Journal of Education and Practice
ISSN 2222-1735 (Paper) ISSN 2222-288X (Online)
Vol.5, No.31, 2014 www.iiste.org

The Effect of Active-Cooperative Learning on Science Generic Skills of Students in Chemical Kinetics Course for Prospective Teachers

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Abstract
The purpose of the research is to determine the effect of active-cooperative learning on science generic skills for students prospective teachers. Research sampling was chemical education students attending the chemical kinetics course of the even semester of 2011 in Makassar State University of Indonesia. The results show there are significant active-cooperative learning on science generic skills of prospective teacher students.

I. Introduction

Many factors affect the success of education, but the teachers are the key factors that are very large role (Soehendro, 1996). The teacher is the single most important factor affecting student learning classrooms at all levels (Bell, 1997). One of the skills that should be given to prospective teachers are generic skills. A generic skill is the skill which can be applied across a variety of subject domains, and takes longer to acquire than domain-dependent (Lim, 1999). The skills acquired in a generic topic in certain subjects can also be used for other topics in the course or in other subjects. One example is in learning basic chemistry in college, students in addition to obtaining one topic of chemical materials also gained the ability that can be used to study the other topics of chemistry or other sciences independently (Moerwani, et al, 2000).

For science learning, generic skills are named science generic skills (SGS). Liliasari (2007) suggested tha tin order to win the global competition, science learning needs to be changed from a scientific study into thinking through science. The ability to think and act based on scientific knowledge possessed called science generic skills. Therefore in the chemistry course in universities, in addition to provisions intended to provide chemical material is also intended to provide a science generic skills. More college students are required to provide general skills in addition to specific skills each field (Luca & Oliver, 2002). Science generic skills that can be developed are: direct observation, indirect observation, sense of scale, symbolic language, logical frame, logical consistency, causality, modeling, logical inference, and abstraction (Moerwani et al, 2000). Therefore, chemical kinetics course should also develop science generic skills of students.

Students engage in learning still lacking (Semiawan, 1999). Research consistently has shown that traditional lecture methods, in the which professors talk and students listen, dominate college and university classrooms (Bonwell & Eison, 2003). Paulson & Faust(1998) also states: "The majority of all college faculty still teach their classes in the traditional lecture mode". The condition also occurs in learning chemical kinetics which is one of the subjects that must be followed by the chemistry education students. Atkins and Jones (Cakmakci & Aydogdu, 2010) states:"The chemical kinetics gives us insights into how chemical reactions take place at an atomic level, so it brings us to the heart of chemistry." Chemical Kinetics is a very important concept in learning chemistry (Tastan, Yalcinkaya, Boz, 2010), though research on teaching and learning chemical kinetics is still lacking (Chairam, Somsook and Coll, 2009; Tastan, Yalcinkaya, and Boz, 2010). On the other hand the concept mastery of chemical kinetics is one competency required for prospective chemistry teacher (Kemendiknas, 2007). Research and documentation show that chemical kinetics is considered as a difficult concept for students (Cakmakci & Aydogdu, 2010).

Learning chemical kinetics are mostly done with an approach dominated by the teacher (Chairam, Somsook and Coll, 2009; Koc et. al, 2010). Chemical kinetics are generally taught by the lecture method. Lecturer explained by using the whiteboard and the students record what is written by the lecturer on the whiteboard. There is also a lecturer who uses OHP and in-focus, but mostly just to make it easier to explain the course material. The amount of time the most is used by the lecturer to explain the course material, while students pay attention and listen. Students work individually to accomplish their tasks and cooperation among students has less attention. With this method, students engage in learning are very less. In order to run smoothly required learning activities for effective learning.

It is essential to equip student teachers with chemical kinetics and science generic skills. Debriefing can be done through the course of chemical kinetics with a student-oriented learning. For that we need to apply the learning that can make students more actively involved in learning. Students are also expected to work together with other students to achieve the learning objectives. Murphy, Picione, & Holme (2010), said to enable the student in the learning process, students need to work collectively to understand the concept or idea.

