

THE DEVELOPMENT OF BIOLOGY MATERIAL RESOURCES BY METACOGNITIVE STRATEGY

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Abstract: The Development of Biology Material Resources by Metacognitive Strategy The study was aimed at finding out the suitability of Biology Materials using the metacognitive strategy. The materials were textbooks, self-understanding Evaluation Sheet and the key, lesson plan, and tests including the answer key. The criteria of appropriateness included the relevance of the resources with the content validity, face validity and the language. This research and development study was carried out employing a 3D model, namely define, design and develop. At the define stage, three topics were selected for analysis, they were virus, Endocrine System, and Genetic material. During the design phase, the physical appearance of the materials was suited with the Metacognitive Strategy. At the develop phase, the material resources were examined and validated by two Biology experts and senior teachers of Biology. The results showed that the Biology material Resources using Metacognitive Strategy developed in the study has fell into the category of very good (score > 3.31) and was therefore considered suitable.

Keywords: biology material resources, metacognitive strategy.

Generally, in Biology learning, thinking skill is rarely practiced directly, well planned or in purpose. Moreover it is often found text book oriented teaching or by memorizing. On the other hand, all teachers ensure and know how important thinking skill in forming human resources. If we want to improve thinking skill, learning process and its evaluation has to be regulated purposely to support it. It is off course, the implementation aspects that must be concerned namely the approach, strategy, method, and other technical learning processes. The implementation of the learning process is not only aimed to transfer or find information, but also to develop high thinking skills ability.

One of the learning strategies which is able to practice student's thinking skill is metacognitive strategy. It can be applied in the classroom with the guidance of Self Understanding Evaluation Sheet (SUES) that is suitable to Indonesia's student culture. In addition, SUES teaches students to be honest, brave to convey mistakes, and evaluate their understanding (Susantini, 2004a, 2004b, 2005, 2007a, 2007b), those behaviors are required in order to solve social problem in Indonesia now. According to Marzano (1988), and Kendal and Marzano (1997), those behaviors include to self regulation skill, meanwhile Broad Based Education (2002) added that those are included in self

awareness. The researchers say that one's thinking skill will be useful in life if one basically has a good moral.

Blakey and Spence (1991), Nelson (1992) and Osborn (1999) stated that metacognitive strategy is a technique facilitating metacognition or "thinking about thinking". Arends (1997) said that metacognition is thinking about think and cognitive process monitoring.

Blakey and Spence (1991) stated that the strategy to develop metacognitive behaviour are (a) identify "What you know" and "What you don't know" (b) discuss thinking, (c) make journal, plan, and self arrangement, (d) explain about thinking process, (e) self evaluation.

Paris and King in Slavin (2000) found that student's mastery is better when they are taught to ask themselves. This finding is suitable with SUES, beside it is taught to ask themselves SUES can create student's prior knowledge, identify misconception, and give chance to dig the material independently. SUES is adapted from Flex Your Brain (Biggs, *et al*, 1997).

Metacognitive strategy is useful for class teachers and students to emphasize in self monitoring and student's responsibility. They can learn that self monitoring is a precious thing since it is a higher thinking skill. The students develop commitment,

positive attitude towards learning and attention including introspection and practice systematically (Marzano, 1988).

Meanwhile, most students develop their cognitive skill step by step and other ones don't develop well. By practicing metacognitive strategy the students are able to be independent, they practice themselves to be honest and brave to convey mistake, which finally brings them to real improvement learning result (Susantini, *et al.*, 2001). Another useful thing of metacognitive strategy is making the students learn how to think about their own thinking process (Nelson, 1992) and apply specific learning strategy to think about their own difficult tasks.

The idea of biology learning process by metacognitive strategy is done if learning resources are available well. In the developed country, Biology material resources are developed by experts. Teachers can use them directly. Teachers task only make lesson plan in order to prepare when and what kinds of material resources they use in the classroom.

In the developing countries, the teachers have to develop the teaching materials by themselves. The difficulties to get qualified material resources, limitation of time, fund, and skill make teachers' task harder. That's why this research will develop biology material resources by metacognitive strategy in order to make the biology teachers' task easier. In addition, it motivates biology teachers whose role at the beginning is as source of information to be a creative facilitator and a mediator in learning process.

This research is aimed to develop biology material resources by metacognitive strategy which might improve senior high school students thinking skill ability. The material resources are addressed to X, XI, XII grades. The biology material developed using metacognitive strategy consists of (a) students book, (b) metacognitive work sheet, these are Self Understanding Evaluation Sheet and its key, and (c) lesson plan using metacognitive strategy. Another purpose of this research is in order to measure the validity of biology material resources by meta-cognitive strategy that is developed.

