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## Relationship Between Prior Knowledge and Creative Thinking Ability in Chemistry

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### Abstract

This study aims to determine the relationship between prior knowledge and creative thinking ability of 11<sup>th</sup> Grade science students. This research is ex post facto. The population for this research was 11<sup>th</sup> Grade science students at a public school in Takalar, Indonesia, and consisted of 39 classes with a total enrollment of 1,537 students. In selecting the sample, the study employed stratified purposive random sampling technique in order to select 134 of the 11<sup>th</sup> Grade science students (from SMAN 1 Takalar, SMAN 3 Takalar, SMAN 1 Polongbangkeng Selatan, and SMAN 3 Polongbangkeng Utara). The data was collected by using a prior knowledge test that consisted of 16 items ( $\alpha = 0.883$ ) and a verbal creativity test consisting of 18 items ( $\alpha = 0.808$ ). Data were analyzed using correlation and regression analysis. The coefficient correlation between the two variables is 0.619 with  $p = 0.000$  ( $p < 0.05$ ). This value indicates the existence of a relationship between prior knowledge and creative thinking ability in chemistry students and that there is a positive relationship between the two variables.

**Keywords:** prior knowledge, creative thinking ability, chemistry.



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## Introduction

Creativity is indispensable for the development of a nation, as through creativity each nation can compete with other nations. The Indonesian Act No. 20 (2003) on the National Education System detailed the goal to develop students to become people of faith who fear God Almighty, and who are noble, healthy, knowledgeable, skilled, creative, independent, and who are democratic and accountable citizens. Based on the Act, one aspect that needs to be developed in the educational process is the creativity of learners.

Based on the National Education goals, the development of creativity in learners is one part of teaching and learning in schools. Thus, chemistry, as one of the subjects taught in schools, can be used as a means to develop the creativity of learners. Creativity in learning chemistry, among other things, is required in terms of completing challenging problems, problems related to the application of chemistry in everyday life, and in the trials or experiments and scientific methods related to chemistry. This is consistent with the statement of Mulyasa (2009), that chemistry is one of the Natural Sciences that closely matches the trials or experiments, as well as other scientific methods, that can provide experiences for learners to perform hypothesis testing. This can be achieved by designing experiments through the installation of instruments, retrieval, processing, interpretation of data, and presenting the results of experiments both orally and in writing. This statement shows that in studying chemistry, it requires a degree of creativity or creative thinking ability of the students. Therefore, creative thinking abilities can be developed through the study of chemistry, and it is one of the responsibilities of chemistry teachers to develop the creative thinking skills of learners.

In general, chemistry teachers, including those in Takalar, South Sulawesi Province, Indonesia, have made various efforts to develop the creative thinking skills of learners; for example, by using a variety of models and instructional media, such as problem-based learning and animated media in their teaching of chemistry. However, the expected outcome has not yet been maximized. This statement is supported by data from one of the high schools in Takalar which shows that the average value of creative thinking abilities of students in hydrocarbon material is 44.41.

Based on the aforementioned state, it should be noted that efforts made by teachers would be meaningless if the learners themselves, as the subject of study, do not involve themselves or do not actively participate in the learning process. Therefore, studies are needed as to the related variables that contribute to the creative thinking ability of students.

Research by Groncher, Johri, Kothaneth, and Lohani (2009) showed that prior ability contributed to the ability of learners to make new engineering design solutions. Prior ability can be defined as the ability possessed by learners who are used to facilitating the acquisition, organization, and rephrasing of new knowledge (Sanjaya, 2012). However, prior ability of each learner is potentially different. These differences affect how they are presented, interpreted, and managed. The differences in processing and integrating new information can influence remembering, thinking, applying, and creating new knowledge (Yaumi, 2013). Therefore, prior ability affects the capability of learners in thinking, and it can be said that prior ability determines the creative thinking ability of students (Semiawan, Putrawan and Setiawan, 2004; Sugiyono, 2009, 2011; Suharnan, 2005; Uno, 2012; Uyanto, 2009; Walgito, 2004; Widyastono, 2009).

Anwar and Rasool (2012) argue that everyone has differences in their creativity, background, motivation, ability, and also differences in their response. Because of these reasons, Anwar and Rasool (2012) conducted a study comparing the creative thinking ability of students of high and low achievers. The results showed no difference in the ability of creative thinking among learners of high and low achievers, but the students were all female and came from a town which has the ability to think creatively better. The results of the study by Groncher et al. (2009) and the opinion of Anwar and Rasool (2012) can be considered in examining the relationship between creative thinking ability and prior knowledge.

