Improvement of student's creative thinking skills by guided inquiry-based student worksheet in acid-base materials

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Keywords	Abstract
  OpenAcces	This study aims to create students' worksheets based on guided inquiry which are valid, practical and effective to gain students' skill in creative thinking in acid-base materials. This study was a Research & Development (R&D) using the 4-D method (Define, Design, Develop, Disseminate). The subjects implemented to this research were 29 students of class XI MIA MAN 4 Kediri. A design of one-group pretest-posttest without any comparison was used to conduct this research. Regarding the outcomes of the research, this can be summed up that 1). The validity of guided inquiry-based students' worksheet obtained score of 89.60% with very valid criteria on content validation and 85.23% with very valid criteria in construct validation. 2). The practicality of guided inquiry-based students' worksheet obtained values in the range of 70.96%-96.77% and on practical and very practical criteria. 3). The effectiveness of guided inquiry-based students' worksheet obtained an increase in N-gain in four indicators of creative thinking skills of more than 0.7 with high criteria. It can be concluded that the students that used guided inquiry based worksheet enhanced student's academic achievment in acid base materials.

Introduction

Indonesian education faces one of the problems, on of which is the weakness of the learning process. In the learning process, thinking skills are slightly developed. The learning process is directed at the learner's skill in memorizing information, the brain is obliged to remember and accumulate all kinds of information without understanding the information it remembers in order to relate it to daily life (Sanjaya, 2008).

The method of lecture and memorization is a method that is still often used by teachers today (Peranginangin et al. 2019). This is due to the lack of variety of methods and media used by teachers. Whereas in the era of technology and science advances, teachers can use various media that suit the needs and learning objectives. Through this media, teachers can streamline the learning process and also make the learning process more effective (Rahayu & Anggraeni, 2017).

Facilities used by teachers to help the student learning process include learning media in the form of audio, print, and visual media. One of them is student worksheet which is example of print media. The development of teaching materials is very important to train students in finding concepts. Students' activity sheets is one example of teaching materials which can be used (Ardiani, 2017).

Student's Activity Worksheets is a printed teaching media containing materials and work instructions which should be finished by the students that are based on basic competences which should be reached (Prastowo, 2011). Student's worksheet is one of the learning media consisting of one or several sheets of paper that are distributed to students in a class, with the aim that students carry out learning activities as stated or listed in the activity sheet. Student's worksheet is used so that students learning activities are directed according to the content of worksheet. For this reason, it is necessary to have student worksheets with inquiry learning orientation that are used as learning materials or learning facilities by students. Student's worksheet is an

example of learning resources which is applied by teachers in supporting the learning process (Rahayu & Anggraeni, 2017).

According to a study which was conducted by Putra et al. (2016), it reveals that the learning process still does not pay attention to students' creative thinking abilities. According to research conducted by Hervyanti & Muchlis (2021), as many as 73% of students with 65 students stated that student's worksheet can help understand the material during the learning process, while students' creative thinking skills are relatively low with results of 41.67% on the indicators of originality and flexibility, 38.89% on the indicator of elaboration, 44.44% on the fluency indicator. Based on the results of interviews, passive and unable to explore creative ideas to solve problems in the learning process are felt by students. Creative thinking skills are higher-order thinking skills based on available data or information (Mumford et al. 2012). Creative thinking skills have five abilities, namely the ability to think fluency, flexibility, originality, elaboration, and evaluation (Munandar, 2014).

Guided inquiry model is one of the effort to improve creative thinking skills. Kuhlthau et al. (2007) explained that a model of guided inquiry learning can support students in creative thinking and discovering creative ways for problems. Inquiry activities through proving a topic or issue to motivate students is a guided inquiry learning model. Aspects of thinking in a creative way can be increased through stage model of guided inquiry learning (Siahaan et al. 2021). High school students are very suitable for using guided inquiry. This is because students at that level still really need guidance and direction from a teacher. Through guided inquiry the teacher can provide guidance and direction to students to carry out investigation activities (Damayanti et al. 2013). Previous research stated that concept discovery with teacher guidance will help students understand the concepts and principles of student findings, because students are trained to use the ability to investigate critically, systematically, analytically, and logically so that students can establish their own knowledge (Pratiwi, 2015). For this reason, it is necessary to have student worksheets with inquiry learning orientation that are used as learning materials or learning facilities by students (Witri et al. 2020). Systematic and interesting learning materials are hoped to make students understand the material being taught (Rahayu & Anggraeni, 2017).

