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THE DEVELOPMENT OF GENETICS GUIDED INQUIRY LEARNING TOOLS FOR BLENDED LEARNING THROUGH LESSON STUDY

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Abstract: The purpose of the research was to develop the guided inquiry learning tools for blended learning through Lesson Study (LS) to improve the quality of the genetics learning processes. The learning tools are syllabus, lesson plan and teaching materials. The research involved 5 lecturers and 1 student who are members of the LS team. Subjects were 54 Biology students who took genetics and divided into two classes, namely class A for the first LS and class B for the second LS. Data was obtained from the 13 LS activities in each class for 11 genetic materials conducted in April-July 2013. Data analysis was performed using descriptive-qualitative approach. The results showed that the input for the development of learning tools were: 1) the syntax of the guided inquiry need to be modified by adding "the students should consult to the lecturers before communicate the inquiry results to other groups"; 2) the students' activities should be adapted to the syntax of modified guided inquiry; 3) the formulation of the practical activity objectives should be more operational; 4) the concept definition should not be written in instructional materials but replaced it with an image so that the students will formulate their own definition. In terms of the implementation of the learning process the inputs were: 1) the students should consult the lecturers before doing the presentation; 2) the lecturers should provide guidance to all groups, not concentrated in certain groups; 3) the students should be motivated to actively submit questions with contextual examples. 4) students' understanding should be made clear by the use of the video that are relevant to the topic; 5) the presented inquiry results should be uploaded to the web in words and power point for blended learning. The results of research and development showed improvement in the quality of the learning processes of genetics. This is demonstrated by: 1) increase concentration of students' learning; 2) increase abilities of students' working together in groups; 3) increase abilities and experience of the lecturers in conducting guided inquiry using blended learning; 3) increase confidence of the lecturers when implementing the learning processes.

Keywords: Blended Learning, Genetics, Guided Inquiry, Lesson Study

1. INTRODUCTION

Communication skills, problem solving, information access and management, decision-making, collaboration, cooperation and the use of a variety of advanced electronic technology need to be mastered by college students (Galbreath, 1999). Therefore, the learning process should be conducted interactively, inspiringly, 3 excitingly, and challengingly, motivating students to actively participate and provide enough space for initiative, creativity, and independence according to their talents, interests, and physical and psychological development of students (Law No. 20 of 2003 on National Education System).

The fact, so far, shows that the practice of teaching in IKIP (Teachers Training College) PGRI Jember is still beyond the expectation, based on the preliminary survey conducted on October 12, 2012. Of the 15 biology lecturers surveyed, most of them still put students as the objects of study and still often use learning strategies which are dominated by the lecturer. Furthermore, sharing between lecturers also has not been conducted, and they are rarely use information technology as a learning medium. Student innovation and creativity are also less developed to process information and find their own knowledge definition. The learning processes as mentioned above lead a number of problems, that is, the student learning outcome is less maximal and is not in line with the expectation. Students tend to memorize in learning, especially in the study of genetics, and they cannot connect one concept with other concepts well. In addition, students are still

less critical of the problems associated with the genetics development which gives positive and negative impacts to society.

Based on the background and the problems as above, lecturers are required to make innovations in the learning process. One innovation that can be done by lecturers is to develop learning tools that can enhance the learning process. This study develops the guided inquiry learning tools on the basis of blended learning through lesson study for genetics courses.

The guided inquiry learning on the basis of blended learning not only develops the interaction of learners but also provides a positive learning environment (Koesnandar, 2008). Guided inquiry learning on the basis of blended learning can also make students become more motivated and interested because they can do a lot of activities, access multimedia and other innovative devices through information technology.

The implementation of guided inquiry learning on the basis of blended learning can be developed to improve the quality of the learning system, which converts the conventional learning system into the constructivist learning system supported by information technology. Implementation of guided inquiry learning on the basis of blended learning can develop a number of students' process skills such as observing, formulating problems, formulating hypotheses, designing experiments, collecting and analyzing data and interpreting data, drawing conclusions based on authentic evidences and communicating the results of their inquiry activities (Schepler, et al 2003; MONE 2003a). Kulthau (2007) says that through the implementation of guided inquiry, students can conduct an investigation, exploration, searching, researching, teaching and learning.

