IOP Conf. Series: Materials Science and Engineering **349** (2018) 012008 doi:10.1088/1757-899X/349/1/012008

Generic Science Skills Enhancement of Students through Implementation of IDEAL Problem Solving Model on Genetic Information Course

A Zirconia[1*], F M T Supriyanti[2], A Supriatna[3]**

[1] Chemistry Education Study Program, Graduate School of Indonesia University of Education
[2,3] Chemistry Education Department Indonesia University of Education

*e-mail: zirconia.ai@gmail.com

Abstract: This study aims to determine generic science skills enhancement of students through implementation of IDEAL problem-solving model on genetic information course. Method of this research was mixed method, with pretest-posttest nonequivalent control group design. Subjects of this study were chemistry students enrolled in biochemistry course, consisted of 22 students in the experimental class and 19 students in control class. The instrument in this study was essayed involves 6 indicators generic science skills such as indirect observation, causality thinking, logical frame, self- consistent thinking, symbolic language, and developing concept. The results showed that genetic information course using IDEAL problem-solving model have been enhancing generic science skills in low category with <g> of 20,93%. Based on <g> result for each indicator, showed that there are indicators of generic science skills classified in the high category.

Keywords: genetic information course, IDEAL problem-solving model, generic science skills.

1 INTRODUCTION

One of the problems faced by students in the Biochemistry 2 course is the concept of genetic information (protein biosynthesis). One of problem that faced by students in biochemistry 2 class is the concept of genetic information flow (protein biosynthesis). The genetic information is the change of DNA into proteins where the genetic code changes the DNA sequences into amino acid sequences. Proteins are arranged of hundreds of amino acids bound by peptide bonds [1].

The DNA molecule is a double helix-shaped polynucleotide chain that has a nitrogen purine and pyrimidine bases. DNA molecules can replicate, transcribe and translate, thereby determining the sequence of amino acids in protein formation. It determines the role of the DNA molecule as a material carrier of genetic information or the nature of heredity in living organisms, such as hereditary diseases such as type I diabetes that can be passed from parent to child.

Genetic information includes a few unobservable and interdependent mechanisms, it is a subject that is poor to be understood by students [2]. In survey previously, genetic information subject has been

defined as the sixth the most difficult subject to learn among thirty subjects [3]. It has been determined that students lack information on understanding the relationships between every stage of genetic information process although students can connect between gene and protein synthesis. In another study mentioned in addition to the biochemical process, students are also difficulties in determining the order of DNA, RNA and amino acid genetic information flow process results [4].

The lack authority of concept causes the students' cognitive learning outcomes to be low. Low cognitive learning outcomes of students also led to the basic capabilities of students to be low anyway. This basic ability is known as generic science skills. According to Liliasari, the generic science skills are constantly evolving along with the increase of high order thinking skills, generic science and creative skills including being in it, so that generic science skills can be seen to relate to students' cognitive learning outcomes [5].

According to Brotosiswoyo generic science skills gained from the learning process, beginning with the observation of natural phenomena (1) observation (direct or indirect), (2) awareness of scale, (3) symbolic language, (4) logical frame (5) logical consistency, (6) causal law, (7) mathematical modeling, and (8) developing concepts [6]. Generic skills consist of fundamental skills, people related skills, personal skills, thinking skills, business related skills, and community-related skills [7]. These skills are ultimately less able by the students if the lecturer uses conventional methods.

One of lecture models that can be used to improve students' generic science skills is the problem solving model. In this study, problem solving model used is the IDEAL problem solving model. The IDEAL problem solving model is a problem solving model introduced by Bransfort and Stein to improve thinking ability and problem solving. This problem-solving model has steps such as (1) identify problem (2) define the goal, (3) explore the solution, (4) act the strategy, (5) Look back and Evaluate the effect [8].

This article discussion about research results related to improving students' generic science skills after implementation IDEAL problem solving model in the genetic information course.

2 METHOD

Method of this research was mixed method, with pretest-posttest nonequivalent control group design. Subjects of this study were chemistry students enrolled in biochemistry course, consisted of 22 students in the experimental class and 19 students in control class. Instrument in this study was essay involves 6 indicators generic science skills such as indirect observation, causality thinking, logical frame, self- consistent thinking, symbolic language, and developing concept.

