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THE DEVELOPMENT OF STUDENTS WORKSHEET ORIENTED PROBLEM SOLVING TO TRAIN CREATIVE THINKING SKILLS IN ACID BASE MATTER FOR 11th GRADE

Utari Ika Cahyani, *Harun Nasrudin, and Bertha Yonata
Chemistry Department FMIPA Universitas Negeri Surabaya
***Email:** harunnasrudin@unesa.ac.id

Abstract

This research aims to produce student worksheet oriented problem solving to train creative thinking skills in an acid base matter for 11th grade that is feasible. Feasibility of student worksheet can be known from its validity, practicality, and effectiveness. Development of the worksheet refers to the Research & Development (R&D) model limited to the trial stage. The validity of the worksheet consists of content validity and construct validity. Content validity in worksheet 1, 2, and 3 have percentage respectively 88.00%, 88.00%, and 86.67%. Construct validity includes a linguistic, presentation, and graphics criteria. Result that got respectively for each worksheet 1, 2, and 3 for language criteria 86.67%, presentation criteria 87.78%, 87.78%, and 86.67%, graphical criteria 88.00%, 86.67%, and 86.67% with highly valid categories. The practicality of the worksheet is determined by the observation of students activities which got a percentage of 100% and students' responses in terms of the criteria of content, linguistic, presentation, and graphics get the percentage of 98.33%, 100%, 98.00%, and 100%. The effectiveness of the worksheet in terms of increasing results of pretest and posttest in creative thinking skills for each student using the N-Gain Score formula and obtained the value $\langle g \rangle \geq 0.7$ with high categories and for creative thinking classically obtained from the assessment of each component of creative thinking skills respectively for fluent and flexible thinking skills get the same percentage which is equal to 94% with very high categories while original and detailed thinking skills get the same percentage that is equal to 81% with a high category. The worksheet can be stated that feasible to use because it has fulfilled validity, practically, and effectiveness criteria.

Keywords: students worksheet, creative thinking, problem solving, acid base.

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INTRODUCTION

Competency standards for high school graduates must have creative, productive, critical, independent, collaborative, and communicative skills through a scientific approach [1]. The curriculum of 2013 is the current curriculum. Based on competency standards for high school graduates above learning of chemistry is to emphasize the students to have creative, innovative, and affective abilities and be able to contribute to the life of the world, nation, state, and world civilization by using chemistry. Learning of chemistry uses scientific approaching that can train students' thinking skills so that student can solve various problems and the problems related to chemistry that occur in daily life and can foster the scientific attitude of students.

An acid base is one example of chemistry matter for 11th grade. This matter is important for students to be learnt because it is a basic concept for understanding other chemistry matter such as buffer solution and solubility. The characteristics of acid base matter are this matter does not only provide concept of information but students are given the opportunity to proof the information or the concept by doing an experiment. In the experiment, the student are asked to investigate, analyze, and conclude the results of the experiment. In addition, many compounds of acid base are the applications in daily life so this matter is very important to understand.

According to the pre-research results at SMAN 1 Driyorejo Gresik on October 2nd, 2018 as many as 69% of a total 31 students considered that acid base is a difficult material especially connecting it with daily life and determining the degree of quality (pH) through calculations. Based on the characteristics of acid base material and the curriculum 2013 which requires that learning of chemistry with student center concept, using scientific approach to solve a problem, and linking chemistry learning with daily life, the learning model is in accordance with the characteristics of the acid base matter namely problem solving learning model.

The selection of problem solving learning models with acid base material is related, for example one of the characteristics of acid base is in this matter not only learn the concept but students are given the opportunity to proof. This is in line with learning using problem solving where after

students are presented with a problem, they are required to find a solution and proof of the solution they made by doing experiment, group discussion or utilizing literary sources such as books, journals, or the internet. The other connection between problem solving model and acid base matter is that there are many examples of the application of acid base material in everyday life so that it is easier for teachers to associate with problems or phenomena that will later be presented with this learning model. Problem solving skills can be known through questions in the form of a description because in the matter of description as a teacher can see the steps taken by students in solving problems.