The implementation of lesson study can help lecturers observe, pay attention to students with learning difficulties, either independently or in groups (Karim, 2006), especially to those who have low academic ability. The observations were analyzed and discussed with the team of Lesson Study to improve further learning process, so that students with high academic ability can assist students who have low academic ability, and students with low academic ability can be in the same level as those with high academic ability. Through the implementation of Lesson Study, lecturers are able to provide information and share experiences each other for their professional development (Cerbin, W & Kopp, B. 2006).

2. METHODOLOGY

Development of guided inquiry learning tools on the basis of blended learning through Lesson Study for genetics courses followed 4D developed by Thiagarajan (1974), which consisted of 4 stages with some modifications. The flow chart of the development of learning tools modified from 4D Thiagarajan is shown on Figure 1.

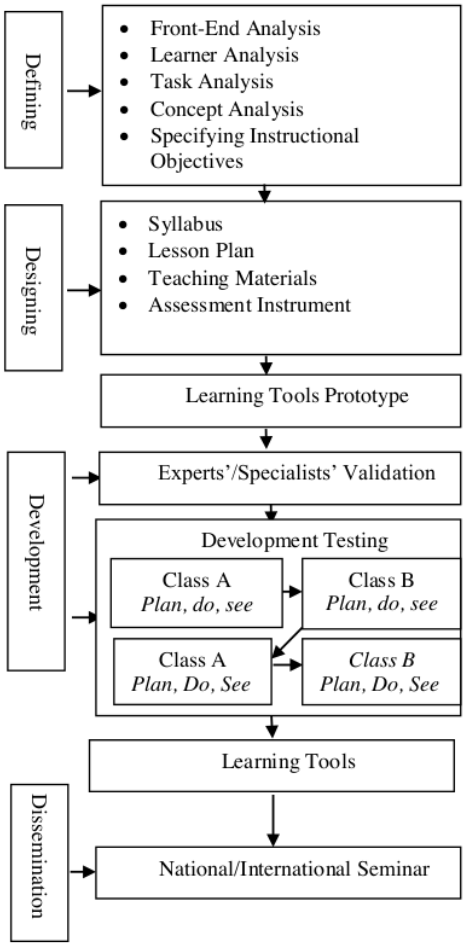

Figure 1. Flow chart of Learning Tool Development Modified from 4D Thiagarajan.

Research subjects in this study were 54 students majoring in biology education FPMIPA (Mathematics and Science Education Faculty) of IKIP (Teacher Training and Education College)

PGRI Jember who took genetics courses. Research subjects were divided into two classes, class A and class B.

The developed learning tools were validated by experts/specialists. Data validated of the experts were analyzed qualitatively-descriptively. The learning tools were said good and fit for use if they reached at least 70% of the experts' consensus. LS activities were carried out within 10 cycles with 13 meetings for 10 subjects of genetics. The first LS activities were conducted in class A, and then the results of LS activity reflection in class A were used to be bases for improvement of the learning process in class B.

3. RESULTS AND DISCUSSION

To obtain a learning tool that met valid and reliable criteria, the researcher applied the procedures of Research and Development of modified 4D models Thiagarajan.

3.1. *Define* stage

The step of defining was started by the activities of: 1) Front-end analysis which aimed to identify the fundamental problems needed in the development of learning tools. The problems that needed management in the study of genetics were the method of presentation of teaching materials and teaching practice that utilized multimedia technology information. PPT teaching materials that have been developed so far were only for fulfilling the lecturers' necessities during the learning process, but the teaching materials for the students were less developed. PPT teaching materials for students learning could be developed by completing the audio-visual, so that they could be learnt anywhere and anytime. PPT teaching materials for students can be uploaded to e-learning web or stored in the form of a compact disk or a flash disk that can be accessed and studied at any time by the students. Uploading the teaching materials to e-learning web directly trained and made the students familiar with the utilization and the use of information technology which is currently growing rapidly. 2) Learner analysis was carried out by examining the students' characteristics, that is, the backgrounds of academic skills (knowledge), the students' cognitive development, the individuals' skills related to the topic of learning, and genetic learning media. Within the last three years, students' learning outcome for the course of genetics was in average of 65 with C category. In 2009, the number of students who took genetics course was 82 who got marks of A (18.5%), B (37.4%), C (41%), and D (3.1%). In 2010, the number of students who took genetics course was 68 who obtained the marks of A (7.3%), B (23.5%), C (57.4%), and D (11.8%). In 2011, the total of students who followed genetics course was 59, who gained the marks of A (6.8%), B (20.3%), C (59.3%), and D (13.6%). The results are used as a frame of reference in the achievement of learning objectives. 3) Task analysis aimed to identify the whole skills in the learning process. The researchers assessed the skills and conducted experiments in the course of genetics such as skills in doing the crossing in Drosophila. 4) Concept analysis was undertaken to identify the major concepts of the materials to be taught. The concepts were then arranged systematically and linked between one concept and other relevant concepts in order to form a complex concept that could be used as a means of achieving basic competencies and competency standards. The results of concept analysis for genetics course were arranged in 11 subjects in sequence from the first subject to the eleventh subject namely: genetics, Mendelian genetics, probability theory and mathematical completion in genetics, patterns of properties inheritance out of Mendelian genetics, sex linkage, sexing, crossovers and chromosome maps, chromosomal abnormalities, gene expression, population genetics, and recombinant DNA technology. These concepts were arranged systematically from the simple/basic concepts to the complex ones. 5) Specifying instructional objectives is a summary of the concept analysis and task analysis to determine the behavior of objects in the form of competence standards, basic competence and indicator. The behavior of an object was the basis for composing a test which was then integrated into the developed learning materials. Standards of competence and basic competence were illustrated clearly and completely in the syllabus and lesson plan.