One of the subject matter of high school chemistry is acid-base. The subject matter of acid-base has material characteristics in the form of concepts and facts. The learning process until now is still not fully in accordance with the 2013 curriculum, because teachers still tend to use conventional methods so that students are less active which causes creative thinking skills cannot be formed during the learning process (Oktafina & Suliyanah, 2020). Teachers more often provide existing information, such as existing concepts or formulas, and then give examples of problems and solutions. This habit results in learners having difficulty understanding chemical concepts and lack of skills that learners have (Hervyanti & Muchlis, 2021). Based on the background above, a Guided Inquiry-Based Students Worksheets was created to improve students' creative thinking skills in Acid-Base Material.

Method

A method of Research and Development (R&D) was applied in conducting this study to create a certain product and examine the product's effectiveness (Sugiyono, 2013). The design of this research uses modified 4-D models (Four-D Models) that was originally consists of the design, define, develop, and disseminate to only consists design, define, and develop. Define, the define phase intends to examine and decide the requirements of the process in learning. At this stage three steps are implemented, they are analysis of students, analysis of initial, and analysis of objectives in learning. Design, the design stage aims to produce Guided Inquiry-Based Student's worksheet to improve students' creative thinking skills in acid-base material. At this stage two steps are carried out namely preparation of instruments and selection of worksheet format. Develop, the develop stage aims to produce revised students' worksheet and revised instruments based on comments, suggestions and assessments from expert validators.

The research was done applying a design of one-group pretest-posttest without any ratio. The schematic is shown as follows:

$$O_1 \ X \ O_2$$

Note:
O1   = Pretest
X   = Treatment, learning implementing guided inquiry based students' worksheet
O2   = Posttest

The validity test is carried out by experts (validators) on the students' worksheet that has been developed. The level validity of the students' worksheet is analyzed using the following equation:

$$P(\%) = \frac{Scores\ obtained}{Total\ score} \ x\ 100\%$$

The students' worksheet progress is said to be valid when it has reached the criteria of valid with the percentage of scores obtained ≥ 61% (Table 1).

Table 1. LKPD Validity Criteria (Arikunto, 2010)

Percentage (%)	Category
< 21	Highly invalid
21-40	Invalid
41-60	Quite valid
61-80	Valid
81-100	Very valid

Practicality is measured by questionnaire sheet of the student response questionnaire. Guttman scale calculation is used to calculate student response data (Table 2).

Table 2. Guttman Scale

Statement	Answer "Yes" Score	Answer "No" Score
Positive	1	0
Negative	0	1

The formula used to calculate the data:

$$P(\%) = \frac{Scores\ obtained}{Total\ number\ of\ students} \ x\ 100\%$$

The students' worksheet progress is said to be practical when it meets the criteria of practical, namely the score obtained ≥ 70% (Table 3).

Table 3. Criteria for interpretation of practicality questionnaire scores (Utomo, 2009)

Percentage (%)	Category
85-100	Very practical
70-84	Practical
55-69	Quite practical
40-54	Less practical
0-39	Not practical

Pretest-posttest is used to obtain data on evaluation test results to determine the effectiveness of students' worksheet. The students' worksheet effectiveness assessment instrument uses a test instrument consisting of description questions. Students are said to be trained in their creative thinking skills if all aspects of the realm of skills in thinking creatively indicators are met in the completion criteria. The data on the value of the creative abilities of learners is analyzed using the formula:

$$N = \frac{Scores\ obtained}{Total\ score} \ x\ 100$$

The amount of improvement in student learning outcomes is measured referring to the N-gain with the formula below.

$$N-Gain\ Score = \frac{Posttest\ score - pretest\ score}{maximum\ score - pretest\ score}$$

Then the acquired score will be examined for its normality by applying IBM *SPSS* Statistics 20, it will be continued to Paired Sample T-Test on *SPSS* when it is distributed in a normal way with a significant score ≥0.05 and if the data are not distributed in normal way, so that a non-parametric test was carried out, namely the Wilcoxon test. The result of the calculation of N-gain is interpreted by applying the Hake's classification (Table 4).

Table 4. N-Gain Criteria (Hake, 1999)

N-Gain	Category
G>0.7	High
0.3≤G≤0.7	Medium
G<0.3	Low

The effectiveness of student worksheets category depends on the results of the n-gain precentage (Table 5).

