Contextual Inquiry Model to Improve Students' Science Process Skill on Microbiology Lesson

Hasruddin, Fauziyah Harahap
Biology Education, Faculty of Mathematics and Natural Sciences, State University of Medan
E-mail address: hasruddin_lbsmdn@yahoo.com
Mahmud
Chemistry Education, Faculty of Mathematics and Natural Sciences, State University of Medan

Abstract: This study aims to develop the design of contextual inquiry learning model to improve students' science process skills in microbiology lectures. The design of learning model developed in the form of contextual inquiry learning model. This Research and Development covers three stages of research that are: Needs analysis, Development of contextual inquiry learning model, and Trial of learning design. The research instruments used to collect data consisted of validation sheets by material experts, designers, and linguists, and a description test to measure the skills of the science process. It used descriptive statistics for data analysis. A preliminary study conducted on 40 students attending microbiology lesson indicated the need for microbiology teaching design which applies active learning process based on contextual inquiry. The results of a limited trial of 34 experimental class students and 35 control class students found that the research hypothesis was accepted, which means that contextual inquiry learning model of microbiology enhances students' process skills higher than conventional method.

Keywords: Microbiology, Process Skills of Science, Inquiry, Contextual

Abstrak: Penelitian ini bertujuan untuk mengembangkan desain model pembelajaran inkuiri kontekstual untuk meningkatkan keterampilan proses sains siswa dalam perkuliahan mikrobiologi. Desain model pembelajaran dikembangkan dalam bentuk model pembelajaran inkuiri kontekstual. Penelitian dan Pengembangan ini mencakup tiga tahap penelitian yaitu: Analisis kebutuhan, Pengembangan model pembelajaran inkuiri kontekstual, dan Ujicoba desain pembelajaran. Instrumen penelitian yang digunakan untuk mengumpulkan data terdiri dari kuesioner kepada ahli materi, ahli desain pembelajaran, dan ahli bahasa, serta tes objektif untuk mengukur keterampilan proses sains. Data dianalisis dengan menggunakan statistik deskriptif. Studi pendahuluan yang dilakukan pada 40 mahasiswa yang sedang mengikuti perkuliahan mikrobiologi menunjukkan perlunya desain pembelajaran mikrobiologi dengan menerapkan proses pembelajaran aktif berbasiskan inkuiri kontekstual. Hasil uji coba terbatas terhadap 34 siswa kelas eksperimen dan 35 siswa kelas kontrol ditemukan bahwa hipotesis penelitian diterima, yang berarti bahwa model pembelajaran inkuiri kontekstual pada perkuliahan mikrobiologi dapat meningkatkan keterampilan proses mahasiswa lebih tinggi daripada model pembelajaran langsung.

Kata kunci: Mikrobiologi, Keterampilan Proses Sains, Inkuiri, Kontekstual

INTRODUCTION

Inquiry as a learning model has been applied in Indonesian school since the 1975 curriculum. But its implementation is fay beyond the expectations. Improvement on the 1984 and 1994 curriculum focusing on process skills approach was basically a modification of inquiry. Likewise the enactment of the 2004, 2006 and even 2013 curriculum also highlighted the achievement of students' competencies by having scientific abilities. Expectations for students to have science process skills are certainly common. Essentially, science process skills possessed by students. Essentially, science process skills possessed by students are expected to encourage them to become scientists who are scientifically credible, skeptical, logical, creative, and free of value

However, in fact, the science process skills of students needs to be taken into account intensely. Essentially, Biology lesson, including microbiology emphasizes processes, products and attitudes which accustom students to actively solve problems through observation, formulating problems, planning investigations, conducting experiments, using devices to collect data, analyzing data, finding answers, making predictions, and communicating the obtained results. In the practice of Microbiology lesson, these ideal conditions cannot yet be fully realized (Pantiwati, 2013). The inquiry learning model that has been applied in learning activities has not been fully maximized hence only less students acquired science process skills (Astuti, 2016; Darlina & Afrianti, 2016).

Research results revealed by Gormally, et al. (2009), Minner (2007), Marjan, et al (2014), (Wilson, 2007); Gul (2016), Kloser (2011) state that learning using inquiry models improve science process skills and student learning outcomes. Therefore, the learning process using the inquiry model develop and improve learning outcomes in the form of cognitive, affective and psychomotor domains. According to Yager et al (2005), inquiry is a form of learning that uses scientific steps and is very effective in improving student science process skills.