## Methodology

Reviewed based on the data, this study employed the quantitative research method. Based on this research, data retrieval is ex post facto research as this research is used to explain the existence of relationship of each variable.

The population in this research were a total of 1,537 science students attending the 11<sup>th</sup> Grade of a State High School in Takalar Regency, South Sulawesi Province, Indonesia, during the 2013-2014 academic year. Sampling employed the purposive stratified random sampling technique. This sampling technique was chosen because the population is not homogeneous and stratified for several high schools in Takalar, and it divisible into high-performing and low-performing schools at different locations both within and outside the city. In order to research data more representative of the population, two schools within the city and two schools outside of the city were selected.

The Department of Education, Culture, Youth and Sports for Takalar advised that the schools located within the city are high-performing schools and schools outside of the city are low-performing schools. Thus, the sample selected for this study was SMAN 1 Takalar, SMAN 3 Takalar, SMAN 1 Polongbengkeng Selatan, and SMAN 1 Polongbengkeng Utara. The 11<sup>th</sup> Grade Science 1 students from each school were selected as the sample. The reason for this sample selection is due to existing SMA Takalar determination of students based on their ability level. Thus, the number of samples in this study were 134 students.

The variable in this study is the students' prior ability and creative thinking ability in chemistry. Prior ability is the prerequisite knowledge possessed by students in order to learn the concepts of acid-base measured using a cognitive test that includes the abilities of remembering (C1), understanding (C2), and applying (C3). Creative thinking ability of students is the ability of learners in completing a verbal creativity test which is based on the cognitive dimension, and includes: fluency, and flexible, original and elaborative thinking.

The instrument applied in this study consists of prior ability tests, and tests of verbal creativity. The test for prior ability was arranged in the form of multiple-choice questions which includes materials related to the acid-base concept such as the periodic system and atomic structure, reaction rate, and chemical equilibrium. The verbal creativity test was arranged as an essay test that consists of six sub-tests that assess based on the beginning of the word, arrangement of words, forming sentences of three words, use of the same properties, to various uses, and what the consequences are. Sub-tests are taken as the basis to determine the ability learners' creative thinking, and includes the ability for fluency, flexibility, original and elaborate thinking. A validity test was performed by testing the content validity and the empirical validity.

Content Validity was tested by seeking the opinion of two experts with regard to the appropriateness of the indicators and the instruments' developed grains; whereas, for testing the empirical validity, one test was carried out with the instrument at one of the schools in the population that was not included in the study sample, and then factor analysis was conducted using product moment correlation. Reliability testing used the Cronbach Alpha formula.

After having tested the validity and reliability, it was noted that the prior ability tests used in the study consisted of 16 items and a Cronbach Alpha reliability coefficient of 0.883. Meanwhile, the verbal creativity test used 18 items and a Cronbach Alpha reliability coefficient of 0.808.

The data obtained in this study were analyzed using the technique of Pearson product moment correlation and regression analysis. The technique of the Pearson product moment correlation was used to test the hypotheses, and regression analysis is used to determine the contribution of prior ability on the ability of creative thinking in chemistry.

## Results

### *Description of student prior ability*

The result of descriptive analysis for prior ability indicates that the prior ability of learners in Takalar have a minimum score of 6, a maximum score of 100, an average score of 53.5, median 50, mode 38, and a standard deviation of 26.7. The results of a descriptive analysis of the prior ability of students is presented in Table 1. The distribution of data frequency by category of prior ability low, middle, and high can be seen in Table 2. In Table 2, it appears that the highest frequency of prior ability is 71 learners in the middle category. Therefore, it can be concluded that in general, the prior ability of learners in Takalar is situated in the middle category. Description of the average value for each aspect of prior knowledge can be seen in Table 3. It can be seen that the understanding (C2) aspect has the highest score. More clearly, the average value for each aspect for each school can be seen in Figure 1.