Table 5. Effectiveness of N-Gain interpretation

| Percentage (%)	Category
< 40	Ineffective
40-55	Less effective
56-75	Quite effective
>76	Effective

Results and Discussion

The results obtained from this research was a guided inquiry-based students worksheet to improve students' creative thinking skills in acid-base material. is developed by paying attention to indicators of creative thinking abilities, namely the skill to think fluency, elaboration, originality, and flexibility.

Define

The define phase purposed to examine and decide the requirements of the process in learning. At this stage three steps are implemented, they are analysis of students, analysis of initial, and analysis of objectives in learning. The analysis of initial pusposed to decide the basic matters experienced during learning including field problems and curriculum so that learning tools' developments is acquired. After doing research in MAN 4 Kediri, it can be seen that the process in learning was still teacher-centered. The learning process requires a method that focuses on students so that guided inquiry is used. Analysis of students purposed to analyze the students' characteristics and find out suitable learning tools which can support students during learning. The suitable learning tool is students' worksheet. Analysis of learning objectives is carried out to formulate learning objectives to be reached. The material used is in accordance with KD 3.10 explains the concepts of acid base and its strength and ionizing equilibrium in solution and KD 4.10 which is analyzing the trajectory of changes in the pH of several indicators which are obtained from natural sources using experiments.

Design

The design stage aims to produce guided inquiry-based students' worksheet to improve students' creative thinking skills in acid-base material (Fig. 1).
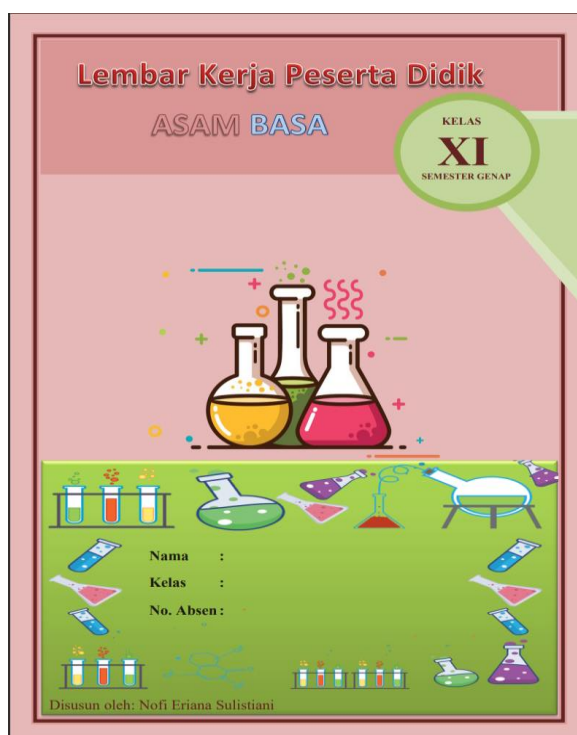
Figure 1. Design of worksheet cover

At this stage two steps are carried out namely preparation of instruments and selection of students' worksheet format. The instruments arranged are in the form of learning tools and data collection instruments. Learning device instrument (lesson plan) is used as a guide for teachers to carry out learning activities in the

classroom so that it is systematic or coherent in accordance with the learning objectives that have been set. The instrument of data collection in the form of a validation questionnaire applied to evaluate the validity, practically and effectiveness of the given students' worksheet. The selection of intended format is to organize and design the contents, layout, and pictures. Students' worksheet is designed using Microsoft Word (Fig. 2).

Figure 2. Worksheet's phenomena

Development

The develop stage aims to produce revised students' worksheet and revised instruments based on comments, suggestions and assessments from expert validators.

Validity of students' worksheet

Validation was done by two UNESA lecturers of chemistry and one MAN 4 Kediri teacher of chemistry. The validity of the students' worksheet is reviewed from the validity of the content and the validity of the construct (Fig. 3).
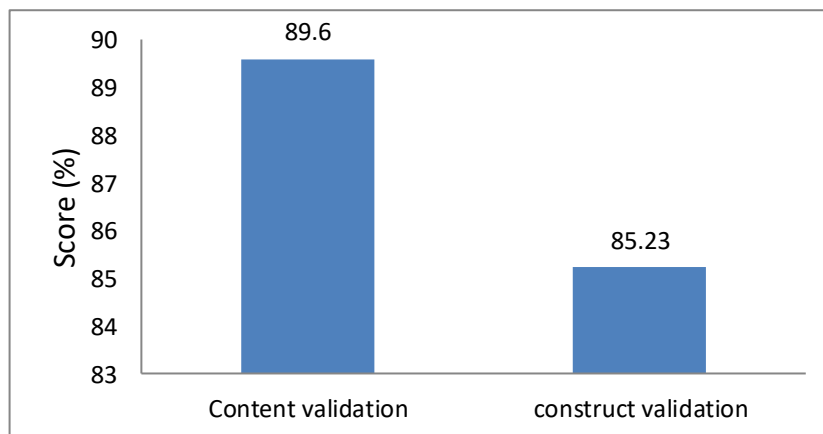

Figure 3. Validation result diagram

According to the criteria for the validity of the Arikunto table, the contents' validity of the students' worksheet developed achieved a percentage of 89.60% with very valid criteria. Meanwhile, the validity of the construct obtained a percentage of 85.23% with criteria of very valid.