Problem solving learning model is a model that makes real life problems and those problems are solved by scientific, rational, and systematic methods [2]. Problem learning model can stimulate students to bring up new ideas and develop it with a given problem. Students can be more active and creative in creating solutions to a given problem so that students are able to put forward problem solving strategies and be able to develop a plan in implementing problem solving strategies. There are four steps in problem solving oriented learning, namely: 1) Understood the problem, 2) Device a plan, 3) Carry out the plan, and 4) Look back [3].

In the 21st century, several capabilities are needed for each individual to become a qualified human resource. The skills needed in the 21st century consist of 4C or communication, collaboration, critical thinking and problem solving, creativity and innovation. One of the abilities that need to be trained in the 21st century is creative thinking skills [4].

Creative thinking skills is a skills to use reason to generate ideas, create something new, original, extraordinary, valuable, both abstract, real in the form of ideas or ideas, seeking meaning and solving problems in an innovative manner which involves flexibility, originality, fluency, detail, modification, and fantasy. Creative thinking skills can be measured and identified through four characteristics or components namely fluency, flexibility, originality, and elaboration [5].

Based on the results of the pre-research conducted at SMAN 1 Driyorejo Gresik on October 2nd, 2018 as an example of one component of fluency thinking skills students in formulating problems was only 47%, one component of students' flexibility thinking skills in formulating hypotheses was 48%, one component of elaboration thinking skills of students in analyzing data by 37%, and one component of the original thinking skills of students in making conclusions by 50%. This is also supported by the results of interviews with the chemistry teacher of SMAN 1 Driyorejo Gresik that students have never been given or trained creative thinking skills. Therefore it is necessary to train creative thinking skills in the process of learning chemistry at school.

There are some correlation between creative thinking and problem solving. They are the ability to think creatively is part of cognitive skills which can provide solutions to a problem or make something useful and new from the ordinary things [6]. Besides that creative thinking skills are needed to solve problems, without the creative thinking skills of an individual it is difficult to develop their imagination skills so that they are less able to see various alternative solutions to problems [7]. That can be illustrated that creative thinking skills allow an individual person to view a problem from various perspectives so that it is possible to find creative solutions to the problems to be solved.

To train creative thinking skills in the process of delivering lessons in the classroom, teacher can use teaching material to deliver the lesson in order to achieve the expected goals. Student worksheet is one example of printed teaching material that can be used as a teacher's aid in the form of sheets containing assignments that must be done by students. Student worksheet also has important components including experimental activities, brief theories about materials, tools and materials, experimental procedures, observation data, questions and conclusions to be discussed [8]. Student worksheet can be used as a guide for students to carry out investigation or problem solving activities because it contains a set of basic activities that must be carried out by students to maximize understanding in efforts to establish basic capabilities according to indicators of learning achievement that must be taken.

METHOD

The development research method used in preparing this worksheet is the Research & Development (R&D). There are three main stages in this method, namely the preliminary study stage, planning study stage, and development study stage [9]. However, this study is limited until the trial stage in the development study stage.

The research subjects that used in this research were 12 students of 12th grade in IPA SMAN 1 Driyorejo Gresik where the determination of students represented the level of ability of students from high, medium, and low. Students who participate in limited trial stage are students who

have obtained acid base material. Analysis of the data used in this study include::

1. Validation Data Analysis

Validation data were obtained after the validator consisting of 2 chemistry lecturers and 1 chemistry teacher gave a quantitative assessment using scores. The formula used to calculate the percentage is:

$$\%Validation = \frac{total\ score\ of\ data\ collection}{score\ of\ criteria}\ x100\%$$

The percentage that got then it's represented into Table 1.

