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CREATIVE THINKING SKILLS OF STUDENT IS TRAINED BY THE DEVELOPMENT OF STUDENT WORKSHEET BASED ON MODIFIED INQUIRY IN BUFFER SOLUTION MATTER

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Abstract

Student worksheet based on Modified Inquiry generated in this study aims to gain students' creative thinking skills on the buffer solution. This research uses development design according to Thiagarajan and Semmel theory (1967) that is 4-D development model (four D). The 4-D development design includes define, design, develop and diseminate. But in this study limited to development stage. The validation result of student worksheet 1 preparation of buffer solution, worksheet 2 characteristic of acid buffer solution and worksheet 3 characteristic of base buffer solution are contents criteria get 84.45% in very feasible category, linguistic criteria get 82.22% with very feasible category, the presentation criteria get 82.22% with very decent category, and the graffiti criteria get 78.33% with decent category. Student response to worksheet get 90.92% in very good category. This is supported by student activity that indicates an average relevant activity is 98.32%. The result of the students' creative thinking test showed that all students get the above of KKM with the average percentage of fluency is 92.73%, the average percentage of flexibility is 91.64%, the average percentage of elaboration is 86, 88% and the average percentage of originality is 91.11%. These four characteristics are in very high category.
Keywords: Student worksheet, Modified Inquiry, Creative Thinking Skills, Buffer Solutions

INTRODUCTION

The results of pre-research conducted at SMAN 1 Krian on September 27, 2017 showed that flueccy thinking skills in formulating problems was 45.5%, flexibility thinking skills in formulating hypothesis was 46.1%, fluency and flexibility thinking skills in determining variable was 24.7%, elaboration thinking skill in analyzing data was 39.8% and originality thinking skill in making conclusion was 47.5%. Based on the results, creative thinking skills need to be trained in the learning process. This is in line with Permendikbud No. 22 year 2016 on the Standard Process of Primary and Secondary Education states that the learning process is held interactively, inspiration, fun, challenging, motivate students to participate actively, and provide sufficient space for initiative, creativity, and independence according to talents, interests and development physical as well as psychological students [1].

Based on Permendikbud's demands, students should be given space to train creative thinking skills. Creative thinking is a problem-solving process that can lead to creative solutions to existing problems, while Guilford considers creative thinking as divergent thinking, a process of creating many ideas about a particular subject in a short time [2]. Creative thinking skills need to be trained in the learning process because divergent thinking still lacks of attention in formal education [3]. Guilford and Torrance determine four characteristics of creative thinking that include originality, fluency, flexibility, and elaboration [2].

Creative thinking skills can be trained in the learning process by using the appropriate learning model. One of the appropriate learning models is based on disclosure or research model. In this case, the appropritae learning model is an inquiry model.

The inquiry learning model that is considered appropriate to trained students' creative thinking skills is modified inquiry. In this model, students are facilitated to identify problems and design process of inquiry and teachers only act as facilitators. Thus, with this model, it is expected to be able to train students' creative thinking skill.

Stages of inquiry learning should be implicated in teaching materials used by students,

one of them is student worksheet. Based on the results of pre-research at SMAN 1 Krian, 92% of students stated that the student workshet only contains a summary of material and exercise questions. This is reinforced by an interview with a chemistry teacher at SMAN 1 Krian stating that the student worksheet contains a few of questions and has not been able to train critical and creative thinking. So it needs an student worksheet that can train students to find ideas. One of the chemicals that can provide a direct learning experience and train students' creative thinking skills is the material of the buffer solution.

The experiment guidance in the buffer solution material does not trace a series of scientific methods of investigation. Whereas based on pre-research results 86.67% of students need worksheet containing phenomena that can be solved by a series of scientific methods.

Based on the description above, student needs worksheet that provides an opportunity to conduct research in accordance with scientific methods by presenting the phenomenon in daily life and students are given space to determine how to solve the problems contained in the phenomenon and can find the concept of solution buffer itself with these lab activities. The task analysis is used to train creative thinking skills consists of observing the phenomenon, formulating the problem, dtermining the hypothesis, defining variables, defining tools and materials, developing trial procedures, analyzing and making conclusion [4]. Thus student worksheet can train students' creative thinking skills.

METHOD

The type of this research is development research of education. It is development of student worksheet based on modified inquiry to train student creative thinking skills on buffer solution. The development of student worksheet uses the 4-D (four D) design [5]. The 4-D design includes, define, design, develop and diseminate. In this research, the dissemination stage is not carried out, but limited trial will be conducted to 12 students of SMA Negeri Krian Class XII to know the practicality and effectiveness of student worksheet developed to produce the proper teaching materials.