Practicality of students' worksheet

The practicality of students' worksheet is measured by a questionnaire of student response. The participating students were 29 people. Student's questionnaire result data can be seen in Table 6.

Table 6. The outcomes of the student response questionnaire

No.	Statement	Learners' responses (%)	Practicality criteria
1.	The information in the students' worksheet is easy to understand	93.54	Very practical
2.	Guided inquiry-based students' worksheet made me understand the acid-base material	80.64	Practical
3.	Practice questions in students' worksheet according to acid-base material	96.77	Very practical
4.	The instructions in students' worksheet are clear, so I'm easy to use	90.32	Very practical
5.	The image on the students' worksheet matches the content of the material so that it facilitates my understanding	87.09	Very practical
6.	The use of letters, font size, and spaces is correct, making it easier for me to read students' worksheet	93.54	Very practical
7.	The color display of students' worksheet is right so I became interested in learning and practicing the questions	70.96	Practical
8.	Students' worksheet motivates me to learn acid-base material	83.87	Practical
9.	Students' worksheet motivated me to discuss with friends and ask questions with teachers	90.32	Very practical
10.	The content of students' worksheet stimulated my reading interest	80.64	Practical
11.	Students' worksheet has an attractive look to read	74.19	Practical
12.	Students' worksheet increased my curiosity in studying acid-base matter	83.87	Practical
13.	This students' worksheet makes me become active in asking if there is material that is not yet understood	80.64	Practical
14.	This students' worksheet helped me answer the teacher's questions well	80.64	Practical
15.	This students' worksheet improves my ability to create as many ideas as possible (Fluency)	70.96	Practical
16.	This students' worksheet improves my ability to answer and solve problems in my own way (Flexibility)	83.87	Practical
17.	This students' worksheet improves my ability to provide new and original ideas (Originality)	87.09	Very Practical
18.	This students' worksheet improves my ability to decompose simple objects into more complex (Elaboration)	70.96	Practical

Based on the student response questionnaire, the students' worksheet developed has met the practical criteria since each question in the questionnaire of response has achieved ≥ 61% which is in the range of 70.96% - 96.77% and on practical and very practical criteria.

Effectiveness of students' worksheet

The effectiveness of students' worksheet is measured by pretest-posttest results. Twenty nine students were given pretest, namely tests carried out before using the developed students' worksheet and posttest, which are tests carried out after using students' worksheet. Students are said to be trained in their creative thinking skills if all aspects of the realm of creative thinking abilities indicators are met in the completion criteria (Fig. 4).

Fluency

To find out whether the pretest-posttest data in fluency indicator is distributed to each other is normal, a normality test is conducted using Shapiro-Wilk test because the sample data is less than 30 samples. Based on the normality test on the fluency indicator, it was found that the value of sig. < 0.05 for pre-test and post-test data shown in Table 7. This means that both data are not normally distributed, which means that t-tests cannot be performed. So that a non-parametric test was carried out, namely the Wilcoxon test. Regarding the calculation outcomes of the Wilcoxon test, fluency indicator have a sig value. smaller than 0.05 this implies that there is an influence on the results of student learning before and after using the developed students' worksheet.
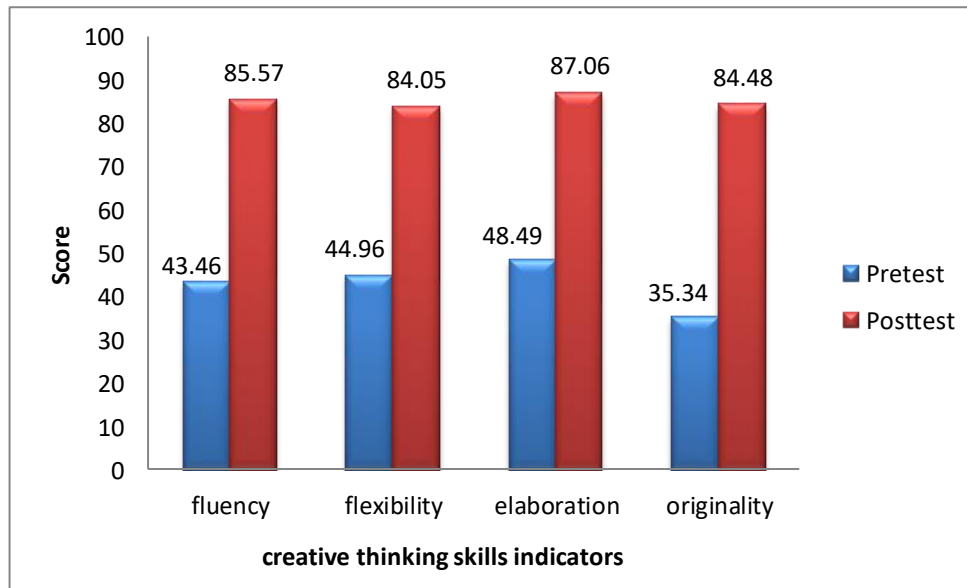
Figure 4. Average value of pretest-posttest