The implementation of the inquiry model in learning is basically based on contextual constructivism. Through contextual learning, the inquiry model becomes more flexible and can provide leverage that has a greater chance of obtaining more optimal learning outcomes, including science process skills. As stated by Johnson (2002) that contextual learning helps lecturers in directing their students to be able to apply their knowledge as family members and the community. Baker (2008) states that contextual learning can improve and develop students' thinking skills, scientific attitudes, and science process skills.

Inquiry learning model combination within contextual learning structure is possible to be conducted. Lawson (2010) argues that the steps of inquiry learning consist of: attention, presenting problems, formulating hypotheses, collecting data, formulating conclusions, and reflecting on problems. Johnson (2002) suggests that contextual learning has eight components, namely: making meaningful correlation, independent learning, meaningful work, collaborating, critical and creative thinking, helping individuals to grow and develop, achieving high standards, and using authentic judgments.

The contextual inquiry learning model is expected to meet expectations to improve scientific investigation (Kubicek, 2005), student motivation (Sears, 2002), offering opportunities to empower student understanding (Susilawati & Suyanto, 2013), providing opportunities to think independently and help each other (Ambarsari et al., 2013), helping students connect subject matter to real-world context (Baker, 2009), and intellectual development, interaction, asking questions, learning to think, openness, with procedures to form problems, submit hypotheses, collect data, test hypotheses, and formulating conclusions (Sanjaya, 2016; Berns, 2001).

The domain of skills in Microbiology lesson learning includes science process skills. Students need to sharpen their science process skills that is practical to find a concept, principle, or theory to develop pre-existing concepts, or to deny an invention. Science process skills can be trained through the application of contextual inquiry. Thus, the problem in this study is: how much the effectiveness of the development of the contextual inquiry model towards improving student process skills in Microbiology lesson. This research is expected to contribute to problem solving in enriching student learning experiences in the science process.

Microbiology lesson should be student oriented. The role of the lecturer switches from determining what will be taught to how to provide and enrich student learning experiences. Learning experience is obtained through a series of activities to explore the environment through active interaction with friends, the environment, and other sources. Microbiology is a group of knowledge about objects or natural phenomena obtained and the results of the thoughts and research of scientists carried out with experimental skills, through scientific methods (Campbell et al., 2008). The scientific method is an easy way to introduce students to the science process (Blystone, 2006).

METHOD

This research was conducted at the Department of Biology, Faculty of Mathematics and Natural Sciences, State University of Medan, North Sumatra. This development research took 40 Biology Education students as the subject of research in a preliminary study. In addition, it involved two expert validators of field of study, two expert validators of learning design, and two expert validators of linguistics aspect. Nine students were taken as limited group subject and It took 34 students as experimental class and 35 students as control class for product trial process. The experimental class was treated by applying contextual inquiry learning while the control class treated by means of conventional learning.

The development model of Microbiology lesson based on contextual inquiry learning employed Borg & Gall (1989), which consists of (1) needs analysis, (2) drafting, and (3) validation and trials. At the stage of needs analysis, identification of competencies and fundamental problems faced by students in learning microbiology was carried out. The techniques used at this stage were surveys, interviews, and documentation studies to observe Microbiology learning process so far. Furthermore, a literature study was conducted to examine learning theories that are relevant to future demands hence it obtained a learning model that are in accordance with the needs analysis.

The preparation phase of the learning model was preceded by the preparation of syllabus, lesson plans, lecture contracts, learning media, student worksheets, and learning evaluations or assessments that are in accordance with the contextual inquiry learning model. The preparation of lecture devices was adapted to the current curriculum in the Biology Department, namely the Indonesian National Qualifications Framework, which pays attention to content standards, process standards, infrastructure standards, and evaluation standards.

The stage of validation and trial was carried out by conducting formative evaluation. Formative evaluation was carried out to collect information, information, data carried out by the researcher when processes, procedures, programs or products are in progress. Formative evaluation was carried out to assess product progress and obtain improvements to increase the effectiveness. Formative evaluation involves experts in their respective fields.