In this research, there are three kinds of student worksheet that developed. Student Worksheet 1 about preparing buffer solution. In this worksheet, student make acid or base buffer solution and test the solution that has been made to prove it buffer or not. Student worksheet 2 about characteristic of acid buffer solution and srudent worksheet 3 about chaarcteristic of base buffer solution. In the workseet 2 and 3, student learn about characteristic of acid and base buffer solution when it is added by some of solutions in same volume or same solution with different volume. So, student can explain about buffer solution matter after using the worksheet.

The developed student worksheet which is draft I is reviewed by one lecturer of Chemistry Education Program. After getting input, the student worksheet was revised hereinafter referred to as draft II and assessed by three validators, namely 2 lecturers of Chemistry Education Study Program and 1 chemistry teacher by giving score based on following likert scale.

Table 1. likert scale

Category	Value Scale
Very appropriate	4
appropriate	3
Enough appropriate	2
Less appropriate	1
Not appropriate	0

[6]

The results of the validator assessment are then interpreted in accordance with Table 2 below.

Table 2. Interpretating Score

Value Scale	Category
0%-2%	Not appropriate
25%-40%	Less appropriate
41%-60%	Enough appropriate
61%-80%	Appropriate
81%-100%	Very appropriate

[6]

Based on these criteria, then the developed Assessment is said to be feasible if every aspect gets the percentage of assessment results of ≥ 61%. The result data of this student response is calculated based on Guttman scale as in Table 3.

Table 3. Guttman Scale

Answer	Scale
Yes	1
No	0

[6]

Then the results are interpreted in accordance with Table 2 and the developed Assessment is said to be practical if the percentage of assessment results obtained ≥ 61%.

While student activity is calculated with the following formula:

(%) Student activity = $\frac{\sum \text{frequency of appears } activity}{\sum total\ frequency}$ x 100% [7]

Student activity said to be performed well and supports the effectiveness of student worksheet in training students' creative thinking skills if the percentage of relevant student activities is greater than irrelevant student activity.

The test of creative thinking includes Originality, Fluency, Flexibility, and Elaboration. Every component of creative thinking is calculated by using the following formula:

Average percentage of each characteristic of creative thinking skills = $\frac{total\ score\ that\ gained}{total\ score}$ x100%

The average percentage of each component of creative thinking is further interpreted in accordance with Table 4 below.

Table 4. Interpretating Score

Value Scale	Category
0%-30%	Very low
31%-54%	Low
55%-74%	Normal
75%-89%	High
90%-100%	Very high

[6]

RESULTS AND DISCUSSIONS

Review result of Student Worksheet

The students' activity sheet developed is examined Student Worksheet Review Results**.** Student worksheet developed consists of preparation of buffer solution, characteristic of acid buffer Solution, and characteristic of base buffer solution which is then referred to as draft I which is reviewed by lecturer of Chemical Education. The result of the review is in the form of input related to the background of student worksheet, the animation used in the student worksheet should reflect the human being creative thinking, the provision of the source of the image on the cover of the student worksheet, the use of learning resources in the supporting information section must clearly and justifiable reference of truth, giving the definition of manipulation, response, and control variables, and improvements in writing in English. Then the student worksheet is revised according to the input of the reviewers and referred to as draft II.

The Validity Result of Student Worksheet

Student worksheet which is a draft II validated by two lecturers of Chemistry Education and one chemistry teacher of SMA Negeri 1 Krian. Validation results can be seen in Table 5.

Table 5. The Validation Result of Student Worksheet 1 Preparing Buffer Solution

No.	Aspects Assessed	The Average Score Percentage (%) and Category
1.	Content	84.45 % (VE)
2.	Linguistic	82.22 % (VE)
3.	Presentation	82.22 % (VE)
4.	graffiti	78.33 % (E)

Table 6. The Validation Result of Student Worksheet 2 Characteristic Acid Buffer Solution

No.	Aspects Assessed	The Average Score Percentage (%) and Category
1.	Content	84.45 % (VE)
2.	Linguistic	82.22 % (VE)
3.	Presentation	82.22 % (VE)
4.	graffiti	78.33 % (E)

Table 7. The Validation Result of Student Worksheet 3 Characteristic Base Buffer Solution

No.	Aspects Assessed	The Average Score Percentage (%) and Category
1.	Content	84.45 % (VE)
2.	Linguistic	82.22 % (VE)
3.	Presentation	82.22 % (VE)
4.	graffiti	78.33 % (E)

Description of the category: NE :Not Eligible, LE: Less Eligible, FE: Fairly Eligible. E= Eligible, and VE= Very Eligible

Based on table above, student worksheet 1, student worksheet 2, and student worksheet 3 have same score in all aspects of validity. it can be seen that the developed student worksheet is in the category very feasible for the criteria of content, language, and presentation as well as criteria of graffiti that are in the category worthy. There are 6 aspects of content criteria where 4 aspects are in very decent category and two aspects are in the category worthy. This is because at the 4-D development stage by Thiagarajan, the planning stage (define) is done front-end analysis, namely

curriculum analysis, concept analysis, and indicator sepsifikasi analysis. Thus, the basic competencies, indicators, and buffer solution materials contained in the student worksheet have been in accordance with the Curriculum 2013 and the student worksheet has been in accordance with the modified inqury or semi-guided inquiry stages according to Joyce [8].