METHOD

This research applied Three D Models. They are define, design, and develop (Thiagrajan, 1994). The stages of Biology Material Resources Development included Three D. First is Define stage. It starts by observing some Senior High Schools in Surabaya in order to get the description of basic competence that is chosen to develop biology material resources. The next is analyzing Biology content standard based on the basic competence. The topics being

chosen were virus for X grade, endocrine system for XI grade and genetic material XII grade. Concept analysis and task are done in this stage and relates them to metacognitive strategy. Then, doing literature study focusing on things having relation-ship with biology material resources development and the implementation of metacognitive strategy in order to improve student's thinking skill. In addition, the development of research instrument is being investigated.

Second is Design stage. It designs the material resources forms which could arise student's motivation by concerning with competence would be reached and metacognitive strategy used.

Third is Develop stage. It analyzes material resources and research instrument through the following stages: (1) Review and validation by experts and senior teachers. Both biology expert and biology education expert review the material resources and the instrument which have developed (Draft I). Furthermore, it also involves two senior biology teachers. Review validation of material resources concerns with content validity, appearance, and language (BSNP, 2006); (2) Revision. The material resources are revised based on review input and validation (Draft II).

RESULTS DAN DISCUSSION

Student's Book

The result of student's book validation that had been developed in three selected topics Virus, Endocrine System, and Genetics Material is in Table 1.

Table 1 shows that student's book which has been developed in three selected topics virus, endocrine system, and genetic material includes in a very good category of validation result. Student's book validation regards to content validity, appearance, and language aspects (BSNP, 2006). The student's book validation result shows that the content validity is 3.51 it is a very good category. It shows that student's book has been developed was suitable with competence standard and basic competence, concepts correctness, the recent content and life skill.

The score for appearance of student's book is 3.34. It is a very good category. It shows that student's book has paid attention for illustration, pictures, and layout.

The score for language is 3.32. It is a very good category. It means that the language used is appropriate with the students thinking stage, could motivate students to learn, and use Indonesian well and correctly. In fact, it concludes that the student's book development has fulfilled Senior High School biology text book writing. BSNP suggests it.

Table 1. The Recapitulation of Student's Book Validation Result

No	Aspects	V	ES	GM	Average
1.	Content Validity				
	a. Scope and the depth of the material based on competence standard and basic competence	3.50	3.50	3.50	3.50
	b. Content (fact, concept, theory, and principle)	3.75	3.25	3.25	3.50
	c. Content is based on the development of knowledge	3.75	3.75	3.50	3.67
	d. The material could motivate students to find out new idea	3.50	3.50	3.25	3.42
	e. Growing curiosity	3.50	3.50	3.50	3.50
	f. Developing living skills (personal, social, academic, and vocational)	3.75	3.25	3.50	3.50
	g. Concerning with the relationship among science, technology and society	3.75	3.50	3.25	3.50
	h. Student's book could be used as guidelines for teachers and students in learning activity	4.00	3.50	3.25	3.58
	Average	3.69	3.47	3.38	3.51
2.	Appearance				
	a. The appearance is systematic	3.75	3.50	3.25	3.50
	b. The appearance is suitable with deductive or inductive thinking concept	3.50	3.50	3.25	3.42
	c. The appearance of concept is from simple to difficult, from concrete to abstract	3.50	3.50	3.00	3.33
	d. The substances between sub topics are in balanced	3.25	3.50	3.25	3.33
	e. Illustration or picture use effective lay out	3.50	3.25	3.00	3.25
	f. The accuracy of using letters (kind and size, space of letters or bold/italic letters)	3.25	3.25	3.25	3.25
	g. The numbering and labeling table/picture are accurate	3.25	3.25	3.25	3.25
	h. Interesting/enjoyable	3.25	3.25	3.50	3.33
	Average	3.41	3.41	3.22	3.34
3.	Language				
	a. Language used is suitable with the development of student's thinking stage	3.50	3.50	3.25	3.42
	b. The material performed is using interesting language	3.50	3.50	3.25	3.42
	c. Language used could motivate students to learn	3.50	3.25	3.50	3.42
	d. Making the students as if they communicate with writer	3.25	3.25	3.50	3.33
	e. Using Indonesian correctly and appropriately	3.50	3.50	3.50	3.50
	f. Using appropriate terms easily to understand	3.50	3.50	3.25	3.42
	g. Using terms and symbols consistently	3.25	3.50	3.25	3.33
	h. Average	3.43	3.43	3.36	3.41
4.	General Evaluation	Feasible			

Note:

V : Virus
 ES : Endocrine System
 GM : Genetics Material

Scoring:

1.00 – 1.69 : Poor
 1.70 – 2.49 : Enough
 2.50 – 3.29 : Good
 3.30 – 4.00 : Very good

Four reviewers stated that the student's book is feasible. It means this book could be applied in senior high school. Even though there are things needed to pay attention, these are picture and or table. It must be adjusted in the script and the sources must be written clearly. The biology terms are also used consistently. Self Understanding Evaluation Sheet (SUES)

The result of Self understanding Evaluation Sheet (SUES) which had been developed in three selected topics Virus, Endocrine System, and Genetic Material is in Table 2.

