

Experiment of Enzyme Kinetics Using Guided Inquiry Model for Enhancing Generic Science Skills

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Abstract. This study aims to enhance generic science skills of students using guided inquiry model through experiments of enzyme kinetics. This study used quasi-experimental methods, with pretest-posttest nonequivalent control group design. Subjects of this study were chemistry students enrolled in biochemistry lab course, consisted of 18 students in experimental class and 19 students in control class. Instrument in this study were essay test that involves 5 indicators of generic science skills (i.e. direct observation, causality, symbolic language, mathematical modeling, and concepts formation) and also student worksheets. The results showed that the experiments of kinetics enzyme using guided inquiry model have been enhance generic science skills in high category with a value of <g> average of 0.77. Four indicators classified in the high category are direct observation, causality, symbolic language, and mathematical modeling with the value of <g> 0.73; 0.70; 0.96; dan 0.85. Meanwhile, indicator of concepts formation in the medium category with a value of <g> 0.62

1. Introduction

Inquiry is the process of discovering knowledge based on search and discovery through a systematic process of thinking. Inquiry can be occurred in the process of students learning and experiment. Inquiry conducted in the experiment can improve skill of thinking, concepts understanding, skill of cognitive, argue ability, learning active^{1,2,3} and reduce misconceptions⁴. One of experiment performed by students in biochemistry lab. The purpose of this course are understanding of the basic concepts of biochemistry and develop laboratory skills. Based on the results of interviews conducted with a professor biochemistry at one of the universities at Bandung, current experiments with semi-open inquiry model. It means using local materials in the optimization of enzyme activity to conducted the best reagents and conditions. However, it was difficult for the students, because of the lack of experience in open inquiry and not all students were able to understand the purpose of the experiment. Students tend to remember the work steps contained of previous student reports. Therefore, there were still many students who need to be guided, then it was used inquiry guided models. Guided Inquiry Model develop analytical skills, cognitive process and social processes better than the open inquiry⁵. Stages of guided inquiry lab are observation, manipulation, generalizations, and applications⁶. Stage of guided inquiry will create an environment that motivate students to active learning by providing opportunities for them to build meaning and find the concept, therefore establishing a framework of an order high thinking skills, experiments in laboratory^{7,8,9,10}. Framework for higher-order thinking skills, also known as scientific thinking or generic science skills.



Generic science skills are abilities of intellectual combination result of complex interactions between science knowledge and skills¹¹. Generic science skills can be used to study various concepts and solve of problems in science¹¹. Therefore, generic science skills are commonly used in a variety of scientific work, and can be used as a basic in doing experiments. To identify generic science skills, according to the indicators formulated by Broto Siswoyo¹³. Indicators generic science skills included, 1) direct and indirect observation, 2) sense of scale, 3) symbolic language, 4) framework logic obey the principle, 5) logical inference, 6) causality, 7) mathematical modeling and 8) concepts formation.

Enzyme kinetics experiment were used in this study. Enzyme kinetics associated with qualitative test of the rate reaction catalyzed by enzyme. The enzyme used in the experiment was polyphenol oxidase (PPO). PPO accepted from natural materials known as local materials. Eggplant was used as a local materials. In the qualitative test of enzyme kinetics can use guided inquiry model. This study aims to enhance generic science skills of students using guided inquiry model through experiments of enzyme kinetics. Indicators of generic science skillstested were direct observation, causality, symbolic language, mathematical modeling, and concepts formation.

2. Research Methodology

This study used quasi-experimental methods, with pretest-posttest nonequivalent control group design. Subjects of this study were chemistry students enrolled in biochemistry lab course, consisted of 18 students in the experimental class and 19 students in control class. Instrument in this study were essay test and student worksheets. The essay test was used to measure the generic science skills of students in enzyme kinetics experiments. The research procedure is describe in Figure 1.

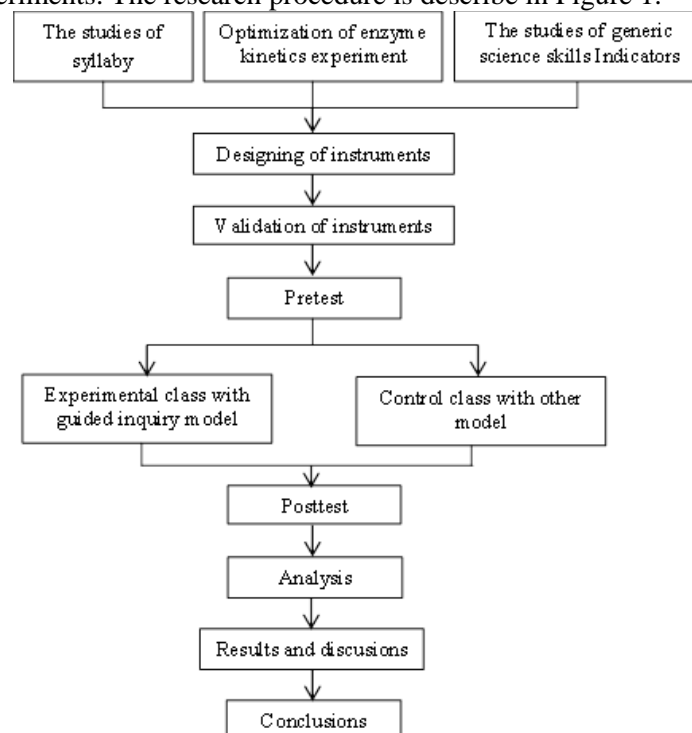


Figure 1. Research procedure

3. Resultsand Discussion

There were 8 aims of enzyme kinetics experiments: 1) isolating the enzyme PPO from local materials, 2) determine the type of substrate, 3) determine the optimum concentration of enzyme on