According Sisovic & Bojovic (2001), one approach that can improve the learning activity is a cooperative group. According to them, cooperative learning is a teaching method that requires the active participation of both students and lecturers. The use of cooperative learning has positive influence on learning outcomes (House, 2008). Learning occurs in the process of interaction between students, student-faculty, and between students and the learning content. In this study we compared the effect of active-cooperative learning with conventional learning on science generic skills in chemical kinetic for prospective teachers.

II. Active-Cooperative Learning

Active–cooperative learning is a learning that combines active learning and cooperative learning. One way to apply active-cooperative learning is to provide questions (Paulson & Faust, 1998; McConnell, 2005). Questions are designed in the form of the Student Work Sheet (SWS). Provision is made in a structured question because chemical kinetics is a subject which has a certain structure and in the study it needs to follow the structure. Active learning is learning that emphasizes the active involvement of students. Lecturer acts as a facilitator who creates environmental conditions that make the students construct their own course material. Cooperative learning is learning that gives students the conditions work in groups to achieve a common goal. Thus, the active-cooperative learning is learning that emphasizes the active involvement of students in groups to achieve a common goal which is done by giving the questions to the students.

In the past decade saw an increase in the attention of the faculty in teaching methods are varied groups that are labeled "active learning" and "cooperative learning" (Paulson & Faust, 1998). Nevertheless there are still many misconceptions and false beliefs about this term (Felder & Brent, 2009). Research shows that the majority of faculty still teach the traditional learning (Bonwell & Eison, 2003). Many studies have shown the advantages of active learning (Paulson & Faust, 1998, Felder & Brent, 2003b). Lectured method is still seen as a lecture a very efficient way to provide information, but to use the lecture method as the only form of learning makes the problem both on lecturer and the student (Paulson & Faust, 1998). If you have not be able to fully use the active learning, active learning can be used as a supplement to lecture learning method, without leaving a lecture at all.

Active learning is a process of engaging students in learning (McConnell, 2005). Involving students in the learning process gives them a deeper understanding and higher level thinking order. Students perform or practice the material learned during the learning progress. Lead the student through the learning process that makes them find the subject matter. For the application of active learning, it is necessary to change the orientation of the teaching. The faculty who have tended to be teacher centered become to students-centered. The key is to change the focus from teaching to learning. Students construct their own knowledge based on what they learned.

Active learning is to involve students in activities that encourage students to think and comment on the information provided (Centre for Teaching and Learning, 1993). In learning, students are not only passively listening to the lecturer. They are actively engaged in learning, including exercises that help students absorb what they hear, noting that exercise that can provide a response to the lecture material, doing complex exercises as a group that gives students application of course material in real life or in a new problem. In order to apply active learning, the role of faculty and students in the teaching-learning process needs to be revamped.

In conventional teaching in college, the most amount of time is used by college professors to explain the course material while students pay attention and listen. Students work individually to accomplish their tasks and cooperation among students has less attention. Learning is centered on the teacher or lecturer is usually lower quality than active learning and cooperative learning. In active learning, students solve problems, answer questions, create questions for their own, discuss, debate, explain idea, or brainstorm during the learning progress. In cooperative learning, students work in groups to solve problems and tasks with a positive interdependence and individual responsibility (Felder, 2001).

Perform a given task success relies heavily on the efforts of each member of the group. Lecturers are expected to create the conditions in which each member of the group can work effectively and support each other. Each member has responsibility towards the success of the group. Besides, each group member is expected to interact with each other. The result of collective thinking is usually better than the ideas of one person only. Students who are academically less have benefit from tutoring by students who are smarter. Academically strong students have benefit from a deeper understanding of the lecture material. Students can complete the task will be able to understand the lecture material better than if they just watched the professors do. Students unable to complete the task will feel they need to know there. By the time the answer is available they will give higher attention. Lecturer encourages communication between members of the group can run well. To determine whether or not the cooperation in cooperative learning groups then need to be evaluated. In order to know what needs to be repaired.