In the linguistic criteria there are 3 aspects where the two aspects are in the category worthy with the percentage of 80.00% and 1 are in very decent category with the percentage of 86.67%, namely the aspect of writing student worksheet using a short and clear language. If the student worksheet is written using a short and clear language and easy to understand, it will facilitate students in doing activities in the student worksheet, so students are not confused and can learn the material of the buffer solution easily.

In the presentation criteria there are 6 aspects where 2 aspects are in very decent category and 4 is on category is eligible. One aspect of the presentation criteria is the presentation of the appropriate image that gains the category worth by 80% percentage. This is because the student worksheet uses pictures showing the role of buffer solutions, such as images of mouth, blood, and citric acid contained in oranges. The blood contains a carbonate buffer, hemoglobin, and phosphate to maintain a fixed blood pH in the range of 7.4-7.8. Darmodjo and Kaligis stated that a good image for student worksheet is an image that can convey the message or content of the image effectively to the student worksheet users [9].

There are 4 aspects of graffiti criteria where 3 aspects are in decent category and 1 aspect with decent category. One aspect of this criterion, Cover draws and presents the contents of student worksheet mendatkan input from the validator to change the color of the cover with a soft color that makes students more motivated in learning and not boring.

Results of Student Response

Student response data is used to determine the practicality of the developed student worksheet. Students will be given student response sheets containing some questions related to content criteria, criterion of language, presentation criteria, and criteria of graft from student worksheet. The result of student response questionnaire can be seen in Table 8.

Table 8. The Result of Student Response

No.	Aspects Assessed	The Average Score Percentage (%) and Category
1.	Content	95.00 % (VG)
2.	Linguistic	87.50 % (VG)
3.	Presentation	87.45 % (VG)
4.	graffiti	93.75 % (VG)

Description: VG = Very Good

Based on Table 6, all aspects of the student response questionnaire include criteria of content, language, presentation, and graffism are in very good category. These four aspects are a very important entity. These four aspects indicate that the students understand the buffer solution material contained in the student worksheet.

Student Activity Data

Observation of student activity aimed to know the activity of student during limited trial to student worksheet which have been developed. Observation of student activity conducted by two observers. Data of student activity observation result is supporting data for student response to know the practicality of student worksheet developed. Table 7 below is the result of observation of student activity as a whole.

Table 9. Observation Data on Student Activity

No.	Meeting	The Average Score Percentage (%) and Category
1.	In a limited trial of student worksheet 1	97.50% (Very Good)
2.	In a limited trial of student worksheet 2	98.29% (Very Good)
4.	On a limited trial of student worksheet 3	99.18% (Very Good)

Based on the data in Table 9, it can be seen that during the limited trials of student worksheet based on modified inquiry to trained students 'creative thinking skills on the percentage of support materials for the greater percentage of students' relevant activities. This shows the students are enthusiastic and interested in the developed student worksheet.

Results of the Student Creative Thinking Skills Tests

The result of the students 'creative thinking skill test is used to know the effectiveness of the student worksheet and posttest given to the

students after using the student worksheet based modified inquiry to trained students' creative thinking skills on the buffer solution material. Test of student creative thinking skills consist of observing the phenomenon, formulating the problem, dtermining the hypothesis, defining variables, defining tools and materials, developing trial procedures, analyzing and making conclusion.

There are four characteristic of creative thinking skill, including fluency, flexibility, elaboration, and originality.

Fluency

Characteristics of fluency thinking are found in determining research variables, problem formulation, and formulating hypotheses. In the limited trial of student worksheet, fluency has been train in phase three of inquiry namely student formulate hypotheses to explain the problem or event [10]. The percentage of fluency increases from posttest 1 to 3, the percentages are 89.50%, 92.78%, and 95.92%. Creative thinking skill is the ability to trigger many ideas, ideas, answers, problem solving, provide many ways or suggestions to do many things [2]. Students are given the opportunity to convey their ideas and ideas in determining how to test buffer solutions, such as by adding different amounts of acid, base, or water solution or by adding different solutions of the same volume.

