The Effectiveness of Contextual-based Instructional Materials of Elements of Group 15 For Inorganic Chemistry

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Abstract: The purpose of research is determine the effectiveness of teaching materials based contextual elements of group 15 for the course of inorganic chemistry. The research design is one group pretest-posttet only. Subjects were students of Chemistry Education University of Palangka Raya as many as 47 people. Based on the research results, is obtained percentage of graduated postes amounted to 93.6%, mean of n-gain score is 0,54 (moderate), and the probability value (p) is 0,000, showed no significant difference between the pretest and posttest. Therefore, teaching materials element of group 15 based on contextual for inorganic chemistry course effective to improve student's learning result.

Keywords: effectiveness, teaching materials, element of group 1, contextual

Chemistry plays an important role in all aspects of human life (Aniodoh, 2001). Nbina & Avwiri (2014) explained that chemistry is one of the basic knowledge and skills which is very important to contribute to the development of science in society. Atkins et al. (2010) states that inorganic chemistry is one branch of chemistry that studies the properties of elements in the periodic table. This field of science discusses broad aspects of life such as catalysis, semiconductors, optical devices, superconductors, and ceramic-making materials. Competencies that must be achieved in the study of inorganic chemistry at the tertiary level are knowledge, and skills to solve problems related to chemical properties, compounds, stability, synthesis, and reactions of non-metallic elements.

Students are required to take Basic Chemistry I and II as a prerequisite for taking Inorganic Chemistry I courses based on the curriculum at one of the universities in Palangka Raya, Central Kalimantan. Inorganic chemistry is an important subject because it contains the topic of group 15 elements. Group 15 elements are closely related to daily life. Based on the results of an interview with one of the lecturers teaching Inorganic Chemistry course in the Chemistry Education Study Program in Central Kalimantan stated that the group 15 element is important to study because the topic presented is closely related to the life around us. The topic group 15 elements can help students learn and understand chemical reactions further. The topics discussed in group 15 elements are the abundance of elements in nature, physical and chemical properties, uses, synthesis, and compounds (Development Team, 2012).

College students at university are adult education with approaches, scope, goals and strategies that are different from education in the school context. Basically, adults tend to prefer learning processes that are free, prioritize problem solving, improve skills, and are not rote oriented (Pannen & Sadjati, 2001; Fry et al, 2013). Group 15 elements are covered in Inorganic Chemistry courses and are studied at the tertiary level. Student learning outcomes for Inorganic Chemistry courses are still relatively low (Nbina & Avwiri, 2014; Sozbilir, 2004). This is based on student learning outcomes at the Palangka Raya University Chemistry Study Program in Inorganic Chemistry I and II courses from 2013, 2014 and 2015. As many as 16.8% of students did not graduate in 2013, as many as 18.2% of students did not graduate in 2014, and as many as 14.3% of students did not graduate in 2015. The results of the pre-research questionnaire on 33 students of the Chemistry Education Study Program at a university in East Java who had taken Inorganic Chemistry courses in general showed that as many as 57.58% of students

stated less than the maximum in understand one of the Inorganic Chemistry materials, namely group 15 (Personal documents that are not published).

Low learning outcomes were due to students tend to memorize instead of understanding the concept. An Inorganic Chemistry lecturer at a university in Central Kalimantan stated that students tend to memorize concepts in group 15 elements. Students should not memorize but understand the topic based on order, consistency, or variable relationships with one another. Students often experience errors in explaining the equation of reaction, notation, symbol, and the geometry of a compound. Therefore, learning designs are needed to improve learning outcomes.

According to Hosnan (2014), Jhonson (2014), Komalasari (2014) contextual-based learning approach offers a wide opportunity to improve learning outcomes. Contextual-based learning approach allows student to acquire and discover a meaningful concept by connecting the discusses learning topic with real-life situation. Eventually, it improves academic outcomes of students (Johnson, 2014). Mertasari (2005) reports that contextual-based learning approach positively influence the learning outcomes among the first semester students of Biology department, Faculty of Science Education at State Teacher's Training College Singaraja. Similarly, Maryam et al., (2005) conducted a research on the first semester students of Sport Science Department at State Teacher's Training College Singaraja. Th results confirm that cotextual-based learning approach improves students learning outcome.

Suyadi (2015) explains some of the benefits of contextual based learning are , (1) encouraging students to find relationships between the material learned and real life situations, (2) encouraging students to apply their learning outcomes in real life, and (3) emphasizing the process of student involvement in constructing the conceptual understanding. Therefore, contextual-based learning needs to be designed in the process of Chemistry lesson.

