The Development of Critical Thinking Inventory Instrument for Biology Department Students

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Abstract. This research aims to develop the inventory instrument of critical thinking for department biology student that valid. This research is a research and development. Preliminary research was conducted to accumulate the critical thinking indicators that are relevant to the inventory of critical thinking for student. The development of prototype (prototype stage) was conducted for designing and implementing the prototype product of critical thinking inventory instrument for student. Porotype inventory of critical thinking of student was assessed (assessment phase) to determine the validity of final product of critical thinking inventory instrument of student that has produced. Instrument Assessment of assessment sheet critical thinking inventory instrument of student and critical thinking inventory instrument sheet of student was conducted by two experts and practitioner validators. The result of validity index (Gregory, 2008) assessment sheet of critical thinking inventory instrument of student is 0,95 (valid and all criteria are fulfilled). The average value of the validity of critical thinking inventory of expert validator is 4,81 with valid category and the average value of validity of student critical thinking inventory of practitioner validators is 4,67 with valid category. The average validity value of critical thinking inventory of student by expert validators and practitioner validators is 4,74 that classified as very valid category.

Keywords: Inventory, Critical Thinking, Research and Development, Student

INTRODUCTION

Human resource improvement is closely related to formal education, especially higher education. Various attempts have been made to improve the quality of higher education such as curriculum changes, strengthening the teaching and learning process, improvement of the assessment system, the training and certification of lecturers and other business related to improving the quality of education. However, the reality in the field that the results achieved are not as expected and experiencing adversity education at all levels is characterized by low competitiveness and quality of the graduates.

Miller & Dunn, 1996 in Santoso (2012) states that the tendency in the development of higher education is to produce cultured human resources for the sustainability of human civilization and producer of human resources to support industrial and environmental communities. While Ramsden (1992 in Wass et. al., 2011) stating the purpose of higher education was relatively unchanged over the years; that students should develop critical thinking skills, as an integral part of the reasoning in this branch of science. Moreover, it can be seen in a different context that is as lifelong learning skills. Therefore, in the world of higher education required learning that equips students with the ability solute generic ability, as conceived by Terenzini, Springer, Pascarella, & Nora, 1995; Barnett, 1997 in Wass, et al, 2011: 317, to answer the concerns that a lot of factual material that is taught in university will soon be forgotten or become obsolete and critical thinking skills are "legacy" durable than higher education.

The efforts that should be made in providing education services is the existence of learning teach and put forward reasoning. Therefore, learning leads to higher level thinking processes (High Order Thinking) into a future requirement (competence of the 21st century). Think at a higher level is considered as the primary instructional goals of higher education and a driving force in education reform.

The development of learning model that can improve critical thinking skills of students has been done, including PBL, PjBL, experiential learning model with scaffolding (Mels), and Inquiry-Discovery learning is believed to empirically improve students' critical thinking skills, because everything is based on constructivist. However, the efforts and procedures to measure/assess the critical thinking skills of students still confront some

constraints, including the limitations of critical thinking instrument that applicable and can be used by lecturer in teaching that emphasizes the development of critical thinking skills of students. For that purpose, learning tools (inventory of critical thinking) was developed to realize the implementation of learning model that emphasizes the higher level thinking in the classroom and at the same time become a reference in the dissemination effort of constructivist-based model.

METHOD

This research is a research & development which aims to produce the products such as critical thinking inventory instrument of students that can support and facilitate the measurement of critical thinking skills in the classroom that put forward the higher-level thinking skills.

The research was conducted at Biology Department, Mathematics and Natural Sciences Faculty, State University of Makassar for eight months in 2015. The subjects were students of Biology Department, Mathematics and Science Faculty, Basic Biology Lecturer, as well as the expert validator and practitioners.

Developing Process of Critical Thinking Inventory

The development model that used in this research is the development model of Plomp and Nieveen 2007 which consists of three main stages, namely the preliminary research, prototyping stage, and assessment phase.

Initial Research (Preliminary Research)

Preliminary researches include the investigation of assessment tools that have been used in lectures at Biology Department which related with the critical thinking instrument that will be developed and about the preparation and implementation of the Basic Biology course. Activities that performed on preliminary investigations is to gather the information that related to measurement problems of critical thinking skills in learning and formulating the rational thought of the importance of developing the critical thinking inventory, identifying and reviewing the theories of and theories that underpin the development of the critical thinking inventory, including discovery learning theory of Brunner, which is based on discovery learning and constructivism.

Prototype Developing

Prototyping stage includes the stages of design and realization/prototype construction. The activities that performed in designing the device components of critical thinking inventory: (1) Designing the components or aspects of students critical thinking (2) Designing the structure of critical thinking inventory (3) Designing the grains or item of students critical thinking in inventories.

Realization stages of the prototype is a continuation of activities in the design prototyping stages. At this stage produced an initial prototype as a result of the realization of inventory device design of students' critical thinking. Inventory device of student critical thinking outcomes / products of this phase hereinafter referred inventory device of critical thinking prototype 1.