The expert validation in this study involved two Microbiologists from higher education with a qualification as Microbiology Doctor. The learning design was validated by two learning design experts who were qualified as educational technology professors, and also involved two linguists who were qualified as linguistic professors. The revised results from this expert validation are the development products that will be continued at the trial stage.

The testing phase was conducted to determine the effectiveness of the use of the design of the microbiology learning model. The implementation of the trials included individual prototype material testing, small group trials, and field trials. This individual trial was conducted to obtain initial input about the design product. Individual trials were conducted on three students, one low-ability student, one student with moderate ability, and one student with high ability in Microbiology lesson. After conducting individual trials, revisions to material, media, and the design of contextual inquiry-based learning based on input from three students were carried out.

Small group trials were conducted on nine students consisting of three low-ability students, three moderate-ability students, and three high-ability students. The results of this limited group trial were used to revise the design of contextual inquiry-based learning models.

The field trial involved 25 research subjects. In this field trial the initial test was carried out first and continued with the process of teaching and learning activities, and ended with a final test. The trial results were used to conduct data analysis thus it can determine the effective learning model to improve student science process skills. The revision of the learning model is carried out after all the devices developed have been tested. Revision activities were carried out to improve products based on input and assessment from experts and input field trials.

Research data was collected through tests of science process skills. The test consists of 40 questions. Before being used, the research instrument was first validated, both content and construction validation. Data relating to student responses were obtained through questionnaires and interviews conducted at the end of learning.

The data analysis technique used in this study was descriptive analysis. The technique used to analyze the results of the validation of the learning model was descriptive qualitative, by looking at the assessment of the feasibility of the learning model from the results of the study. Validator material experts, learning design experts, and linguists answered questions by giving a check list to 1-4 scale scores. Then the percentage score of the learning model was calculated.

Student responses to the design of contextual inquiry-based learning models in microbiology lectures were analyzed using percentage techniques. To find out the effectiveness of the learning implementation plan produced in this study, a trial was conducted in two different classes. One class employed products that have been developed and one class employed the conventional learning model that is commonly used. Measurement of student science process skills through initial tests and final tests used questions included in the learning implementation plan. The difference in the average science process skills in the two different groups was analyzed by the t test at the 5% significance level using SPSS version 22.0.

RESULTS AND DISCUSSION

Results

Based on the results of observations, questionnaire tabulations, and descriptions of interview data on the Microbiology learning process, the learning process undertaken by students has been categorized as active learning. Learning that is done already employs the inquiry model by involving students to ask questions, compose hypotheses, design experiments, analyze data, and form conclusions. But the conditioning in the form of cooperative learning in solving problems and also reflecting is still not performed intensively. Inquiry learning carried out still does not pay attention to the overall components of science process skills and has not been contextually conducted.

The learning process was done by performing a routine learning activities and mechanistic approach. Students were asked to do practicuum as practicing a cook book. Students are given less freedom of thought and expression to explore the potential. There are several steps in learning that have not run perfectly, for instance in formulating and testing hypotheses. This reality provides an opportunity for improvement in the design and implementation of learning.

In line with the existence of such fundamental problems, the development is needed, where learning models that are already good, it should beconsistently maintained to be better. When learning innovations are carried out, it should pay attention to the meaningful philosophy of learning, in which in the structure of contextual learning.

Microbiology learning material was adjusted to the characteristics of contextual inquiry learning. The topics discussed were Bacterial Analysis in Colonic Morphology, Bacterial Staining, Bacterial Measurement, Bacterial Grouping Based on Cell Forms, Mold Analysis in Laboratory Rooms, Tempe and Nata de Coco Production, Microbiological Analysis of Food and Beverages. From the analysis of the topic, it is possible to perform investigation according to the steps of the scientific approach.

Description of Validation Results

The first validation was conducted by two Microbiology experts whi are qualified as Doctor. The data is presented in Table 1 below.

The second validation was conducted by two learning design experts whi are qualified as Professor. The data is presented in Table 2 below.

The third validation was conducted by two Linguists whi are qualified as Professor. The data is presented in Table 3 below.

The individual trial was given to three students who have attended Microbiology course class. The obtained data is presented in Table 4.