According to Hinde and Kovac (2001) learning implementation will make students learn better if: *first*, they are actively involved in the activities and thinking in the classroom; *second*, they construct and describe their own conclusions by analyzing data and discussing ideas; *third*, they learn how to work together to understand the concepts in the learning process; *fourth*, faculty serve as facilitator to help the group in the learning process; *fifth*, lecturer does not answer questions whose answers can be expected from the students themselves. By giving students the opportunity to brainstorm as a group so they can compare and develop their responses as a group. At this early stage in this way can enable passive students to become more active (Felder & Brent, 2003a). Research indicates learn by doing, and practice will give students one more step forward in the study (Paulson & Faust, 1998). Implementation active learning cooperative in the course of chemical kinetics is expected to equip students science generic skills better.

III. Science Generic Skills

In order to improve the thinking skills , the learning need to be changed, from a scientific study into thinking through science. Students are given the ability to think and act on scientific knowledge possessed, or better known as generic science skills (Liliasari, 2007). Science generic skills are common thinking skills of science learning. Science generic skills in teaching science at college chemistry including courses in chemical kinetics that can be developed are: direct observation, indirect observation, sense of scale, symbolic language, logical frame), logical consistency , causality laws, modeling, logical inference, and abstraction (Moerwani, et.al, 2000). In this study, the attention focuses on logical frames, logical consistency, mathematical modeling and logical inference.

Logical framework is a generic skill to think systematically based on the regularity of the phenomenon. Chemistry although is developed inductively but findings in chemistry then generalized. The result of this generalization is then used to explain other phenomena. For example, the generalization that a spontaneous reaction if ΔG reaction is negative, can be used to determine spontaneous of reaction or not. If the calculation is obtained from its ΔG reaction is negative, then the reaction is spontaneous reaction and vice versa if ΔG is positive then the reaction is not spontaneous.

Logical consistency is the skill to use the findings and laws in chemistry consistently. Chemistry originally developed inductively. Experimental observation is the first step to development of chemistry. After tested its validity, the data compiled from various aspects. Regularities that occur later developed into a theory. The theories used to predict other properties of the system are considered to have the same characteristics.

Modeling is necessary because a lot of studying chemistry abstract phenomenon. For example, to describe the shape and the size of atoms needed a modeling that can be seen in practice. In addition, the rules the laws of chemistry are also written in the form of a mathematical modeling. By mathematical modeling we can describe the quantitative relationships of various natural phenomenon and can reduce the equations that describe the phenomenon. Therefore it is also science generic skills very needed by students.

Science generic skills to deduce logically necessary to allow students to draw conclusions based on logical consideration of the foregoing without having to do a new experiment. Thus, students draw conclusions based on logical consequence of several phenomena that have been previously known. This skills well known as logical inference.

IV. Chemical Kinetics

Atkins and Jones (Cakmakci & Aydogdu, 2010) states: "The chemical kinetics Gives us insights into how chemical reactions take place at an atomic level, so it brings us to the heart of chemistry." The concepts in chemical kinetics is very important in learning chemistry (Tastan, Yalcinkaya, Boz, 2010; Sözbilir, Pinarbasi & Canpolat, 2009). Chemical kinetics is very important in chemistry to equip prospective teachers. Learning chemical kinetics at the middle school emphasize on qualitative aspects. At the college level, chemical kinetic concepts taught more complex, because in addition to more complex quantitative explanation also use more complex mathematics, both for the equation and the variables that affect the rate of a reaction (Chairam, Somsook & Coll, 2009; Koc, et al, 2010).