3.2. *Design* Stage

The stage of designing was performed through lesson study especially in the plan stage. At this stage, the designing of learning tools prototype was carried out which included the syllabus composition, lesson plans, teaching materials and assessment instruments. The format of learning tools prototype was used or adapted with the format developed by the National Education Standards. The format that was developed is shown in Figure 2 and Figure 3 as follows:

SYLLABUS

A. Course Identity
Course Name : .....
Code/Total Credits (SKS) : .....
Course Group : .....
Requirement : .....
Semester : .....
B. Course Description : .....
C. Competence Standard : .....

No	Basic Competence	Subjects	Learning Strategy	Indicator	Blended Learning Nature	Assessment		Learning Source	Time allotment
						Technique	Form		
1									
2									

Figure 2. Syllabus Format

LESSON PLAN

Study Program :
Course Name :
Code/Total Credits (SKS) :
Semester :
Time Allotment :
Course Requirement :
Lecturer :

A. Competence Standard
A. Basic Competence
B. Indicator
C. Learning objectives
D. Learning Materials
E. Teaching Method
F. Teaching Steps

Step	Time	Blended Nature	Lecturer Activities	Learner Activities
First step	.....	.....	.....	.....
Core step	.....	.....	.....	.....
Final step	.....	.....	.....	.....

G. Learning Sources
H. Assessment
-Assessment Technique
-Assessment Form

Figure 3. Lesson Plan Format

Specification of assessment instrument produced was in the form of questionnaire to measure learning motivation and scientific attitudes. Observation sheet was to measure learning motivation, scientific attitudes, and motor skills. Essay test and rubrics were to measure cognitive learning and critical thinking skills.

The developed assessment instruments were validated by experts/specialists and were also tried out to students who had taken genetics course in total of 58 students. Data resulted from try-out were analyzed to determine the validity and reliability. The analysis showed that 65 questionnaire items of learning motivation were all valid and reliable, 50 items of questionnaire on scientific attitudes were all valid and reliable, and of the 22 essay test items, 20 were valid and reliable, while 2 were not.

3.3. Development Stage

Development stage was started with the experts' validation on the developed learning tools. The results of the tools validation are shown on Table 1.

Table 1. Mean Value Results of Validation on Guided Inquiry Learning Tools on the Basis of Blended Learning for Genetics Course

Type of Tools	Mean Value of Validation					Average
	Validator I	Validator II	Validator III	Validator IV	Validator V	
Syllabus	88.71%	93.55%	89.52%	-	-	90.59%
Lesson Plan	87.47%	77.66%	88.86%	-	-	84.66%
Teaching Materials	79.95%	71.92%	-	84.82%	-	78.90%
Assessment Instruments:	86.11%	94.44%	88.89%	-	-	89.15%
• Motivation	86.11%	94.44%	86.89%	-	-	89.15%
• Scientific Attitude	91.67%	100%	87.50%	-	-	93.06%
• Critical Thinking Skills	85.71%	100%	89.29%	-	-	91.67%
• Psychomotor Skill						
• Cognitive Learning Outcome	82.50%	100%	88.89%	-	-	90.46%
WEB Blended Learning	-	-	-	-	79.2%	79.2%

In general, the results of the validation by experts/specialists were in good category, so that the learning tools developed can be used with little revisions, i.e.: 1) In the future, the practicum activities should be based on hands-on activity. 2) It is suggested to distinguish the concepts of gene, DNA and chromosomes for prokaryotic cells with the concept of gene, DNA and chromosomes of eukaryotic cells. 3) Be careful with the use of genetic symbols. 4) Please clarify with pictures on non-disjunction material.