The development of instructional material is one of the important components in contextual-based learning approach because instructional material is not only from textbooks, but is developed from the context of the daily life environment of students such as physical environment, social life, culture, economics , and psychology (Komalasari, 2014). Somantri (2001) explained that in general instructional materials taken from the community environment did not pay attention to topics covered selection. The existing textbooks tend to demand students to memorize concepts but do not invite students to think in constructing knowledge and experience. Students have not been guided independently
in finding concepts , meanings , and material relations with individual life and society.

The development of instructional materials is required if the existing textbooks do not meet the needs of the learning process in terms of quality, language, and limited time to complete the existing material appropriate curriculum to the learning objectives achieved (Pannen & Purwanto, 2001). Tasdelen & Koseoglu (2008) also explained that textbooks generally simplify content and applications and provide little information to develop the learning process into daily activities.

Empirical study conducted by Istiyono *et al* . (2007) in the odd semester students of the Physics Study Program Department of Mathematics and Natural Sciences Faculty of Yogyakarta State University proved that the use of teaching materials in the form of contextual-based modules in the electrical circuit analysis course increased. Purnawati (2013) also conducted research at the Vocational High School among students taking Chemistry Expertise in Madiun. The analysis showed that there was an increase in learning outcomes of 86.7% after using instructional materials in the form of contextual-based modules. Based on his findings, Eswindro (2012) also explained that the use of instructional materials in the form of modules could improve learning outcomes by 90.0% on research subjects in the International Standard Vocational High School (RSMKBI) Pioneering Program at SMKN 1 Blitar. Nentwig *et al.* (2007) on the contextual development in Germany known as *Chemie in Context, is* proven that contextual active learning improves the quality of chemistry learning from the process to the results. While Muhlisin (2012) explained that the use of

contextual-based instructional materials can improve learning outcomes by 0.64% (N-gain score) on research subjects in SMP Nusantara 1, Gubug District, Grobogan Regency. The contextual-based instructional teaching can improve learning outcomes, thus it need to be developed to support group elements 15 discussion. Therefore, this study is entitled **The Effectiveness of Contextual-based Instructional Materials of Elements of Group 15 For Inorganic Chemistry.**

METHOD

This study used a one group pretest-posttest only research design. The design of this study was chosen because in the Chemistry Study Program of the Department of Mathematics and Natural Sciences at the Faculty of Mathematics and Natural Sciences University of Palangka Raya there was only one class of Inorganic Chemistry I. The research design can be seen in Table 3.1. The number of subjects of this study were 47 people. Contextual-based group 15 instructional materials have been researched and developed. The average validity based on expert judgment obtained a value of 92.9% with the proper category, while the results of individual trials obtained a value of 85.7%.

Table 1 One Group Pretest-Posttest Only Design

Pretest	Treatment	Posttest
O_1	X	O_2

(Creswell, 2009)

Annotation:

O_1 = *pretest*

O_2 = *posstest*

X = The use of instructional materials

Nieveen (2007) explains that an effective product is if the product being developed provides results according to plan. The criteria for effective instructional materials according to experts are: (1) the percentage of achievement of at least 75% (Hackathorn et al, 2011 & Maryatun, 2015), (2) n-gain score is greater than 0.3 (Ramlawati et al, 2014 & Nugraha et al, 2013), (3) if the value of probability, p is smaller than 0.05 (Efe, 2015 & Nasir et al, 2014). Therefore, the effectiveness of instructional materials is measured based on a review of the percentage of the achievement, n-gain scores, and t-test data of learning outcomes.

Pretest and posttest results were used to count the number of students with grades that reach the standard before and after using instructional materials. The minimum standard for student achievement in the Chemical Education Study Program at Palangka Raya University is C or 55.5 for a scale of 100. The greater percentage of students who pass the standard shows the higher effectiveness of instructional materials.

The analysis used on the results of the pretest and posttest was to use n-gain score (g). The n-gain score was calculated by dividing the increase in actual average (G) by increasing the actual maximum mean value (Gmax) (Hake, 1998). The calculation formula is as follows.

$$\textit{N-gain score} = \frac{G}{G_{max}} = \frac{\text{postest} - \text{pretest}}{100 - \text{pretest}}$$

Tabel 2 Qualification Degree of *N-gain Score*

N-gain score (g)	Annotation
$\geq$ 0,70	High
0,70 > g $\geq$ 0,30	Moderate
< 0,30	Low

(Hake, 1998)

Arikunto (2010) explained that to calculate the effectiveness of the treatment in the design of the pretest posttest was to use the t-test with the condition that the data was normally distributed. Test the comparative hypothesis of the average of two samples if the data was in the form of intervals or ratios using a t-test (Sugiyono, 2014). Data analysis was performed with the assistance of SPSS 16.0 for Windows with paired sample t-test at the significance level $\alpha = 0.05$. H0 is rejected if the probability value, p is less than 0.05. Conversely, H0 is accepted if the probability value, p is greater than 0.05. Based on the research design, the proposed statistical hypotheses are:

H0: There is no difference between the results of the pretest and posttest

Ha: There is a difference between the results of the pretest and posttest

FINDINGS

The results of research on the effectiveness of contextual group 15 teaching materials in the form of a percentage of the number of students

achievement, n-gain scores, and t-tests are presented below.