Table 1. Score Interpretation Criteria

Percentage (%)	Category
0-20	Invalid
21-40	Less valid
41-60	Valid enough
61-80	Valid
81-100	Highly valid

[10]

2. Analysis of Students Activity Observation

Observation of student activities were obtained during the trial process of the worksheet application. Three observers filled out the student observation sheet according to the activities that carried out by the students while doing the worksheet and experiment. The data of students activity obsertvation is calculated based on the Guttman scale in Table 2.

Table 2. Guttman Scale

Answer	Score
Yes	1
No	0

[10]

Data that got is analyzed using the calculation:

$$\% = \frac{Total\ of\ \text{"Yes" answered}}{Maximal\ total\ of\ \text{"Yes"}\ answered} x100\%$$

The percentage can be categorized based on Table 3.

Table 3. Score Interpretation Criteria

Percentage	Criteria
0% – 20%	Unpractice
21% - 40%	Less practice
41% - 60%	Practice enough
61% - 80%	Practice
81% - 100%	Very practice

[10]

3. Questionnaire Analysis Data of Students Responses

Questionnaire analysis data of students responses were got by a form that given to the students after using the worksheet. Questionnaire analysis data counted based on Guttman scale like in Table 2. The formula used to calculate the questionnaire analysis data of students responses is:

$$P(\%) = \frac{F}{N}\ x\ 100\%$$

Description :
P : Percentage of students responses
F : Frequency of "Yes" or "No" answer
N : Number of respondents
The percentage that got then it's represented into Table 3.

4. Analysis Test Results of Creative Thinking Skills

Analysis test results of creative thinking skills of each student evaluated from the increasing score of *pretest* and *posttest* using *N-Gain score.* The formula of *N-Gain score* is:

$$g = \frac{S_{post} - S_{pre}}{100 - S_{pre}}$$

Description :
g (gain) : Improvement in student learning outcomes
S_{pre} : Average pretest
S_{post} : Average posttest
Score that got is interpreted using Table 4.

Table 4. *N-Gain score* Interpretation Criteria

<*g*> Score	Criteria
<g> ≥0,7	High
0,7 > <*g*> ≥0,3	Enough
<*g*> < 0,3	Less

[11]

Analysis of creative thinking skills counted classically based on all characteristic of creative thinking skills which are fluently, flexibility, originality, and elaboration. Each characteristic is counted using formula:

$$\%\ Characteristic\ of\ creative\ thinking = \frac{Score\ that\ got}{Maximal\ Score}\ x\ 100\%$$

Score that got is interpreted using Table 5.

Table 5. Score Interpretation Criteria

Percentage (%)	Category
0-30	Very low
31-54	Low
55-74	Normal
75-89	High
90-100	Very high

[12]

RESULT AND DISCUSSION

The feasibility of student worksheet oriented problem solving to train creative thinking skills in an acid base matter for 11th grade is determined by validity, practicality, and effectiveness [13].

Worksheet Validity

Worksheet validity is determined by content and construct validity. In Table 6 there is the result of content and construct validity for worksheet 1, worksheet 2, and worksheet 3.

Table 6. Validation Data Result

Criteria	Percentage of Worksheet (%)			Category
	1	2	3	
Content	88.00	88.00	87.67	HV
Linguistic	86.67	86.67	86.67	HV
Presentation	87.78	87.78	86.67	HV
Graphics	88.00	86.67	86.67	HV

*HV : Highly valid

In content validity, there are five aspects assessed, they are the suitability of worksheet content with basic competence and indicators achieved with curriculum 2013, suitability of worksheet content with learning objectives, suitability of worksheet with steps of problem solving learning model, suitability of worksheet with creative thinking skills, and truth phenomenon and material.