Flexibility

Determination of variables, problem formulation, formulating hypotheses can also contain the characteristics of flexible thinking not just the characteristics of fluency thinking. In addition to these three components, the characteristics of flexibility can be seen in the planning of investigation and processing data. This is because flexibility g is the ability to generate various ideas, answers, or questions and be able to see a problem from a different point of view [2]. The student's creative thinking step in the verification stage was developed in phase IV of the inquiry model syntax, which is to test the hypothesis [11]. Characteristics of flexible thinking can also be seen from students' ability to plan investigations and process data. This is supported by Schlenker who states that with inquiry, students can improve science, be productive in creative thinking and more skilled in obtaining and analyzing information [12]. Table 10 below is a result of a test of students' creative thinking skills on the characteristics of flexible thinking on a limited trial.

Table 10. The result of flexibility thinking skill

No.	The Result of	The average percentage (%) of flexibility
1.	*Posttest* 1	87.03
2.	*Posttest* 2	91.98
4.	*Posttest* 3	95.90

Elaboration

Elaboration exists in data analysis. Elaboration is the ability to develop ideas by detailing the details and expanding ideas [2]. This is in accordance with the data analysis, where in the data analysis there are several questions that help students in detailing the analysis of the results of experiments they get. This is also in accordance with semi-guided inquiry learning, where inquiry is an investigation activity conducted by students in solving existing problems by generating valid or valid solutions or valid solutions based on existing theories and supported by experimental evidence [13].

Thus, students will analyze the results of the experiments and combine them with answers to questions on data analysis, at which point students' elaboration thinking skills are trained. In this section, students will understand the buffer solution and how the nature and working principle of the acid and base buffer solution in maintaining its pH. Table 11 below is the result of a student's creative thinking skill test on the characteristics of elaboration thinking in a limited trial.

Table 11. The result of elaboration thinking skill

No.	The Result of	The average percentage (%) of elaboration
1.	*Posttest* 1	77.31
2.	*Posttest* 2	87.50
4.	*Posttest* 3	95.83

Originality

Originality exists in planning investigations and drawing conclusions. Thinking originality is the ability to give birth to new and unique expressions and be able to make combinations of parts or elements [2]. In this case according to formulate the formulation of the problem, the activity of planning the investigation and draw conclusions. Table 12 below is the result of a test of students' creative

thinking skills on the characteristics of originality thinking on a limited trial.

Table 12. The result of originality thinking skill

No.	The Result of	The average percentage (%) of originality
1.	*Posttest* 1	85.96
2.	*Posttest* 2	91.53
3.	*Posttest* 3	95.14

Drawing conclusions should be based on experimental results and existing theories regarding buffer solution materials. The auxiliary solution is a solution whose pH is unchanged but is added slightly acidic, alkaline or diluted [14]. In addition, the buffer solution has the nature and working principle of maintaining the pH. Based on the results of these experiments and existing theories students can draw conclusions correctly.

Based on the result of the students 'creative thinking skill test, it can be seen that all the students get the above the minimum score at SMA Negeri 1 Krian, that is ≥75 and it can be concluded that student worksheet based modified inquiry to train students' creative thinking skill on the developed buffer material fulfill the criteria of effectiveness.

It's supported by the research result of Rahayu and Yonata, that creative thinking skill successfully trained by implementation of semi-guided inquiry learning model with demonstration-experiments method [4].

CLOSURE

Conclusion

Based on the discussion it can be concluded that:

1. The validation result of student worksheet 1 preparation of buffer solution, student worksheet 2 Nachaarcteristic of acid buffer solution and student worksheet 3 of characteristic of base buffer solution for the content criteria is 84.45% with very feasible category, linguistic criteria is 82.22% with very reasonable category, criteria presentation is 82.22% with very decent category, and the criterion of graffiti is 78.33% with decent category. This indicates that the student worksheet meet the criteria of validity.
2. Student's response to student worksheet content gets percentage of 95.00%, criterion of language gets percentage equal to 87.50%, presentation criterion gets percentage equal to 87.45%, and criterion of keqjian gets percentage equal to 93.75% where all criterion are at category is very good.
3. Student activity during student worksheet limited trials showed that the student's relevant activity was 97.50% at the first meeting, 98.29% at the second meeting, and the third meeting was 99.18%.
4. The result of the students 'creative thinking skill test shows that all students get the above minimum score, that is ≥ 75 with the result of the students' creative thinking skill test shows all students get the above minimum score with percentage characteristic of average thinking is 92.73%, percentage of characteristic average thinking is 91.64%, the percentage of characteristic of elaboration thinking is 86.88% and the average of characteristic of average thinking is 91.11%. These four characteristics are in very high category.

Suggestion

Further research is expected to desiminate stage, involving sub-chapter pH calculation of buffer solution, and when starting the lesson teacher should gives phenomenon in daily life so that students are motivated in learning, especially in buffer solution matter.

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