3 RESULTS AND DISCUSSION

The purpose of this study is determine generic science skills enhancement of students after the implementation of IDEAL problem solving on genetic information lecture. The findings obtained from test result in the form of pretes and postes, observation sheets, and student worksheets.

3.1. Finding based on score test result

The purpose of this subtopic is to get information about enhancement generic science skills enhancement of students based on test result. The test scores included pretest and postest obtained from a essay test consisting of 10 questions which developed from 6 generic science skills indicators. Results of average scores pretest and posttest generic science skills students in the experimental class and control obtained can be seen in Figure 1.

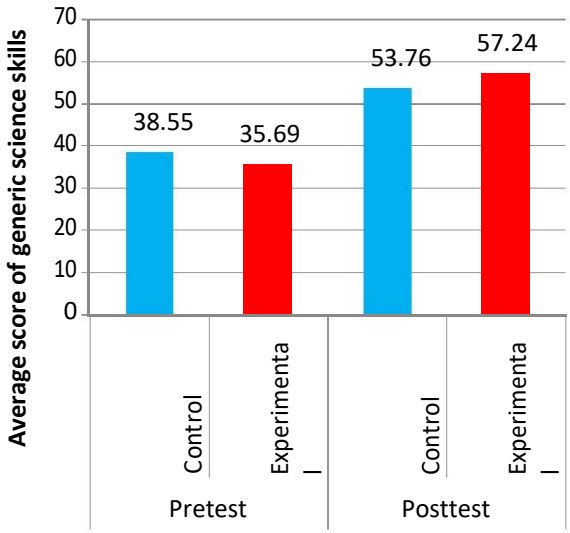

Figure 1. Results of average scores pretest and posttest generic science skills students in the experimental class and control

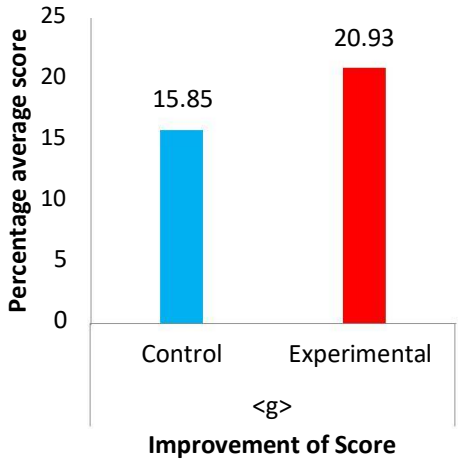

Figure 2. Percentage average scores <g> generic science skills student experimental and control class

Based on Figure 1 can be seen that experimental class pretest score less than the control class pretest, whereas experimental class posttest score higher than the control class pretest. It means IDEAL problem solving model can increase generic science skills students better than expository class. If the <g> experimental class score and <g> control class score is compared and both are obtained <g> score according to Figure 2.

Based on Figure 2 can be seen that <g> experimental class score with <g> of 20,93% in the low category better than <g> control class score with <g> of 15,85% in the low category. This proves that the result of the improvement of generic science skills in experimental class is better than control class. In the IDEAL problem solving model, the generic science skills students can developed using stages according to problem solving model developed by Bransford [8] appropriate Table 1.

Table. 1 Relationship IDEAL Problem Solving Stages and Generic Science Skills

IDEAL Problem Solving Stages	Generic Science Skill Indicators
Identify problem	1. Indirect Observation 2. Causal Law
Define the goal	1. Logical Frame 2. Self- Consistent Thinking
Explore solution	1. Self- Consistent Thinking 2. Symbolic Language
Act the strategy	1. Causal Law 2. Developing Concept
Look back and evaluate the strategy	1. Developing Concept

In Table 1, it can be seen that IDEAL problem-solving model genetic information course can be used to develop 6 generic science skill indicators according Brotosiswoyo[6] and Ramlawati et al[11] while 3 other indicators cannot be developed that is direct observation, awareness of scale and mathematical modeling.

In Figure 1, the average Postes and Pretes scores on generic science skills of experimental class and control class students have increased, but each class needs to be further analyzed on generic science skills improvement in both classes and whether there is a significant difference.