Assesment Phase

Assessment phase aims to see the validity, effectiveness and efficiency of inventory device of critical thinking. This phase to evaluate whether the target user can work with a intervention that has given and whether they are willing / able to apply the inventory of critical thinking in their learning (relevance and sustainability), and whether the intervention are effective. Especially for the inventory of critical thinking that was developed only served the validity of test results.

Assessment of Inventory device student critical thinking assessment instrument is analyzed using index criteria of Gregory (2008) $V \geq 0.75$, declared valid and there is no items that obtain the value 1 (one) from one of validator. Assessment of Inventory device of student critical thinking validity that was developed based on the analysis results of the validation of the experts validator and practitioners with valid category of the following categories:

$4{,}5 < M \leq 5{,}0$ = Very Valid
$3{,}5 < M \leq 4{,}5$ = Valid
$2{,}5 < M \leq 3{,}5$ = Quite Valid
$1{,}5 < M \leq 2{,}5$ = Less Valid
$M < 1{,}5$ = Invalid

The criteria that used to declare the inventory of critical thinking has a sufficient degree of validity is the average value of the validity for all aspects that are in **very valid** category and the validity value of each minimal aspect in **valid** category.

RESULT AND DISCUSSION

Based on the description in method that in this development research use the Plomp and Nieveen development models 2007, the results of this study are described by following the steps in the model.

Initial Research

The basic theory in the development of Inventory device of student critical thinking is the theory of student critical thinking from Ennis theory (6 indicators), Robert theory (13 indicators), Perkins theory (4 indicators), Beyer theory (7 indicators), Greenstein theory (9 indicators), and critical thinking according to Ministry of Education (11 indicators). Results of previous research that are relevant also be a focus of study in the initial research stage. The analysis is done by looking at the curriculum standards of competence and basic competences of Basic Biology subject that are a result of Biology Department curriculum workshop in 2013.

Based on observation result that conducted in Biology Department of Mathematics and Science Faculty of UNM, the weight of credits Basic Biology course is 3 credits where 1 credit for observation that held by separately scheduled. Basic Biology lecture conducted with team teaching, generally still use methods of lecture and discussion / question and answer, which include of use power point slides or animations in presenting the lecture material. Assessment is done through the midterm and final exams as well as lab test material using multiple choice questions and true-false with low cognitive level (only 2% C3 and nothing, C4, C5, and C6) based on the revision of Bloom's taxonomy level. Some lecturers use the worksheet in lectures on a particular material and based concepts. There is no lecturer that planning the lecture and higher level thinking assessment specifically in lectures and observation. Learning motivation the of students that participate in the Basic Biology course are currently on quite well category with a value is almost reached the good category and considered feasible as a research subject.

Prototype Developing

Inventory device of student critical thinking that developed included nine indicators of of student critical thinking. Based on the study of supporting theories and research relevant past, successfully designed Inventory of student critical thinking with the 36-point declaration as an assessment instrument that is different from the learning assessment tools in the Basic Biology course which has been used in the Mathematic and Science Faculty of UNM.

Based on the results of student critical thinking inventory design that has been done at the beginning of the prototype developing. Next step is stages of realization prototype product of student critical thinking inventory that specific and unique to be product prototype 1 (the initial product). Indicators of student critical thinking that developed in this inventory is (1) understand the instructions/statements/questions, (2) analyzing the information, (3) formulate the problem, (4) determine and apply the concepts, (5) accurately draw conclusions, (6) choose a strategy in solving the problem, (7) use the data to develop the critical thinking/knowledge, (8) evaluation, and (9) synthesis. Each indicator of critical thinking are translated into 4 item statements concerning positive statement or negative statements. Appearance design of this critical thinking inventory followed a pattern of Erickson that modified from Dennis models. Designs generated of critical thinking inventory presents simultaneously charging before and after treatments are given. The following are snippets sample of critical thinking inventory that has developed with nine indicators.

CRITICAL THINKING INVENTORY OF STUDENT

Name and ID : _____

A. INSTRUCTION

Through this inventory, you can respond the following statements, true or false about you by choosing number 5 until 1, by circling the available space first before you learn with ..... and then while learn with ..... using semantic differential scale model criteria below.

	5	4	3	2	1	
TRUE	**<.....**	**.....**	**.....**	**.....**	**.....>**	**FALSE**

Sooth you fill out this questionnaire contributed a great deal in achieving the objectives of this assessment. Thank you for your attention and cooperation.

B. ASSESMENT TABLE

Before learn with MELDS-BK Learning Model					**STATEMENT**	**While** Learn with MELDS-BK Learning Model				
5	4	3	2	1	1. Understanding the instructions / statements/questions correctly	5	4	3	2	1
5	4	3	2	1	2. Unable to identify some different information details	5	4	3	2	1
5	4	3	2	1	3. Identify all main issues of information and see the implications.	5	4	3	2	1
5	4	3	2	1	4. Determine the information priority and see the implications.	5	4	3	2	1
5	4	3	2	1	5. Unable to identify/understand the main problem and some differences that exist/	5	4	3	2	1
5	4	3	2	1	6. And so on.....	5	4	3	2	1

Assessment of Development Product

The initial product (prototype 1) which has been constructed further evaluation by the validator (experts and practitioners). The assessment is done by giving the first prototype device inventory of critical thinking developed in conjunction with the assessment sheet instruments inventory of critical thinking that has been validated (Gregory index = 0.95) to each validator separately and simultaneously.