Suitability of the contents of the student worksheet with the basic competence and indicators achieved with the curriculum of 2013 and the suitability of the contents of the worksheet with learning objectives, the truth of the phenomenon and material in the worksheet get ≥61%. This is because in the preliminary study phase a literature study was conducted in which researchers analyzed basic competencies and acid base matter in the curriculum of 2013. The worksheet was developed with the steps of the problem solving learning model according to Polya and be adapted to the creative thinking skills that will be trained.

The selection of teaching materials used in the learning process must be accountable for the truth of the material in it [14]. These acid base materials are obtained from various sources of national and international chemical books such as General Chemistry by Brady, Chemistry Concepts and Applications by Wistrom et al.

The construct validity criteria consist of linguistic, presentation, and graphics criteria. Language criteria consist of two aspects, namely writing worksheet using good and correct Indonesian and writing worksheet using appropriate and easy to understand terms. Language criteria is the important criterion in preparing a media, especially student worksheet. The best of teaching materials or books are teaching materials or books written in good language and easy to understand, presented with interest. By using this book or teaching materials in the learning process it is expected that learning objectives will be easily achieved [15].

The presentation criteria contained six aspects that were assessed including the presentation of worksheet containing clarity of purpose, order of systematic presentation of worksheet contents, presentation of illustrations or drawings that could motivate students to understand problems or material, presentation of images accompanied by references, presentation of interesting and fun worksheet, and the presentation of the worksheet is student-centered and arouses motivation and curiosity. The presentation of the content in the worksheet must be systematic so it doesn not make the students feel confused to learn it. The order of the preparation of the contents of the worksheet is also adjusted to the learning objectives and basic competencies used.

Graphic criteria consist of five aspects including cover and worksheet's design that can increase the attractiveness of students so that they want to study the contents of the worksheet, uses of font types and text sizes used makes it easier for readers to use worksheet, harmony of text and image layout on worksheet, material presentation encourages students to be actively involved, and harmony between illustrations, graphics, images and photos.

In developing of worksheet must fulfill technical requirements which include the use of printed letters and not using Latin or Roman letters, use bold letters for non-ordinary topics that are underlined, use no more than 10 words in a row, and try to compare letters with the size of the image accordingly. The appearance of the worksheet also be considered, if the appearance of the worksheet is full of words, it will cause students feel bored and make it's not attractive. Therefore, it is necessary to

combine a harmonious picture and writing and an appropriate layout so that the worksheet looks interesting and the information in it can be channeled well to students [16].

The results of validity obtained based on the criteria of content validity and construct for each criterion in worksheet 1, worksheet 2, and worksheet 3 get ≥61% with a highly valid category. This is relevant with the results of previous studies that worksheet oriented problem solving in the reaction rate material has met the validity criteria with the results of highly valid criteria [17, 18].

Worksheet Practicality

The practicality of the worksheet in terms of the observations of the activities of students during the trial was limited and the results of the questionnaire responses of the students. The following in Table 7. presented the results of observations of students.

Table 7. Observation Result of Student Activity

Activity	Percentage	Category
Worksheet 1	100%	Very practice
Worksheet 2	100%	Very practice
Worksheet 2	100%	Very practice

Student activity on the worksheet is in accordance with the phase of the problem solving learning model. In Table 8 it appears that active students carry out activities and get 100% for student activities in all worksheet in a very practice category. Based on Polya there are four steps in problem solving oriented learning, they are: 1) Understood the problem, 2) Device a plan, 3) Carry out the plan, and 4) Look back [3].

Questionnaire responses of students consist of aspects are covering the criteria of content, linguistic, presentation, and graphic. The results of the student questionnaire responses are presented in Table 8.

Table 8. Questionnaire Responses of Students Result

Criteria	Percentage	Category
Content	98.33%	Very practice
Linguistic	100%	Very practice
Presentation	98.00%	Very practice
Graphics	100%	Very practice

The aspects assessed were the suitability of the worksheet content in accordance with the learning indicators, the suitability of the questions in the worksheet according to the characteristics of the creative thinking skills, the suitability of the activities in the worksheet with the material, giving space to the worksheet to give their ideas in solving problems based on phenomena and the material in worksheet is easily understood which got ≥98%. This is in accordance with the function of the worksheet that it can facilitate students to understand the material, find a concept, and carry out experimental activities [19].