Effectiveness Based on The Number of Passed Students

Pretest was conducted to determine the initial knowledge of students about group 15 elements. Table 3 presents the recapitulation data of the pre-test and post-test results, while Table 4 presents data on the percentage of passed score and the average score of the post-test pretest in terms of ranking.

Table 3 The Percentage of Passed Score on Pretest and Posttest

Test	Passed Score (%)	Avg
Pretest	8,5	36,60
Posttest	93,6	70,70

Annotation:

Minimum passed score = 55,5

Score range = 0 – 100

Table 4 The Percentage of Passed Score on Pretest and Posttest based on Score Rank

Score rank*	Passed Score Percentage (%)**		Avg**	
	Pretest	Posttest	Pretest	Posttest
Low	0,0	66,6	15,57	56,65
Moderate	0,0	96,9	37,67	73,04
High	50,0	100,0	38,10	72,60

Annotation:

* Determined based on the mean and standard deviation of the pretest value.

** Calculated based on the number of students per rank.

In the contextual learning process, an assessment of the activities and attitudes of students was conducted in group discussions. Table 4 is a recapitulation of student activity assessment in group discussions, while Table 5 is a recapitulation of attitude assessment in group discussions.

Table 5 Recapitulation of Student Activity Evaluation in Group Discussions

Aspect	Percentage (%)	Category
Analyzing data in the form of tables, schemes, and readings	53,2	Good
Answering questions on self-test, questions, activities, and blue boxes	42,6	Good
Finding concepts based on analysis		
Asking questions between students or with lecturers	46,8	Good
Presenting the results of group discussions	51,1	Good
Analyzing data in the form of tables, schemes, and readings	46,8	Good

Table 6 Recapitulation of Student Attitude Assessment in Group Discussions

Aspect	Percentage (%)	Category
Discipline	68,1	Good
Responsibility	40,4	Good
Tolerance	51,1	Good
Cooperation	48,9	Good
Attention	40,9	Good

Effectiveness based on N-gain Score

The results of the pretest and posttest analysis using n-gain scores show the effectiveness of instructional materials which is presented in Table 7. While Table 8 is the n-gain score in terms of score rank.

Table 7 *N-gain Score* of Pretest-Posttest Category

Percentage (%)	Category	*N-gain score (g)**
2,1	Low	< 0,30
93,6	Moderate	0,70 > g ≥ 0,30
4,3	High	≥ 0,70
Total avg	Moderate	0,54

Annotation: * Category intervals criteria according to Hake (1998).

Table 8 *N-gain Score* based on Score Rank

Score Rank	*N-gain Score Category*	Percentage (%)*	*N-gain Score Avg**
Low	Low	0,0	0,49
	Moderate	100	
	High	0,0	
Moderate	Low	3,03	0,56
	Moderate	93,9	
	High	3,03	
High	Low	0,0	0,56
	Moderate	87,5	
	High	12,5	
	Total avg		0,54

Annotation: * Calculated based on the number of students in each rank.

Effectiveness based on T-test

Analysis of the normality test is presented in Table 9, while Table 10 is a t-test pretest-posttest score.

Table 9 Normality Test of Pretest-Posttest Score

	One-Sample Kolmogorov-Smirnov
Pretest	0,803
Posttest	0,111

Table 10 T-test of Pretest-Prosttest

Test	p
Pretest-Prosttest	0,000

DISCUSSION

Effectiveness Based on The Number of Passed Students

The percentage of students who passed after learning by using instructional materials is one indicator of the effectiveness of instructional materials. The minimum standard for student achievement in the Chemical Education Study Program at Palangka Raya University is C or 55.5 for a scale of 100. Pretest was conducted to find out the initial knowledge of students about group 15 material elements. Students who participated in the pretest were 47 people. Pretest consisted of two test formats, tests with code A and B with sequential numbers that were randomized but have the same questions. Posttest was carried out after the implementation of the learning process using Contextual Based Group 15 Teaching Material. Table 3 presents the recapitulation data of the pretest and posttest results. The implementation of learning used a contextual approach. The learning was conducted in five meetings with face-to-face approach. During the learning process, it was assisted by three observers. The observers were assigned to assess the teaching and learning process of each meeting using the rubric of the teaching and learning process.