Table 7. The Outcomes of the normality test indicator fluency

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre-test fluency	.150	29	.093	.919	29	.029
Post-test fluency	.224	29	.001	.798	29	.000

Flexibility

To find out whether the pretest-posttest data in flexibility indicator is distributed to each other is normal, a normality test is conducted using Shapiro-Wilk test because the sample data is less than 30 samples. Based on the normality test on the flexibility indicator, it was found that the value of sig. < 0.05 for post-test data shown in Table 8. This means that post-test data is not normally distributed, which means that t-tests cannot be performed. So that a non-parametric test was carried out, namely the Wilcoxon test. Regarding the calculation outcomes of the Wilcoxon test, flexibility indicator have a sig value. smaller than 0.05 this implies that there is an influence on the results of student learning before and after using the developed students' worksheet.

Table 8. The outcomes of the normality test indicator flexibility

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre-test flexibility	.102	29	.200[*]	.954	29	.230
Post-test flexibility	.238	29	.000	.878	29	.003

*. This is a lower bound of the true significance.
a.   Lilliefors Significance Correction

Elaboration

To find out whether the pretest-posttest data in elaboration indicator is distributed to each other is normal, a normality test is conducted using Shapiro-Wilk test because the sample data is less than 30 samples. Based on the normality test on the elaboration indicator, it was found that the value of sig. < 0.05 for post-test data shown in Table 9. This means that post-test data is not normally distributed, which means that t-tests cannot be performed. So that a non-parametric test was carried out, namely the Wilcoxon test. Regarding the calculation outcomes of the Wilcoxon test, elaboration indicator have a sig value. smaller than 0.05 this implies that there is an influence on the results of student learning before and after using the developed students' worksheet.

Table 9. The outcomes of the normality test indicator elaboration

|	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre-test elaboration	.131	29	.200*	.939	29	.097
Post-test elaboration	.267	29	.000	.775	29	.000

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Originality

To find out whether the pretest-posttest data in originality indicator is distributed to each other is normal, a normality test is conducted using Shapiro-Wilk test because the sample data is less than 30 samples. Based on the normality test on the originality indicator, it was found that the value of sig. < 0.05 for pre-test and post-test data shown in Table 10. This means that both data are not normally distributed, which means that t-tests cannot be performed. So that a non-parametric test was carried out, namely the Wilcoxon test. Regarding the calculation outcomes of the Wilcoxon test, originality indicator have a sig value. smaller than 0.05 this implies that there is an influence on the results of student learning before and after using the developed students' worksheet.