**Table 1.** Descriptive Statistic of Students Prior Ability

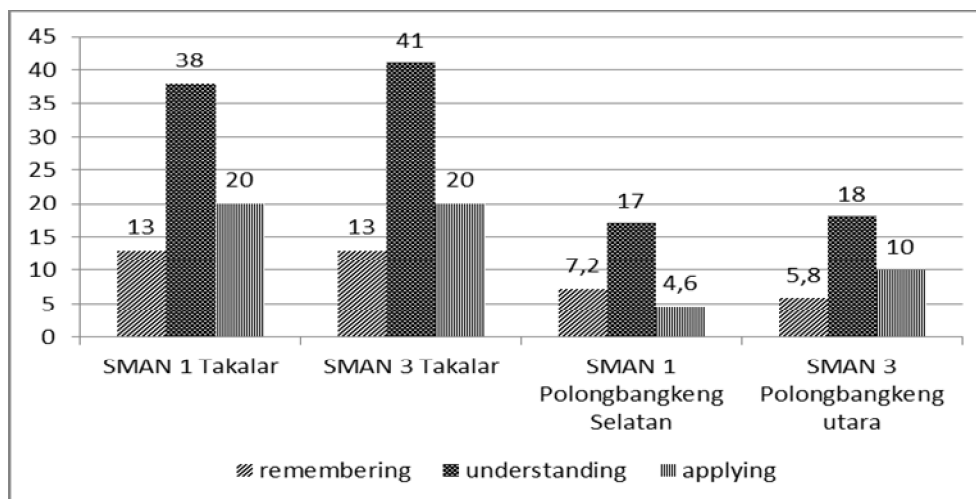
Statistic	Statistic Score
Minimum score	6.0
Maximum score	100.0
Ideal score	100.0
Mean score	53.5
Median	50.0
Modus	38.0
Standard deviation	26.7

**Table 2.** Frequency Distribution of Students Prior Ability

Category	Interval	F
Low	< 26.7	30
Middle	26.7 – 80.2	71
High	> 80.2	33

**Table 3.** Average Value of Each Aspect of Prior Ability

Aspect of prior ability	Average value
Remembering (C1)	9.8
Understanding (C2)	28.5
Applying (C3)	13.7



**Figure 1.** Average value of each aspect of prior ability for each school

*Description of creative thinking ability of students*

The results of the descriptive statistical analysis of students’ creative thinking ability through verbal creativity tests indicate a minimum score of 16, a maximum score of 93, an average score of 48.6, median 42, mode 20, and a standard deviation of 23.9. The results of the analysis of students’ creative thinking ability based on verbal creativity tests are presented in Table 4.

The frequency distribution of creative thinking ability through verbal creativity tests with categories of low, middle, and high can be seen in Table 5. It can be seen that the highest frequency of creative thinking skills through the verbal creativity test is 82, which is in the middle category. So it can be concluded that in general, the creative thinking ability of learners in Takalar is in the middle category.

Description of the average value for each aspect of the verbal creative thinking abilities can be seen in Table 6. It can be seen that the fluency aspect of creative thinking has the highest average. More clearly, the average value for each aspect of the creative thinking abilities at each school can be seen in Figure 2.

**Table 4.** Descriptive Statistics for Students’ Creative Thinking Ability

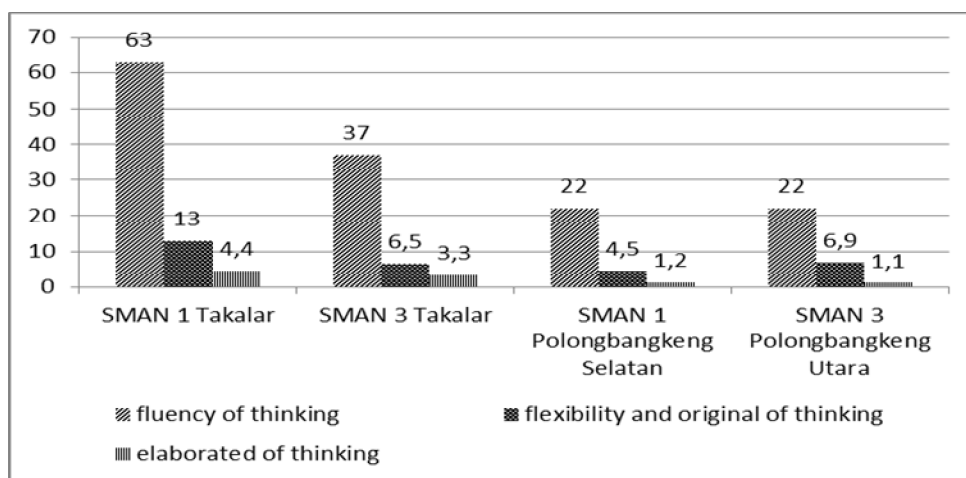
Statistics	Statistic Score
Minimum Score	16.0
Average Score	48.6
Median	42.0
Mode	20.0
Standard deviation	23.9