Table 1. Validation Results on Lesson Plan by Microbiology Experts

Aspect	Indicator	Items	Score	Avg (%)	Criteria
Feasibility of Content	Quality of Lesson Materials	Profoundness of material	3	75	Good
		Accuracy of material coverage	3	75	Good
		Material logics	3	75	Good
		Accuracy of material sequence	3	75	Good
		Clarity of learning objective	2	100	Very Good
		Conformity with the curriculum	3	75	Good
		Simplicity of understanding	3	75	Good
		Validity of concept	4	75	Good
Contextual Inquiry Model	Lesson Delivery	Conformity with contextual inquiry	3	75	Good
		Students involvement	3	100	Very Good
		Free-thinking encouragement	3	75	Good
Presentatian Quality	Learning Strategy Quality	Quality of introduction	4	100	Very Good
		Quality of feedback	3	75	Good
		Presentation time	3	75	Good
		Quality of reflection	3	75	Good
		Quality of exercise items	4	100	Very Good
Total score obtained			52	81,25	Very Good

The small group trial was given to nine students who have attended Microbiology course class. The obtained data is presented in Table 5.

The field trial was given to 25 students who have attended Microbiology course class. The obtained data is presented in Table 6.

Table 2. Validation Results on Lesson Plan by Learning Design Experts

Aspect	Indicator	Items	Score	Avg (%)	Criteria
Feasibility of Content	Quality of Lesson Materials	Profoundness of material	3	75	Good
		Accuracy of material coverage	3	75	Good
		Material logics	3	75	Good
		Accuracy of material sequence	3	75	Good
		Clarity of learning objective	4	100	Very Good
		Conformity with the curriculum	3	75	Good
		Simplicity of understanding	4	100	Very Good
		Validity of concept	4	100	Very Good
Contextual Inquiry Model	Lesson Delivery	Conformity with contextual inquiry	3	75	Good
		Students involvement	3	75	Good
		Free-thinking encouragement	3	75	Good
Presentatian Quality	Learning Strategy Quality	Quality of introduction	4	100	Very Good
		Quality of feedback	4	100	Very Good
		Presentation time	3	75	Good
		Quality of reflection	2	50	Poor
		Quality of exercise items	4	100	Very Good
Total score obtained			53	82,81	Very Good

Table 3. Validation Results on Lesson Plan by Linguists

Aspect	Indicator	Items	Score	Avg (%)
Penggunaan Bahasa	Accuracy of sentence structure	3	75	Good
	Effectiveness of sentences	4	100	Very Good
	Clarity of language in the material	3	75	Good
	Clarity of sentences	4	100	Very Good
	Attractiveness of language style	4	100	Very Good
	Using language rules	4	100	Very Good
	Ease of understanding	3	75	Good
	Clarity of language meaning	4	100	Very Good
Ketepatan Bahasa	Clarity of letters	3	75	Good
	Clarity of symbols used	3	75	Good
	Clarity of orders	4	100	Very Good
Kesesuaian perkembangan mahasiswa	Use of punctuation	4	100	Very Good
	Conformity of students' level of thinking	3	75	Good
	Stimulate imagination	3	75	Good
	Inspire	2	50	Poor
	Build a way of thinking	3	75	Good
Total score obtained		54	84,38	Very Good

Table 4. Individual Response on Microbiology Learning Design

No	Avg Score (SRr)	Criteria	Percentage(%)
1	3,00 < SRr ≤ 4,00	Very Positive	22,52
2	2,00 < SRr ≤ 3,00	Positive	79,48
3	1,00 < SRr ≤ 2,00	Negative	0

The Effectiveness of Microbiology Learning Design

The product effectiveness of the contextual inquiry-based learning design in the microbiology lecture was tested using the t test by using SPSS version 22.0. Table 7 below shows the results of the t test.

Based on Table 7, data at equal variances assumed, there are differences at the level of 5% where $t = 4.722$; $p = <0.05$. The experimental group had a significant change compared to the control group. This means that the treatment given to the experimental group has higher posttest score of science process skills when using contextual inquiry-based learning designs compared to conventional learning.

DISCUSSION

The results of the needs analysis indicated that it is necessary to develop a learning design that creates active learning to improve student science process skills. Therefore, the learning model developed in this study is contextual inquiry. Contextual inquiry can encourage students to ask questions, conduct investigations, and develop their thinking abilities.