Table 2 shows that the score for SUES has been developed in three selected topics virus, endocrine system, and genetic material is 3.67. It is a very good category too. It means that (1) SUES gives the students chance to interact with another. It could increase academic achievement and it is cheap to apply (Arends,

1997; Lyman & Foyle in Blosser, 1992) which finally it is able to practice student's thinking skill; (b) SUES guides students toward questions that could check their concept comprehension. Moreover, the students have chance to evaluate their own comprehension. It supports Biggs (1997) statement, *Flex Your Brain* gives students chance to dig an organized topic as a way to evaluate one self, (c) SUES which has been developed could encourage students to find further information in order to fulfill their curiosity, (d) SUES supports the teaching learning process application on students centered and it is suitable with constructive point of view, the teacher does not transfer knowledge to students directly. Its purpose is to make the knowledge given meaningful. Thus, they must process information they get, rearrange and integrate it with the knowledge they have (Slavin, 2000).

Table 2. The Recapitulation of SUES Validation Result

No	Aspects	V	ES	GM	Average
1.	The Suitability SUES with the metacognitive strategy				
	a. Stimulating students to think about what, why, and how the material they learn	3.50	3.75	3.50	3.58
	b. Fulfilling constructive concept, students build self understanding from new experience based on the prior knowledge	3.75	3.50	3.50	3.58
	c. Growing curiosity	3.50	3.50	3.50	3.50
	d. Encouraging students to find further information	3.75	3.75	3.50	3.67
	e. Fulfilling asking components (questions to check student's understanding	3.50	3.75	4.00	3.75
	f. Motivating students to communicate, interact, and cooperate with other people	3.75	4.00	4.00	3.92
	g. Creating feed back to self evaluation	3.75	3.75	3.75	3.75
	h. Fulfilling reflection components, students could respond event, activity, and their experiences	3.75	3.50	3.75	3.67
	i. Supporting teaching learning process application concerning with students centered, hence students could build knowledge independently	3.50	3.50	3.75	3.58
	Average	3.64	3.67	3.67	3.67
2	Appearance				
	a. It is suitable with students thinking stage	3.50	3.50	3.50	3.50
	b. Arising motivation/ interest/curiosity	3.50	3.50	3.25	3.42
	c. Encouraging students involved actively	3.25	3.75	3.50	3.50
	d. The appropriateness of Self Understanding Evaluation Sheet with purpose of the study and the material	3.50	3.50	3.50	3.50
	e. The accuracy of using letters (kind, size, space among letters or bold/italic	3.75	3.50	3.50	3.58
	f. Interesting/enjoyable	3.50	3.50	3.25	3.42
	Average	3.50	3.54	3.42	3.49
3	Language				
	a. Language used is suitable with the development of students thinking stage	3.25	3.25	3.50	3.33
	b. The material performed is using interesting language	3.50	3.50	3.50	3.50
	c. Language used could motivate students to learn	3.75	3.50	3.25	3.50
	d. Making the students as if they communicate with the writer	3.50	3.50	3.25	3.42
	e. Using Indonesian correctly and appropriately	3.50	3.50	3.50	3.50
	f. Using appropriate terms easily to understand	3.50	3.50	3.50	3.50
	g. Using terms and symbols consistently	3.50	3.50	3.00	3.33
	Average	3.50	3.46	3.36	3.44
4	General Evaluation			Feasible	

The score for appearance of SUES is 3.49 in average and categorized to be very good. It means that SUES encourages students to involve themselves actively, this is suitable with students centered characteristics. SUES appearance is interesting and arising curiosity. Furthermore, SUES is in line with the purpose of the study and students thinking stage.

Language aspect is 3.44 in average included in a very good category. Language aspect is SUES that uses Indonesia well and correct, its language is interesting so that it could motivate students in learning. The term used is precise and could be understood well and used consistently. The language used is suitable with the students thinking stage. Opinion and suggestion of revision for those three SUES that have been developed should be carried out score for each number of items and pay attention more to time allocation.

Lesson Plan

The result of lesson plan validation in three selected topics Virus, Endocrine System, and Genetic Material is in Table 3.

Table 3 shows that the lesson plan that has been developed for three selected topics virus, endocrine system, and genetic material is in a very good category of validation result.

Lesson plan components obtain 3.45 with a very good category. Those components have paid attention to the following introduction, main activities, and closing. Another one is evaluation. It is suitable with the objective of learning.

The point for lesson plan writing is 3.59 and it is a very good category. It regards to prior knowledge, develop higher thinking skill, use minds on activity and plan feedback for self evaluation.