**Table 5.** Frequency Distribution of Students' Creative Thinking Ability

Category	Interval	Frequency
Low	< 90.058	32
Middle	90.058 – 124.42	82
High	> 124.42	20

**Table 6.** Average Value Aspects of Creative Thinking

Aspect of creative thinking	Average value
Fluency of thinking	36.0
Flexibility and originality of thinking	7.7
Elaboration of thinking	2.5



**Figure 2.** Average value for each aspect of verbal creative thinking abilities at each school

*Correlation between prior knowledge and creative thinking ability*

From the data processing, the coefficient correlation between prior knowledge and creative thinking ability using the Pearson Product Moment technique is 0.619, with a significance value of  $0.000 < \alpha$ . It means that the presented hypotheses are accepted, or there is a relationship between prior knowledge and the creative thinking ability of students.

Regression analysis showed that the value of the variable constant prior ability and the creative thinking ability is 18.885 and the value of the regression coefficient is 0.556. Thus, the pattern of the relationship between prior ability and creative thinking ability can be expressed in the equation of the regression line:  $\hat{Y} = 18.885 + 0.556 X_1$

**Conclusion and Discussion**

The result of analysis descriptive showed that the prior knowledge of Takalar learners was in the middle category. Results of this study illustrates that learners in Takalar have sufficient ability in terms of remembering, understanding, and applying their knowledge in order to gain further knowledge.

Based on the analysis of the average value of each aspect of prior knowledge, it can be seen that the understanding aspect has the highest average and the remembering aspect has the lowest average. This value indicates that learners in Takalar have the ability to

understand more than the ability to remember. Of the four schools that participated in the study, the average value of achievement for each aspect of prior knowledge at high-performing schools located in the city is higher than that for low-performing schools located outside of the city. The result of descriptive analysis also showed that creative thinking ability of learners in Takalar is in the middle category, and that the fluency aspect of thinking has the highest average whilst the elaboration of thinking aspect has the lowest average. This means that learners in Takalar have fluency of thinking. Each school presented a different average value for each aspect of creative thinking ability, but the high-performing schools located in the city have higher average values than the low-performing schools outside of the city. This is because the high-performing schools located in the city had study groups and performed tutoring, while the low-performing schools located outside of the city offered no form of tutoring. Tutoring affects the ability of learners as they learn through the additional practice and further develop their prior knowledge. The result of this study corresponds to the results of the study by Anwar and Rasool (2012), who stated that students from city institutions had the ability to think more creatively than students from outside the city (Al-Hajjaj, 2010; Cameroon and Bryan, 1992; Mariati, 2006; Munandar, 2009; Prawiradilaga, 2009; Purwanto, 2011; Raehana, 2013).

The results of correlation analysis showed a relationship between the prior ability of students and their creative thinking ability. The coefficient correlation between these variables is 0.619. This value indicates that the direction of the relationship between prior knowledge and creative thinking ability is positive. It means that the learners who have higher prior knowledge have higher creative thinking ability. Conversely, learners who have lower prior knowledge have lower creative thinking ability.

The results of regression analysis indicate that the pattern of the relationship between the variables of prior knowledge and creative thinking ability is  $Y_1 = 18.885 + 0.556 X_1$ . The pattern of the regression equation provides the information that each unit of change in the score of prior ability leads to changes in creative thinking ability score by 0.556. In addition, the coefficient of determination (R square) between the two variables is 0.384. This value explains 38.4% variance of the creative thinking ability variable as explained by prior ability and 62.6% influenced by other variables.

The results of the analysis of the average value for each aspect of the initial capabilities and aspects of creative thinking abilities found that, at the beginning, prior knowledge variables and aspects of understanding had average values that were the highest among the other aspects. The creative thinking ability variable and the fluency aspect of thinking had the highest average value. In terms of these aspects, it can be said that there is a relationship between prior knowledge and verbal creative thinking abilities, as the understanding aspect in prior ability makes students more fluent in expressing words or phrases in verbal creativity testing. In summary, there is a relationship between prior knowledge and creative thinking ability in the learning of chemistry.

## Notes

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