mathematics worksheets have advantages in terms of increasing students' creativity in algebraic material. This is because each question on the worksheet contains indicators of creative thinking and the worksheet integrates a guided discovery-base learning approach [21].

V. Conclusion And Recommendations

Research development in which this was done generates e-worksheet is the integration technique of an integral rational function of the linear factors differs on integral calculus. Product development is done using the development model of ADDIE. Judging from the results of the test of the validity of the e-worksheet conducted by the two experts, the e-worksheet technique is the integration of an integral rational function of the factors of linear different have been declared valid and feasible to use the student on the subject of integral calculus. Based on the test results of the practicality of e-worksheet by using questionnaire responses of students after using the e-worksheet, in general, the e-worksheet technique is the integration of an integral rational function of the factors of linear difference has to meet the criteria of practicality. It can be seen from the average percentage of the value of the practicality of 83.89 and is in the category of very practical. Refer to the test results effectiveness e-worksheet, the results showed that e-worksheet technique is the integration of an integral rational function of factors linear contrast is effective to use and can improve the ability of creative mathematical thinking. This look from the average n-gain the ability of creative thinking mathematically student of 0.54 and is located in the medium category. Because the e-worksheet technique is the integration of an integral rational function of the factors of different linear meets the criteria for validity, practicality, and effectiveness, it can be said that the e-worksheet technique is the integration of an integral rational function of the factors of linear different can be developed to improve the ability of creative mathematical thinking of students on the subject of integral calculus.

Refer to the results of the students' questionnaire responses, there is a statement who earns an average score under 80, that the statement "I do not feel difficulty in using the e-worksheet". Based on the results of interviews with students, acquired causes students feeling difficulty using e-LKM. This is because students are not accustomed to using a google doc in doing a worksheet. In addition, the limitations of the equation in the google doc also cause students difficulty doing e-worksheet.

Refer to the research results and the limitations of existing research, the researchers provide recommendations for other researchers in the same field. First, e-worksheet techniques of integration courses integral calculus this only discuss one topic an integral rational function of the factors of different linear course. Therefore, the material in the e-worksheet can still be expanded, not limited to the technique of integration course. Second, the e-worksheet integral calculus can be developed to improve the ability of creative mathematical thinking. E- worksheet is still to be developed to improve the ability to think of the other high-level. Third, before the students are given an e-worksheet, a good lecturer provides socialization related to using the google doc not to be confused when working on a google doc. Fourth, an e-worksheet not only can be developed using a google doc. Other researchers can develop e-worksheet using another application that students efficiently use.

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