The tools that had been validated by experts were then tested for tool development on the research subjects i.e. 54 students of IKIP PGRI Jember who took genetics course divided into two study groups, namely group A and group B. Development test was intended for the improvement of learning tools, and to see whether there was an increase in cognitive learning outcomes of the students. Development test of learning tool application was the second stage (*do*) and third stage (*see*) of the Lesson Study activities. Lesson Study activities were carried out within 10 cycles with 13 meetings for 10 subjects. Lesson Study activities were conducted from April to July, 2013. The results of Lesson Study activity reflection as the tool development test obtained: 1) The concept definition should not be described in the teaching materials but be replaced with images, so that the students would formulate the concept definition by themselves. 2) Students should consult the lecturer prior to the presentation. 3) Lecturer provided fair supervision to all groups in order not to be concentrated in a certain group. 4) The student group was motivated to actively give questions with contextual examples. 5) The student concept understanding of student learning was made clear by the use of the video that was relevant to the topic. 6) The results of the presented discussion were uploaded to Blended Learning in documents of *words* and *power point*.

In development test, pre-test was first conducted to determine the preliminary ability of the research subjects, and post test after development test was conducted to identify the increase in learning outcome after the learning process using the developed learning tools. The mean values of learning outcomes in class A and B are shown in Table 2.

Table 2. The Mean Value of Pre-Test and Post-Test

Assessed Aspects	Class	Pre-Test		Post-Test		Increase (%)
		Value	Categori	Value	Categori	
Motivation	A	68.50	Fair	90.38	Very high	31.94
	B	66.68	Fair	89.08	Very high	33.23
Scientific Attitude	A	59.56	Low	90.07	Very high	51.22
	B	59.09	Low	93.51	Very high	58.25
Cognitive Learning Outcome	A	47.96	Very low	79.11	High	64.95
	B	45.73	Very low	76.00	High	66.19
Critical Thinking Skill	A	45.66	Very low	67.26	Fair	47.31
	B	44.72	Very low	66.52	Fair	48.75

In general, Table 2 shows that there is an increase in all assessed aspects. The increases in motivation, scientific attitude, cognitive learning outcome and critical thinking skill in class B were higher than those in class A. This happened because the learning process in class B was conducted based on the results of reflection of the learning process in class A, so that the strengths and weaknesses found in class A were fixed in the learning process in class B. The implementation of guided-inquiry learning strategy on the basis of Blended learning could help students perform a variety of activities ranging from observing, questioning, explaining, designing and testing the hypothesis that optimally involved the whole student's ability to seek and investigate systematically, critically, logically and could formulate their own inventions. In line with this, Joyce *et al* (2000); Nurhadi *et al* (2004); Wahab Jeffri (2007); Handoko (2007); Bodzin *et al* (2007) argue that the implementation of the guided-inquiry on the basis of Blended learning is effective to improve thinking skills, attitudes, cognitive learning outcomes, and student leaning motivation. Wahyudin's study (2010) showed that student interest and understanding increase from 72.90% to 76.81% after the application of guided-inquiry strategy assisted by multimedia. In addition, because the implementation of genetics learning tools are based on Blended Learning, students find it helpful to access more literatures, to give broader learning rooms, to provide longer study time, as well as to provide an opportunity for students to explore and find the concepts of genetics by themselves through inquiry and use of information technology. The study by Rathomy Baisa (2010) indicates that 78.35% of the students feel interested and motivated in the learning which uses internet media.

3.4. *Disseminate* Stage

Dissemination stage was a late stage of development. Phase dissemination was done to promote the development of products that can be received by users, either individually or in group, or system. Dissemination was performed through a process of transmission to the relevant learning practitioners in particular forums such as seminar or scientific journal publication.

D. CONCLUSIONS

Based on the validation by the expert and analysis of the test results, it can be concluded that the development of genetics learning on the basis of blended learning through lesson study can improve the quality of learning process of genetics course. This is indicated by the presence of: 1) an increase in of student concentration during the learning process; 2) an increase in ability to work together in student groups; 3) an increase in lecturers' and students' ability and experience in conducting inquiry using Blended Learning; 4) an increase in lecturer confidence when implementing the learning process.

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