The language criterion consists of the writing of the worksheet using an exact and correct Indonesian and writing of the worksheet uses vocabulary that easy to understand. Materials, phenomena, and questions on the worksheet are prepared using Indonesian language that is good and correct and easy to understand so that readers or students can more easily to use and study the worksheet.

The presentation criteria include the sequence of material in a systematic ways, the presentation is interesting and can motivate the students also make the students feel curious, and illustration or drawing aspect of the worksheet can motivate you to solve the problem. Good teaching materials are teaching materials that can motivate readers to carry out an activity [20]. In this worksheet illustrations or images used are expected to motivate students so that students can be excited and have an interest in learning the worksheet and conducting activities or activities in the worksheet.

Graphic criteria consist of cover aspects and design of worksheet can enhance the attractiveness of students, the use of font types and text sizes used makes it easier for students to use it, illustrations or drawings in worksheet help understand concepts, and the layout of text and images on the worksheet is harmonious. When the appearance of the worksheet is full of words and questions that can lead students feel bored and make the student worksheet unattractive [16]. Therefore the presentation of the worksheet has a very important role, it requires a combination of picture and writing that is aligned and the appropriate layout so that the worksheet looks interesting and the information in it can be channeled well to students.

According to previous research regarding the development of learning-based media problem solving that learning with these models can change passive learning patterns into student centered learning by conducting experiments and solving problems in everyday life [20]. The use of problem solving oriented worksheet can increase student activity by an average of 82.64% and student responses reach 76.56% [21]. Based on the observations of the activities of the students and the

questionnaire responses of students, they got ≥61% in a very practice category.

Worksheet Effectiveness

The effectiveness of worksheet is obtained from the results of creative thinking skills tests. For the classicaly creative thinking skills is looked from each characteristic or component of creative thinking while for the individually creative thinking skills is looked from increasing between pretest and posttest of each student using N-Gain Score. The results of the tests of creative thinking skills of each student were assessed by increasing the pretest and posttest using the N-Gain score. In Figure 1. shows the comparison of the pretest and posttest of creative thinking skills.

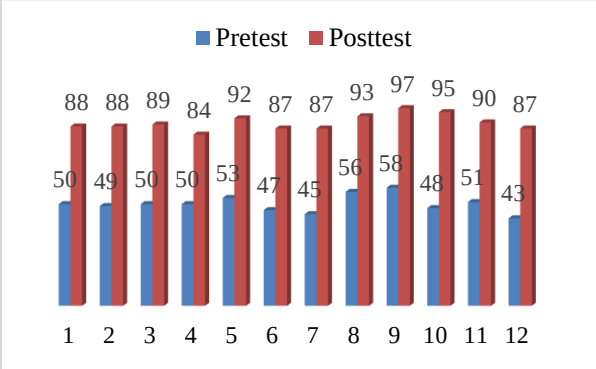

Figure 1. Comparison of Pretest and Posttest Score

The results of the pretest and posttest values were tested for normality using the Kolmogorov-Smirnov feature in the SPSS program to determine that the data for the N-Gain value was normally distributed. Data obtained is normally distributed with the value of Sig. equal to 0.2. When the Sig value is more than 0.05 indicates that the data obtained has been normally distributed so that it can be continued to calculate the N-Gain Score of each student. In Table 9. shows the calculation of N-Gain Score on tests of students' creative thinking skills.

Table 9. Calculation of N-Gain Score of Creative Thinking Skills.