The steps of the scientific method according to Blystone (2006) include: defining problems, obtaining background information, formulating hypotheses, making observations, testing hypotheses, and drawing conclusions. Ergul (2004) states that some scientists complete the steps of the scientific method by communicating the results with the form of the final report. The steps are (1) Formulating and defining problems, (2) Conducting literature studies, (3) Formulating hypotheses, (4) Determining models to test hypotheses, (5) After the hypothesis is established, then formulating approach to test the hypothesis, (6) Collecting data, (7) Arranging, analyzing, and providing interpretations, (8) Making generalizations and conclusions, and (9) Compiling scientific reports. The final step of a scientific research is to compile a scientific report about the results obtained from the research.

Biology Education students must be accustomed to working scientifically, hence students must have the ability to become a scientist through the scientific method. Through the scientific method, students can apply and develop their skills in asking questions, formulating hypotheses, planning experiments, identifying experimental variables, collecting data, interpreting data, drawing conclusions, and communicating results. If the teacher/lecturer possesses these skills, it is expected to be able to apply in classroom learning, and can build students to always have a conduct like a scientist in gaining knowledge (Yokhed, 2010). Microbiology is one branch of Biology which includes an explanation of the application of microbiology to solve various problems in various fields, namely: health, clothing, food, energy, security, environment, agriculture, and industry. Thus, in line with the opinion of Musyaddad (2012), that contextual-based microbiology can be implemented in the learning process.

Process skills are thinking skills used to process information, solve problems, and form conclusions (Sukiniarti, 2016; Abdi, 2014). Process skills are physical and mental skills related to fundamental abilities that are owned, acquired and applied in a scientific activity thus scientists succeed in finding something recent (Haryono, 2006; Dewi & Sudana, 2016). By developing acquisition of processing skills, students are able to discover and develop their own facts and concepts and grow and develop attitudes and values demanded (Davis, 2013).

Tabel 5. Group Response on Microbiology Learning Design

No	Avg Score (SRr)	Criteria	Percentage(%)
1	$3,00 < SRr \leq 4,00$	Very Positive	28,26
2	$2,00 < SRr \leq 3,00$	Positive	71,74
3	$1,00 < SRr \leq 2,00$	Negative	0

Tabel 6: Field Trial Response on Microbiology Learning Design

No	Avg Score (SRr)	Criteria	Percentage(%)
1	$3,00 < SRr \leq 4,00$	Very Positive	24,58
2	$2,00 < SRr \leq 3,00$	Positive	75,42
3	$1,00 < SRr \leq 2,00$	Negative	0

Science process skills-based learning emphasizes the ability of students to find their own knowledge based on learning experience, laws, principles, and generalizations, so as to provide opportunities for the development of higher-order thinking skills (Fry, 2003).

Based on the nature of learning, Biology lesson is ideally developed towards the development of scientific processes, scientific products, and scientific attitudes. Scientific processes are identical in the process of scientific activities that develop student science process skills (Lawson, 2010; Rothstein & Rebecca, 2006). The skills of the process include skills in observing or identifying, calculating, measuring, classifying, identifying for space/time relationships, composing hypotheses, planning research/experiments, controlling variables, interpreting data, compiling inferences, predicting, applying, and communicating results (Haryono, 2006). The approach applied in presenting science learning (including microbiology) is a blend of science process experience and understanding of products and science technology in the form of direct experience that impacts on students' scientific abilities (Susilawati & Suyanto, 2013).

Habituation of learning through the science process can train scientific skills and systematic work, and form scientific thinking patterns of students. Therefore, the development of science process skills can have implications for the development of high-order thinking skills (Mahmudin, 2010; Cooper, 2002).

Science process skills that are elaborated in science learning can involve a variety of skills including intellectual, manual and social skills. By means of knowledge products formation through this scientific work process, scientific attitudes are important to maintain the purity of knowledge and continuity in its development. Therefore, the development of science process skills in students must continue to be carried out through continuous evaluation and assessment.

CONCLUSION

Based on the results of the study, it concludes that the design of appropriate contextual inquiry-based learning is used to improve science process skills of students in Microbiology lesson at the Biology Department of State University of Medan and science process skills of students taught with contextual inquiry are higher than conventional learning.

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