Some literature suggests that chemical kinetics is a subject that is considered difficult by students (Alper, 1999; Banerjee, 1995; Eberhart, 1995; Gerharti, 1994; Adesoji & Ibraheem, 2009; Cakmakci & Aydogdu, 2010). In fact, according to Nicoll and Francisco (2001) physics chemistry is not only considered to be difficult by students but also by the lecturers. They also suggest that students enter the classroom with negative perceptions of physical chemistry and the low expectations of the courses and their success. Chemical kinetics is a part of physical chemistry

Learning chemical kinetics are mostly done with an approach dominated by the teacher (Chairam, Somsook and Coll, 2009; Koc, et al, 2010). The lecturer is still very dominant, while the student is still very passive. To be able understanding the concepts of science including chemical kinetics in depth required the active participation of students in the learning process (Keer, Geerlingsb, and Eisendrath, 2004).Learning chemical kinetics is often seen as an application of mathematics when the mathematics it should be used as a tool to understand chemical kinetics. Because of these problems it is necessary applied chemical kinetics course that can be used to improve the ability of a chemistry teacher.

V. Research Methodology

This study was a quasi-experimental study aimed to determine the effect of active-cooperative learning on science generic skills of students in the chemical kinetics. Students were divided into two classes. Students who have a odd number of students are grouped in first class and students with an even number are grouped into second class. Selection of experimental class and control class is done randomly. To determine the effect of active-cooperative learning, one class taught by active–cooperative learning and the second class taught by conventional learning. After learning, science generic skills were measure at both the classes. The skills examined in this study are: mathematical modeling, logical frame, logical consistency, and logical inference. A tool to determine science generic skills of students is science generic skills test that has been validated by two experts. Test reliability of the test is 0.74. The samples were chemistry education students who follow chemical kinetics course at even semester of academic year 2011 at the State University of Makassar, Indonesia. The data were analyzed using t-test for normally distributed data and Mann-Whitney test for not normally distributed data.

VI. Result and Discussion

Table 1. Examine Score Comparison of Science Generic Skills of Experimental and Control Class

Science Generic Skills	Class	N	Mean	Std. Dev.	*P*	Conclusion
Mathematical Modeling	Experimental	39	54.74	8.69	[b]0.002	significant
	Control	42	46.99	12.35		
Logical Frame	Experimental	39	57.78	11.78	[b]0.001	significant
	Control	42	48.25	11.39		
Logical Consistency	Experimental	39	57.05	13.65	[a]0.0045	significant
	Control	42	48.30	15.43		
Logical Inference	Experimental	39	55.26	13.67	[b]0.028	significant
	Control	42	49.52	16.26		
Average	Experimental	39	56.21	8.19	[a]0.0005	significant
	Control	42	48.27	11.63		

[a]Uji *t* (α=0,05)
[b]Uji Mann-Whitney (α=0,05)

In Table 1 are presented the results of statistical tests comparing scores of science generic skills of the experimental class and control class of student prospective chemistry teachers. Score mathematical modeling, logical frame, logical consistency, logical inference, and an overall average of students in the experimental class showed significantly higher than students in the control class. Test scores comparison of mathematical modeling, logical framework, and the logical inference is done with the Mann-Whitney test. Determine comparison of logical consistency and the overall average is done by t-test.