Table. 2 Test Results Statistics of Generic Science Skills on Pretest

Class	Normality Test	Homogeneity Test	Sig	Ref
Experimental	0,715	0,141	0,355	No diff.
Control	0,194			

In Table 2 can be seen that t test result obtained of 0,705 at significance level of 5%, because 0,705 > 0.05, there were no significant differences between the experimental class and control class. It means the ability of Generic Science Skills student in experimental class and control student at the beginning of the term did not differ significantly. Furthermore, the significance test on <g> total for Generic Science Skills can be seen in Table 3.

Table 3 Test Results Statistics of Generic Science Skills on <g>

Class	Normality Test	Homogeneity Test	Sig	Ref
Experimental	0,003	0,388	0,266	No diff.
Control	0,000			

Based on Table 3, it can be seen that the average score of pretest and postes is increasing, but not a significant improvement. This is evidenced from the U test results obtained for 0,266 at significance level of 5%, because 0.266 > 0.05 there were no significant differences between the experimental class and control class. After testing the significance of differences <g> total between the experimental class and control class is done, then the pretest-postest score of each indicator in the experimental class was tested for improvement through <g>.

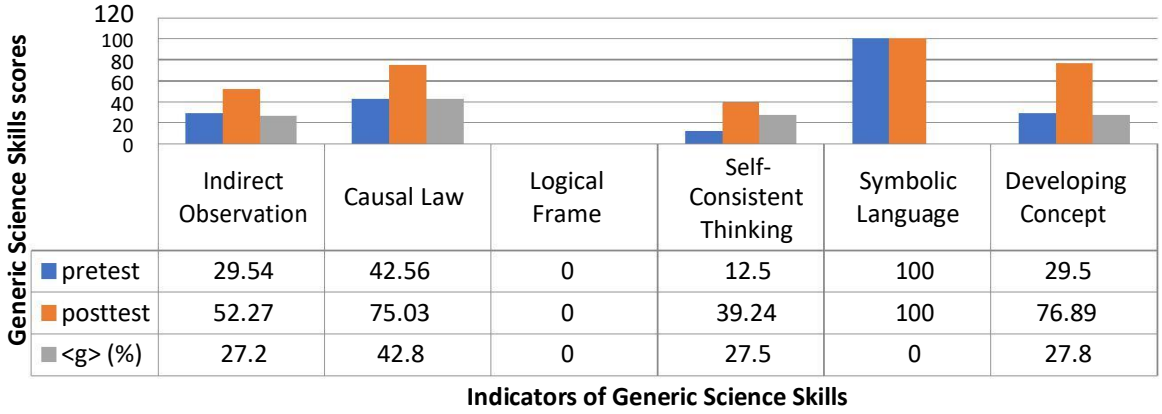

Figure 3. The score of generic science skills students experimental class at pretest and postest for each indicator.

Based on Figure 3 it can be seen that there are 6 indicators of Generic Science Skills which improved. Indicators of Generic Science Skills are indirect observation, causal law, logical frame, self-consistent thinking, symbolic language, and developing concept. The score of <g> showed just indicator causal law classified in middle category while score of <g> for 5 other indicators developed are low. Causal law indicators are observed at the identify problem and act the strategy stage problem-solving. Causal law is the ability to express the relationship between two or more variables in the phenomenon of heredity and estimate the cause, where there is a series of relationships between the various factors of the phenomena observed.[10] The causal law can be assessed from students' ability to state the relationship between two or more variables in a natural phenomenon and be able to estimate the cause of the natural phenomenon.[6] In these findings, causal law is assessed from students' ability to analyse the cause of heredity and determine the complementary DNA sequences, RNA sequences and amino acid sequences of the translation. This condition is suspected because students are less able to estimate the causes of heredity. Different results obtained by Agustin where in her research on improving the generic skills of science on the concept of interaction between molecules found that the causal law indicators classified into the low category of 27.62%. This is because Agustin's research emphasizes the modelling of interactions between molecules using interactive media.[9]

Indicators of generic science skills that have increased the most low is logical frame and symbolic language. Logical frame indicator can be assessed based on students' ability to connect between phenomena with a concept.[6] The logical frame indicator in this finding is the ability of students to be able to reveal the logical connection between genes and the process of genetic information through the central dogma concept. Based on the assessment, <g> the lowest of the generic science skill indicators developed, one of which lies in the logical frame indicator. Based on the results, score for logical frame indicator of 0% on low criteria. This is because students cannot express the physical meaning of the concept of central dogma and cause students to be less able to express the logical connection between genes and the process of genetic information through concept of central dogma. Students are only able to explain the concept of the central dogma verbally, but difficult to apply it to everyday problems. Unlike Anwar's research on chemistry kinetic lectures where in his research found that the indicators of obedience framework is classified in the middle category. This is due to the subject of Anwar's research emphasizing the chemical kinetics count so that students easily find a logical relationship between two variables.[13]