The observer was also assignet to assess student activities and attitudes in learning. Based on Table 5, each aspect of the assessment of student activity in groups was considered good. Similarly, the attitude of students in group discussions can be seen in Table 6, each aspect was good. The results of the assessment conducted by the observer showed that the lecturer had carried out learning using contextual-based instructional materials for group 15 elements well. In the process of learning, teaching approach greatly affects student learning outcomes. According to the percentage of passed score and the average score of pretest-posttest based on the rank, students' learning outcomes in each classification improves.

Table 4 presents the percentage of passed score on pretest and posttest based on rank. It was obtained that the lower rank students acquired an improvement in the posttest of 66.6%, from 0.00% in pretest. The average learning outcomes also increased, pretest by 15.57 and post-test by 56.65. The percentage of pretest for students in the lower rank is 0.00% and posttest is 96.6% accompanied by an average increase in learning outcomes, pretest is 37.67 and posttest is 73.04. Students in the top rank also experienced an increase of 50.0% for the pretest and 100.0% for the posttest.

The average percentage of students who passed received an increase from 8.5 to 93.6% and it is presented in Table 3. The average score of student learning outcomes increased from 36.60 to 70.70. Mahmudi (2005) explains that the effectiveness is defined as the relationship between output and goals, the greater the contribution of output to the achievement of goals, the more effective a program or activity. Hackathorn et al (2011) & Maryatun (2015) revealed that

instructional materials are said to be effective if the minimum percentage of achievement is at least 75%. The data in Table 3 shows an increase in the percentage of achievement and the average learning outcomes of at least 75%. Thus, contextual-based instructional material for group 15 elements effectively improve learning outcomes.

Effectiveness based on N-gain Score

Analysis of the results of pretest and posttest using n-gain score identify the effectiveness of instructional materials. Based on Table 7, the percentage of students who received a low n-gain score was 2.1%; moderate was 93.6%; and high was 4.3%. The n-gain score category used was the criteria proposed by Hake (1998), which is high if it is greater than or equal to 0.70; moderate if between 0.70 and less than or equal to 0.30; and low if less than 0.3. The average n-gain score is 0.56% in the medium category. N-gain score gives information on the increase of the pretest posttest. Instructional materials can improve student learning outcomes at each rank. The average n-gain score of students ranked lower, medium, and upper respectively 0.49; 0.56; and 0.56. Difference in value is not too significantly different. According to Ramlawati et al (2014) and Nugraha, et al (2013) instructional materials are said to be effective if the n-gain score is greater than 0.3. Based on the results of the analysis, the instructional material is effective in improving student learning outcomes in group 15 element material.

Effectiveness based on T-test

Before the t-test analysis was done, the normality test of pretest and posttest was performed. Table 9 shows the pretest and posttest scores Sig. respectively 0.803 and 0.111. Statistical test results give values greater than 0.05. Therefore, the pretest and posttest scores were concluded normal so that they could proceed to the t-test. T-test results from the pretest and posttest data are listed in Table 10. The analysis stage after the normality test was the t-test which aims to determine the significance of the data. Based on Table 4.14, the t-test for pretest and posttest scores gives a probability value, p of 0,000. The p value obtained is smaller than 0.05 so it can be concluded that the pretest and posttest scores are significantly different

Arikunto (2010) explained that to calculate the effectiveness of the treatment in the design of the pretest posttest using t-test with the condition that the data is normally distributed. Test the comparative hypothesis of the average of two samples if the data is in the form of intervals or ratios using a t-test (Sugiyono, 2014). Data analysis was performed with the help of SPSS 16.0 for Windows with paired sample t-test at the significance level $\alpha = 0.05$. H0 is rejected if the probability value, p is less than 0.05. Conversely, H0 is accepted if the probability value, p is greater than 0.05. Based on empirical studies, the t-test for pretest and posttest scores gives a probability value, p of 0,000. The p value obtained is smaller than 0.05 so it can be concluded that the pretest and posttest scores are significantly different.

CONCLUSION AND SUGGESTIONS

Conclusion

Based on the results of the study, IT obtained a percentage of the number of passed posttest score of 93.6%, an average n-gain score of 0.54 in the medium category, and a probability value, p of 0.000 which indicates a significant difference between the pretest and posttest scores. Therefore, contextual-based instructional material for group 15 element in inorganic subjects effectively improves student learning outcomes.

Suggestions

The suggestions that the researchers offered are (1) the effectiveness test should not only be conducted at Palangka Raya University students but can be applied at other universities, and (2) the number of research subjects should be added to see the effectiveness of teaching materials.

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