Analysis of the validator assessment shows that the average value of the indicator Understand Instructions/statement/question is 4.69, the average value of the indicator analyzes the information is 4.70, the average value of the indicator formulate the problem is 4.67, average value average indicator determining and implementing the concept is 4.75, the average value of the indicator choose a strategy in problem solving is 4.83, the average value of the indicator using the data to develop the critical thinking/knowledge is 4.81, the average value of the indicator assessing is 4.92, the average value of synthesize indicator is 4.80. The average value of total validity of this critical thinking inventory acquired (including aspects of language and instructions) is $\bar{x} = 4.74$ with very valid Category. As such in terms of all aspects of criteria of critical thinking inventory that was developed declared meet the level of validity. However validator still advise a revision to certain aspects such as the formulation of indicators and redaction of the statement formulation, and the scope of each item statement. The following are the average results of the critical thinking inventory instrument assessment of validator.

Table 2. The average of assessment result of validator
to critical thinking inventory of student assessment aspects

No	**Aspect and Critical Thinking Indicator**	**Average of Expert Validators**	**Average of Practitioner Validators**	**Total**
1	Critical thnking indicator aspect			
	Understand the instruction/statement/question	4,75	4,62	**4,69**
	Information analyze	4,80	4,60	**4,70**
	Problem formulated	4,83	4,50	**4,67**
	Determine and apply the concept	4,88	4,63	**4,75**
	Acurate deductive	4,80	4,60	**4,70**
	Choose the strategy in problem solving	4,83	4,83	**4,83**
	Using the data to develop the critical thinking	4,87	4,75	**4,81**
	Assessed	5,00	4,83	**4,92**
	Synthesize	4,90	4,70	**4,80**
2	Languange aspects	4,50	4,50	**4,50**
3	Instruction Aspects	4,75	4,75	**4,75**
	Total	**4,81**	**4,67**	**4,74**

DISCUSSION

Based on the results of the analysis of Standard Competence and Basic Competence showing that the object of Basic Biology course is broad, covering ten subject matter are: Introduction, Structure and Function of Cells, Structure and Function of Body Plant, Structure and Function of Animal Body, Reproduction, Metabolism, Genetics, Evolution, Biotechnology, and Interaction of Living Things and Environment. The whole subject material is presented in fourteen weeks. Lab activities includes 11 experimental units in 9 weeks, all of them requires higher level thinking assessment skills assessment (critical thinking).

Looking at the characteristics of the material presented in a face-to-face and units of the experiments conducted in the observation, clearly illustrated that a number of materials and activities are very relevant and possible to implement assessment critical thinking skills , supported by Instructional Materials and Worksheets according to constructivist learning. This can be explained that the modeling in learning can be used to describe the domains of information stored. Each source of information should be designed so that it allows the students to think critically and creatively (Arends et al., 2010). The planting of critical thinking skills is the development and the use of continuous analysis capabilities (Scriven & Paul, 2005 in Arend, 2009). Critical thinking is viewed as life skill that is needed. The process of improving think basically creates habits of reflection and questioning each aspect of life (King, 1995; Scriven & Paul, 2005 in Arend, 2009). The educators want students to use the order cognitive high such as critical thinking, but tend in practice to focus on the efforts of learners to memorize or tasks assigned are at a cognitive level lower (McKeachie, Pintrich, Lin & Smith, 1986 in Arend, 2009). Therefore it expected that with developing critical thinking inventory is an alternative that can deliver lecturer can assess the students in think critically.

From the device inventory that was developed it is expected that lecturer will be able to assess the students as a critical thinkers that have characteristics (a) put forward any questions and important issues, formulate it clearly and accurately (b) Bring up new ideas that are useful and relevant to working task, assess the benefits of new ideas, selecting the best ideas, or modify ideas if necessary (c) collect and assess that are relevant information, using abstract ideas to interpret it effectively, (d) Make a conclusions and solutions with good reason, the evidence is strong, and test it using a relevant criteria and standards, (e) Open minded by using a variety alternative system of thinking, while recognizing, assessing, and looking for relations between all the assumptions, implications, practically consequences (f) Able to solves the confusion, able to distinguish between facts, theories, opinions, and belief, (g) Communicating effectively with others in an effort to find solutions of complex problems, without being influenced by other people's thinking about the topic are concerned (h)Be honest with self, rejecting manipulation, holding the scientific credibility and integrity, and intellectually independent, impartial, and neutral.

CONCLUSION

Based on research and development result that has been done, it can be concluded that the critical thinking inventory pruduct of students that consist of nine indicators and thirty six point statements is very valid category (average value 4.74), so the otherwise qualified use in learning to self-assess students' critical thinking skills.

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