Regarding the calculation outcomes of the Wilcoxon test, all indicators (fluency, flexibility, elaboration, originality) have a sig value. smaller than 0.05 this implies that there is an influence on the results of student learning before and after using the developed students' worksheet. Therefore, it can be summed up that learning applying guided inquiry students' worksheet is effective for gaining learning outcomes in acid base material. To see the magnitude of the influence of overall student learning outcomes, the calculation of N-gain values is carried out. The average increase in the creative thinking ability of learners is shown in Fig. 5.
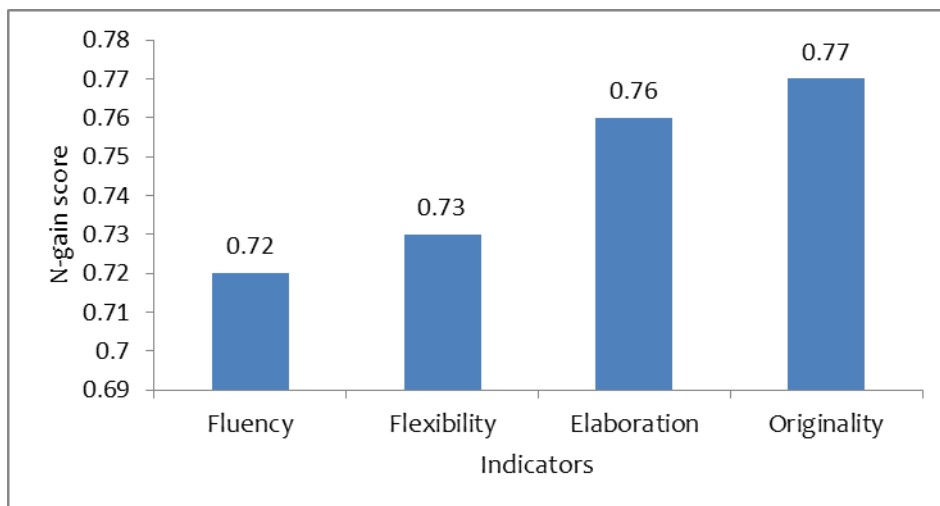
Figure 5. Average score N-gain

Based on the outcomes of the N-gain test analysis, there was a rise in fluency, flexibility, elaboration, and originality indicators. Fluency is judged based on the ability of learners to come up with many answers, ideas, solve problems and questions, learn various ways and suggestions to perform things and always consider answer more than one. Efforts to improve creative thinking using students' worksheet based on guided inquiry in this study were able to develop aspects of fluency of students. This is supported by the average value of pretest and posttest which has increased by 0.72 with high criteria.

Flexibility is assessed based on the ability of students to produce various ideas, answers and questions, able to view a problem from various points of view and able to change the way of approach or thinking. Efforts to improve creative thinking using students' worksheet based on guided inquiry in this study are able to develop aspects of student flexibility. This is supported by the average value of pretest and posttest which has increased by 0.73 with high criteria.

Elaboration is assessed based on the ability of students to develop, add, enrich an idea and details an object or idea so that it becomes interesting. Efforts to improve creative thinking using students' worksheet based on guided inquiry in this study are able to develop aspects elaboration of students. This is supported by the average value of pretest and posttest which has increased by 0.76 with high criteria.

Table 10. The results of the normality test indicator originality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre-test originality	.452	29	.000	.561	29	.000
Post-test originality	.388	29	.000	.677	29	.000

a. Lilliefors Significance Correction

Originality is judged based on the ability of students to give birth to new and unique expressions. Efforts to improve creative thinking using students' worksheet based on guided inquiry in this study are able to develop aspects of authenticity (originality) of students. This is supported by the average value of pretest and posttest which has increased by 0.77 with high criteria.

The developed student worksheet is said to be effective if the average value n-gain is in the category with G<0.3 with medium criteria (Hervyanti & Muchlis, 2021). The data from n-gain test show the range value 0.72-0.73 with high criteria so that can be said the worksheet that has been developed is effectively used to improve students' creative thinking skills because it shows an increase in the results of the pretest and posttest of each indicator of creative thinking skills. The results of the study are in accordance with the research that has been done by Putra et al. (2016), creative thinking skills can be improved using the guided inquiry model.

The results of this study are in accordance with Jack (2013), guided inquiry activities help students to develop their individual responsibility, cognitive methods, report making, problem solving, and understanding skills. According to Ritter & Mostert (2016), if a goal is to train creative thinking skills, effective creativity training programs need to be developed and succesfully implemented. In this study, a training program to improve students' creative thinking skills was carried out by providing worksheets that successfully implemented with evidence of high n-gain values.

Conclusion

Regarding to the research and development which has been conducted, there are several conclusions from the aspects of effectiveness, practicality, and validity, namely; The validity of guided inquiry-based students' worksheet obtained a percentage of 89.60% with criteria of very valid on content validation and 85.23% with very valid criteria on construct validation. The guided inquiry-based students' worksheet practicality test obtained values in the range of 70.96% - 96.77% and on practical and very practical criteria. The effectiveness of guided inquiry-based students' worksheet obtained an increase in N-gain in four indicators of creative thinking skills of more than 0.7 with high criteria. It can be concluded that the students that used guided inquiry based worksheet enhanced student's academic achievment in acid base materials.

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