Opinion and suggestion of revision for those three lesson plans should carried out time allocation oriented so that it is more realistic since the application of metacognitive strategy in the classroom needs time relatively longer.

Test

The result of learning test validation which has been developed in three selected topics Virus, Endocrine System, and Genetic Material is described as follows.

Table 3. The Recapitulation of Lesson Plan Validation Result

No	Aspects	V	ES	GM	Average
1.	Lesson Plan Components				
	a. School identity	3.75	3.75	3.25	3.58
	b. Time allocation is suitable with curriculum	3.50	3.00	3.50	3.33
	c. Competence Standard is based on curriculum	3.75	3.75	3.25	3.58
	d. Basic Competence is based on curriculum	3.75	3.50	3.75	3.67
	e. Indicator is spelled out from basic competence and written operationally	3.75	3.25	3.50	3.50
	f. The purpose of the study is suitable with indicator and written operationally	3.50	3.25	3.25	3.33
	g. The learning material is based on Competence standard/Basic Competence	3.25	3.50	3.25	3.42
	h. The learning method is suitable with material characteristics	3.50	3.50	3.50	3.50
	i. Learning aids and learning resources support learning activity	3.50	3.25	3.00	3.25
	j. The stages of activities are as follows:				
	1) Introduction	3.50	3.50	3.50	3.50
	2) Main activities	3.50	3.50	3.50	3.50
	3) Closing	3.25	3.25	3.50	3.30
	k. The evaluation is based on the purpose of the study	3.50	3.50	3.25	3.42
	Average	3.54	3.42	3.40	3.45
2	Lesson Plan				
	a. Paying attention to students prior knowledge and apperception	3.50	3.50	3.50	3.50
	b. Using minds-on activities in the learning process	3.50	3.50	3.75	3.58
	c. Planning learning process by students centered than teacher centered	3.50	3.75	3.50	3.58
	d. Planning concept and theory learning process begins with concrete to abstract	3.50	3.50	3.50	3.50
	e. Emphasizing students' activities to cooperate in creating better learning	3.50	3.75	4.00	3.75
	f. Developing higher thinking skill	3.50	3.50	3.50	3.50
	g. Planning learning process democratically and interactively	3.50	3.50	3.50	3.50
	h. Planning feedback for self evaluation	3.75	3.75	4.00	3.83
	Average	3.53	3.59	3.66	3.59
3.	General Evaluation			Feasible	

The kinds of multiple choices item for three selected topics is valid. Forty seven percent (47%) of multiple choices are valid without revision (A), mean-while 53% is valid with revision (B). 53% of essay is valid without revision (A) and 47% is valid with revision (B). There is none of the item invalid (C).

There are 70% items of the virus multiple choices needs to be revised by paying attention to the objective of learning, items stem, key and picture. Meanwhile, 30% items do not need revision. There are 40% items in endocrine system need to revise by paying attention to item stem, item classification, option, and objective of learning. And 50% items do not need revision.

The essay for the three topics is also valid, even though 75% in virus topic needs to be revised by concentrating to item stem and objective of learning. 25% items do not need revision. 40% of endocrine system still needs to be revised based on item stem, key, and item classification. 60% of them do not need revision. 37.5% in genetic material need to be revised by following criteria: item stem and keys. And 62.5% items do not need revision.

The reviewers stated that development of learning test is valid both multiple choice and essay. None of them is invalid. Thus, the items are appropriate with indicator or objective of learning. It is in

line with Salim (2006) the items made must be suitable with indicators. It means that items have to ask behavior and material that would be measured based on indicator.

Salim (2006) and Suryabrata (1987) stated that multiple choice items in learning test have items stem criteria. They are as follows: (a) It has to be drafted clearly and firmly, (b) It contains needed statement only, (c) It does not direct to correct answer and it does not contain double negative statement.

Reviewers said that some of the items have been developed, the classification need to increase by giving stimuli to items. Generally, the learning test is valid to be tried out.

CONCLUSION AND SUGGESTION

Conclusion

Biology material resources have been developed by metacognitive strategy in three selected topics virus, endocrine system, and genetic material which could practice student's thinking skill. The material resources are student's book, Self Understanding Evaluation Sheet (SUES), lesson plan, and test.

Student's book, SUES and lesson plan that have been developed included in a very good cate-

gory; that is more than 3.31 and stated feasible. Learning items that have been developed are valid.

Suggestion

There are some suggestions to review material resources that have been developed (a) picture/table on student's book should be mentioned on text and

completed by reference; (b) the number of answer on each item's number on SUES should be written and completed by scoring; (c) time location in writing the lesson plan should be suitable with class condition; (d) every item of learning test that has been developed, its classification is still be able to be increased by stimulating the items.

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