concentration of substrate remains, 4) determine the optimum concentration of substrate on concentration of enzyme remains, 5) determine of optimum temperature on enzymatic reaction of PPO, 6) determine of optimum pH on enzymatic reaction of PPO, 7) determine the most influential inhibitor against enzymatic reaction rate of PPO, 8) determine the type of inhibition that occurs in PPO enzymatic reaction. In the experimental class, enzyme kinetics experiment used guided inquiry model. To enhanced of generic science skills of students, they helped by worksheets. Generic science skills of students were assess based of pretest and posttest. An increase of generic science skillsbased on the value of normalized gain<g> obtained. The value showed in each indicatorsin both classes can be seen in Table 1.

Table 1 Analysisof studentsgeneric science skills in enzyme kineticsexperiment

Indicators	Experimental class				Control class			
	Pretest Average	Posttest Average	<g> Average	Category	Pretest Average	Posttest Average	<g> Average	Category
Direct observation	50,00	86,11	0,73	High	45,61	74,56	0,53	Medium
Causality	64,49	89,13	0,70	High	60,87	77,12	0,42	Medium
symbolic language	71,19	98,15	0,96	High	71,82	92,98	0,75	High
mathematical modeling	27,50	88,89	0,85	High	20,84	68,37	0,60	Medium
concepts formation	59,83	84,83	0,62	Medium	58,50	74,70	0,39	Medium
Average	54,60	89,42	0,77	High	51,44	77,55	0,54	Medium

Based on analysis of research results, it can be stated generally that two classes of study have been increased in generic science skills. The generic science skills improvement that occurred in the experimental class was higher than in the control class, this is evidenced by the value of <g> respectively for 0,77 and 0,54. Increased generic science skills of students in experimental class because of the model used in enzyme kinetics experiments. In the experimental class, enzyme kinetics experiments using a model of guided inquiry and other model in the control class. Based on statistical test between the experimental class and controlclass, the increase of generic science skills has significantly different. This proves that the experiments of enzyme kinetics using guided inquiry model can improved generic science skills of student better than other model. The stages that exist in the guided inquiry model were able to train students in improving laboratory skills⁹ as well as generic science skills. Stages of guided inquiry model was developed based on the phases of Wenning⁶, included observation, manipulation, generalization, and application.

Stages of guided inquiry conducted in enzyme kinetics experiment begins with observation. At the observation, students observe the phenomenon of enzyme kinetics that associate with live everyday. At this stage, it will be assess direct observation skill. Direct observation skill would be increased of this stage. Direct observation skill rated based on the ability of students in finding related phenomena enzyme kinetics of PPO in everyday live, finding a relationship phenomenon enzyme kinetics with the concepts, and determining the tools and materials enzyme kinetics experiments. The enzyme kinetics experiments using guided inquiry model have value of <g> 0,73 on direct observation skill in high category. Increased direct observation of students in experimental class at high and medium category. Based on the test results statistically significant differences between the high and medium category ($p=0.002$) at level of significance 5%. This proves that experiments of enzyme kinetics were using guided inquiry lab suitable for increasing the direct observation of students in the high category.

Stages of guided inquiry after observation was manipulation. At this stage, student determining influential variables in the experiment, and then prove the influence of these variables⁵. The ability to express the relationship between two or more variables in the phenomenon of enzyme kinetics and estimating the cause was known from generic science skills indicator causality. There were a series of relationships between the various factors of the observed phenomena¹¹. Causality skill rated based on the ability of students in finding related phenomena enzyme kinetics of PPO in everyday live, finding a relationship phenomenon enzyme kinetics with the concepts, determining the tools and materials enzyme kinetics experiments, analysis of data enzyme kinetics experiments. The stages of manipulation in determining variables involved in experiments of enzyme kinetics, generic science skill indicator causality would be better. This evidenced by the value of $\langle g \rangle > 0,70$ in the causal laws in enzyme kinetics experiments using guided inquiry model is classified in high category. Statistical tests carried out showed that there are significant differences between experimental class and control class ($p=0.000$) at a level of significance 5%.

Causality trained by worksheet in found of association phenomenon enzyme kinetics with concepts, determine the tools and materials used in experiments of enzyme kinetics, conducting experiments of enzyme kinetics by connecting all the variables, for example, the type of suitable substrates, varying substrate that observed brown color changes were more significant. With a variety (type of substrate, temperature, pH, and the inhibitor) undertaken by students in the experiments of enzyme kinetics, causality of students should be trained. Increased causality student experimental class at the high and medium category. Based on the test results statistically significant differences between the high and medium category with ($p=0.000$) at level of significance 5%. This proved that experiments of enzyme kinetics using guided inquiry model was suitable for increasing the causality of students in the high category.