Indicators of generic science skills that lowest increase secondly is an indicator of symbolic language that observed in the exploration strategy stage. In this finding, the ability of the symbolic language in question is that students can determine the complementary DNA sequences. Based on the research, IDEAL problem-solving model cannot improve student symbolic language with <g> 0%. This is because students have been able to estimate the sequence of complementary DNA on pretest. This is evidenced from the score of student pretes with a maximum score of 100. Different results obtained from research Rafiuddin where the research on generic science skills on the subject of protein metabolism indicators showed relatively symbolic language middle category of 68.44% for the the dehydrogenation reaction concept and 50.02% for the concept of amino acid catabolism.[14]

4 CONCLUSION

The results showed that genetic information course using IDEAL problem solving model have been enhance generic science skills in low category with <g> of 20,93%. Based on <g> result for each indicator, showed that there is indicators of generic science skills classified in the high category.

REFERENCES

1. Merrick W C 2010 Eukaryotic Protein Synthesis: Still a Mystery. *The Journal Of Biological Chemistry* **285** 28 21197–21201
2. Lewis J & Robinson C W 2000 Genes, Chromosomes, Cell Division and Inheritance- Do Students See Any Relationship? *International Journal of Science Education* **22** 2 177-195
3. Venville G J, & Treagust D F 1998 Exploring Conceptual Change in Genetics Using Multidimensional Interpretive Framework *Journal of Research in Science Teaching* **35** 9 1031-1055
4. Concannon J, & Buzzetta M 2010 Students conceptualizing transcription and translation from a celluar perspective. *Science Activities* **47** 83-88.
5. Liliasari 2011 *Membangun Masyarakat Melek Sains Berkarakter Bangsa Melalui Pembelajaran* Makalah Seminar Nasional Unnes tahun 2011.
6. Brotosiswoyo, B.S. 2001. *Hakikat Pembelajaran Fisika di Perguruan Tinggi,* Dalam hakikat pembelajaran MIPA dan Kiat Pembelajaran Fisika di Perguruan Tinggi Jakarta : Proyek Pengembangan Universitas Terbuka, DEPDIKNAS
7. Singh, Harshvardhan dan Gera, Manju. 2015. Developing Generic Skills in Higher Education. *Indian Journal Of Applied Research*. **5** 6 824-826
8. Bransford *et al* 1998 *The IDEAL Workplace: Strategies for Improving Learning, Problem Solving, and Creativity* (Woshington DC: Nashville)
9. Agustin, R R 2013 Pengembangan Keterampilan Generik Sains melalui Penggunaan Multimedia Interaktif. Jurnal Universitas Pendidikan Indonesia. **18** 2 253-257
10. Muh Tawil dan Liliasari, 2014. *Keterampilan- keterampilan sains dan implementasinya dalam pembelajaran IPA (* Badan penerbit UNM : Makassar)
11. Ramlawati, Liliasari, Martoprawiro, Muhamad A, and Wulan A R 2014 The Effect of Electronic Portofolio Assessment Model to Increase of Students' Generic Science Skill in Practical Inorganic Chemistry *Journal of Education and Learning*. **8** 3 179-186.
12. Anwar M 2014. The Effect of Active-Cooperative Learning on Science Generic Skills of Students in Chemical Kinetics Course for Prospective Teacher *Journal of Education and Practice* **5** 13 149-154
13. Moerwani P C, Radiman S, Akhmad E, Ratnaningsih 2001 Hakikat Pembelajaran MIPA di Perguruan Tinggi. (Jakarta: Pusat Antar Universitas Untuk Peningkatan dan Pengembangan aktivitas Instruksional Universitas Terbuka).
14. Rafiuddin 2012 Pengembangan Program Pembekalan Kecakapan Generik Biokimia pada Materi Pokok Metabolisme protein bagi mahasiswa Calon Guru Disertasi SPS UPI: Tidak dipublikasikan