There are four science generic skills were targeted in this study. *First*, the mathematical modeling is a skill to disclose and use the relationship variables that explain the phenomenon. The ability of using mathematical modeling is necessary because many natural behaviors could not be expressed simply by using everyday language. Besides, a lot of chemistry material is abstract phenomenon that required a mathematical modeling to explain it. For example, to describe the energy and the probability of the presence of electrons in an atom is described by a wave function. Another example is the various rule or laws of chemistry are also written in the form of a mathematical modeling. By mathematical modeling we can describe the quantitative relationships of various natural phenomena and can reduce the equations that describe the phenomena. it is a generic skills required by students. Model of mathematics that has been developed and used in the chemical kinetics are the skill of using mathematical modeling and skills using the graphs. *Secondly*, logical frame science generic skill is the logical framework for thinking systematically based on the regularity of the phenomenon. Chemistry although developed inductively but findings in chemistry then generalized so that the logical frame skill is needed. *Third*, the logical consistency science generic skill is skill to use the findings and laws in chemistry consistently. Chemistry originally developed by inductive experimental. Observation is an initial step to developed chemistry. After tested the validity of scientific development, the data compiled from various aspect. Regular that occur later developed into a theory. The theories used to predict other properties of the system are considered that have the same characteristics. *Fourth*, logical inference science generic skill is a skill to conclude logically phenomena or facts that existed previously based on logical considerations without having to do a new experiment.

In the experimental class, science generic skills can develop well because the students are given the opportunity to apply in learning. Students trained to apply these skills in learning. Learning approach that challenges students to strive accomplishing chemical kinetics problems can provide enhanced science generic skills of students better. Learning that a greater emphasis on more active students can develops independent skills learning. The learning chemistry material is directed to chemical kinetics can develop KGS students. Science generic skills are less developed if students are not given the opportunity to apply them independently. The effectiveness of learning depends on the student's participation in learning. When students apply their own science generic skills in learning, they integrate conceptual knowledge with procedural skills. Oakley, et al (2004) stated that compared with learning conventional (traditional), learning where students are taught in a group has higher learning outcomes, deeper learning, having retain information longer, and fewer drop-outs. This makes science generic skills of students in the experimental class is better than the control class. Overall students in the experimental class showed significantly higher scores than students in the control class.

In the control class lecturers are still very dominant role, while the student is still very passive. Most of the course time is used by lecturers to explain the material by using whiteboard or *OHP* and *LCD*. This makes the course look monotonous and less able to stimulate students to be active in learning. According Kazempour (2009), teachers should be able to create learning conditions that directs and facilitates learning experiences that provide opportunities for students to be actively involved in constructing their knowledge.

Similarly, proposed by Sudjana (2000), according to the requirements for effective learning are engagement, responsibility and feedback. In the control class students work individually to accomplish their tasks and cooperation among students have less attention. Science learning activities including chemical kinetics can generally be described as an activity for the participants to self learning. The activity learning requires an active attitude and a change in the conception. By learning activities should create conditions that can facilitate conceptual change in students.

In conventional chemical kinetics study (control class), the amount of time used by most college professors explain, while students more attention and heard. And to be able to understand the science concepts in depth required the active participation of students in the learning process (Keer, Geerlingsb, and Eisendrath, 2004). The results of the study Cakmakci & Aydogdu (2011); and Chairam, Somsook & Coll (2009) showed that the active learning and cooperative approach to chemical kinetics gives higher learning outcomes. This has caused scores of science generic skills of students in the control class lower than the class experiments.

In the experiment class sought class active learning. Students solve problems, answer questions, discuss or exchange ideas during the learning, learning in groups cooperative. Students work in groups to solve problems and tasks with interdependencies positive. Lead the student through the learning process that makes them find the course material. Perform a given task success relies heavily on the efforts of each member of the group. Lecturers are expected to create an environment where every member can work effectively and support each other. So, each member has a responsibility towards the success of the group. This is consistent with research conducted by Koc et al. (2010). Their result show that the cooperative learning on chemical kinetics have better learning outcomes compared to traditional learning.

VII. Conclusions

Active-cooperative learning effects significance on the science generic skills of students. The average score of mathematical modeling, logical frame, logical consistency, and the logical inference science generic skills to the class taught by active-cooperative learning are 54.74, 57.78, 57.05, and 55.26, respectively,. The average score for mathematical modeling, logical frame, logical consistency, and the logical inference science generic skills of students taught by conventional learning are: 46.99, 48.25, 49.52, and 48,27, respectively.

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