No.	Name	*N-Gain Score*	Category
1.	MH	0.8	High
2.	DAP	0.8	High
3.	RIA	0.8	High
4.	ALZ	0.7	High
5.	AFS	0.8	High
6.	YW	0.8	High
7.	DRS	0.8	High
8.	AAN	0.8	High
9.	JES	0.9	High
10.	FD	0.9	High
11.	NA	0.8	High
12.	MIS	0.8	High

Calculation of N-Gain scores for 12 students got a score of ≥0.7 with a high category for each student. The analysis of students' creative thinking skills is also calculated classically based on the components or characteristics of creative thinking skills namely thinking fluently, flexibility, originality, and elaboration. The fluently and flexibility thinking skills got the same percentage are 94% with a very high category while originality and elaboration thinking skills get a percentage of 81% with a high category. Based on the results obtained from the test of creative thinking skills for each individual get a score of ≥0.7 with a very high category and classicaly analysis based on each component or creative thinking characteristics students get the percentage of each characteristic of ≥75% so that student worksheet is oriented towards problem solving to train creative thinking skills in the acidic base material of 11th grade has been effective.

CLOSURE

Conclusion

The results of research and discussion on the development of problem solving oriented student worksheets to train creative thinking skills in acid base material for 11th grade are said to be appropriate to use based on the following conclusions:

1. Students worksheet oriented problem solving to train creative thinking skills in acid base material for 11th grade fulfilling the validity criteria, in terms of the content validity and construct. Content validity in worksheet 1, 2, and 3 had percentage respectively 88.00%, 88.00%, and 86.67%. Construct validity includes a linguistic, presentation, and graphics criteria. Result that got respectively for each worksheet 1, 2, and 3 for language criteria 86.67%, respectively for presentation criteria 87.78%, 87.78%, and 86.67%, respectively for graphical criteria 88.00%, 86.67%, and 86.67% with highly valid categories.
2. Students worksheet oriented problem solving to train creative thinking skills in acid base material for 11th grade fulfilling the criteria of practicality, in terms of the observations of the activities of students and the questionnaire responses of students during the limited trials of

worksheet. The observation of students activities which got a percentage of 100% and students' responses in terms of the criteria of content, linguistic, presentation, and graphics got the respectively percentage of 98.33%, 100%, 98%, and 100%.

3. Students worksheet oriented problem solving to train creative thinking skills in acid base material for 11th grade fulfilling the effectiveness criteria, in terms of the increasing results of pretest and posttest in creative thinking skills for each student using the N-Gain Score formula and obtained the value <g>≥0.7 with high categories and for creative thinking classically obtained from the assessment of each component of creative thinking skills respectively for fluent and flexible thinking skills get the same percentage which is equal to 94% with very high categories while original and detailed thinking skills get the same percentage that is equal to 81% with a high category.
4. Students worksheet oriented problem solving to train creative thinking skills in acid base material for 11th grade can be stated that feasible to use because it has fulfilled validity, practically, and effectiveness criteria.

Suggestion

1. Students worksheet oriented problem solving to train creative thinking skills in the acid base material developed does not include all sub-material present in acid base material such as the concept of acid base according to experts and also artificial indicators. Therefore, further research can complement the chapter so that the overall acid base material is more complete.
2. Students worksheet oriented problem solving to train creative thinking skills can be developed in other chemical materials so that students' creative thinking skills can be more developed and students are ready to confront the 21st century.
3. Training of students creative thinking used students worksheet 3 about the strength of acid base was a little bit difficult rather than student worksheet 1 and 2. It because the sub matter in student worksheet 3 is certain and the students can not be creative and explore related to the matter. For the next researchers who also train creative thinking skills, thinking about matter or sub matter that suitable for training creative thinking skills.
4. Students worksheet oriented problem solving to train creative thinking skills in acid base material for 11th grade which is developed using the design of the R&D development only until the trial stage. Therefore, research needs to be carried out to the wider testing phase by implementing the worksheet developed so that the worksheet can be more useful and efficient for all students.

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