There were no significant difference between experimental class and control class for the symbolic language and mathematical modeling occurs. Kinetics enzyme experiment was a procedural knowledge, regarding the activities of how to do something¹⁴. While the symbolic language and mathematical modeling is a conceptual knowledge. Symbolic language and mathematical modeling obtained by the students during the course of biochemistry. With the guided inquiry model, students will form a construction of thought and conduct a recall of concepts that have been obtained¹¹. Symbolic language and mathematical modeling skills trained by worksheets, where was described the data in tables and graphic. The increased of symbolic language and mathematical modeling are high and low categories at experimental class. Based on the test results statistically significant differences between high and low categories ($p=0.003$) at significance level 5%. This proved that enzyme kinetics experiment using guided inquiry model lends itself was enhancing symbolic language and mathematical modeling of students in the high category.

From the generalization, students will be have a conclusion to find the concept of the relationship of each variable. Generic science skills that can be observed in this case that concepts formation. With the conclusion obtained by students through the stages of generalizing the generic science skills indicator concepts formation will be better. Concepts formation skill trained by worksheets, where was completing all of question. This evidenced by generic science skills indicator concepts formation in experiments of enzyme kinetics using guided inquiry model value of $\langle g \rangle > 0.62$ were classified in medium category and statistical tests carried out showed that there are significant differences between experimental class and control class ($p=0.012$) at level of significance 5%.

The experiments of kinetics enzyme using guided inquiry model increased concepts formation study of student in high, medium, and low category. Based on the test results statistically significant differences between the high and medium category ($p=0.003$), between medium and low categories ($p=0.003$) and between high and low categories ($p=0.000$) at level of significance 5%. This proved that the enzyme kinetics experiments using guided inquiry model suitable for increasing concepts formation of students in the high category. Concepts formation skill assisted by the student worksheet.

The application of guided inquiry model on experiments of enzyme kinetics based on local materials improved generic science skills overall students in high category. With four indicators of generic

science skills classified as high category that direct observation, causality, symbolic language, and mathematical modeling. While one of indicator in generic science skills concepts formation in medium category . Application of guided inquiry model of enzyme kinetics experiments based on local materials suitable for improving science generic skills of students particularly high category on indicators of direct observation, the causality, symbolic language, and mathematical modelling.

4. conclusions

The results show that experiments of kinetics enzyme using guided inquiry model have been enhance generic science skills in high category with of average $\langle g \rangle$ value 0.79. Four indicators classified in the high category. There are direct observation, causality, symbolic language, and mathematical modeling with $\langle g \rangle$ value 0,73; 0,70; 0,96; dan 0,89. Meanwhile, indicator of concepts formation in the medium category with $\langle g \rangle$ value 0.60.

5. references

- [1] Arias H, Lazo L, and Canas F 2014 *J. Chil. Chem. Soc* **59** (4) 2747-52
- [2] Supasornand S & Lordkam A -*Social and Behavioral Sciences* **116**
- [3] Simonson S.R, and Shadle S.E 2013 *Journal of STEM Education* **14** (1) 56-62
- [4] Sesen B.A., and Tarhan L 2013 *Res SciEdu* **43** pp 413-35
- [5] Wenning C.J 2010 *J. Phys. Tchr. Educ* **5**(3) Winter 11-20
- [6] Wenning C.J 2011 *Journal Physic Teacher Education* **6**(2) Summer 9-16
- [7] Gaddis B.A, and Scoffstall A.M. 2007 *Journal of Chemical Education* **84** (5) 848-51
- [8] Bailey C.P., Minderhout V., and Loertscher L 2012 *Biochemistry and Molecular Biology Education* **40** (1) 1-7
- [9] Fakayode S.O 2014 *Anal Bioanal Chem* **406** 1267-71
- [10] Simonson S.R., and Shadle S.E 2013 *Journal of STEM Education*, **14** (1) 56-62
- [11] Tawil M and Liliyasi 2014 *Keterampilan-keterampilan Sains dan Implementasi nya dalam Pembelajaran IPA* (Makasar: Badan Penerbit UNM)
- [12] Bailey C.P., Minderhout V., and Loertscher L 2012 *Biochemistry and Molecular Biology Education* **40** (1) 1-7
- [13] Brotoiswoyo B.S 2012 *Kiat Pembelajaran MIPA dan Kiat Pembelajaran Fisika di Perguruan Tinggi* (Jakarta: Departemen Pendidikan Nasional Kualifikasi Nasional Indonesia)
- [14] Anderson L.W, (Ed.), Krathwohl D.R, (Ed.), Airasian P.W, Cruikshank K.A, Mayer R.E., Pintrich P.R, Raths J, and Wittrock M.C 2001 *A taxonomy for learning, teaching, and assessing: A revision of Bloom's Taxonomy of Educational Objectives* Complete edition (New York: Longman)