EFFECTIVENESS OF CRITICAL THINKING INDICATOR-BASED MODULE IN EMPOWERING STUDENT'S LEARNING OUTCOME IN RESPIRATORY SYSTEM STUDY MATERIAL

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ABSTRACT

Research and development are aiming to develop critical thinking skills-based modules on the respiration system materials to empower the learning outcomes; verify the effectiveness of critical thinking skills-based modules with teaching materials in schools based on student learning outcomes. Research and development method are using Borg & Gall development procedure with nine phases. Data analysis that used for the research and development are qualitative and quantitative descriptive. Research and development results show that critical thinking skills-based modules on the respiration system materials were developed according to the indicators of critical thinking skills and knowledge dimension that visualised on the objectives, materials, activities and evaluation questions which are developed to empower the learning outcomes. The result of module effectiveness test, showed by Anacova test result are F_{Count} = 180,4 on factual, conceptual, procedural learning outcomes which are visualised in the form of multiple choice questions and F_{Count} = 40.2 metacognitive learning results are visualised in the form of essays.

INTRODUCTION

The development in 21 century needs human resources which have quality and adaptation capability to face the changes of the times (Widhy, 2013). As an impact, everyone needs skills. Skills that needed are life skills and career, skills in technology, media and information, also innovation and critical thinking skills (Ledward & Hirata, 2011).

Critical thinking is a capability to consider any information from any sources and then processing in a creative and logic way, also analysing until it was concluded if that is correct and can be maintained (Moon, 2008). Critical thinking is thinking seriously, active, accurate in analysing all of the information which has been received with a rational reason; therefore, every action that taken is correct (Liberna, 2011). Critical thinking is used to make an assessment of the information, explain the reasons and solve the problem (Thomas, 2011). Critical thinking has an important role in making the right decisions to resolve problems during the study or in daily life (Snyder & Snyder, 2008).

Critical thinking can be trained in formal schools through the interaction between teachers and students which is visualised in the learning process (Nafi'ah & Prasetyo, 2015; Thompson, 2011). Learning process which is designed to

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train students to think critically,; therefore that students have a purpose to survive and compete in real life (Nusarastriya, Sapriya & Wahab, 2013). The learning process which is integrated with critical thinking trained through all subjects in high school, and also biology. Characteristic of biology is requires a distinctiveness in thinking, and this makes it possible to train critical thinking skills to enhance the concepts of biology (Nuryani, 2005).

Critical thinking in learning biology is developed one through literature because literature is a kind of text types that capable to empowering critical ideas (Khatib & Alizadeh, 2012). The literature which accommodates critical thinking does not promote about rote learning content, but to focus on the learning process (Lunenburg, 2011). Literature that accommodates critical thinking skills can be either as a book or modules.

A module which is containing critical thinking components, those are interpretation, analysis, conclusions, evaluation, explanation and self-regulation are called as critical thinking skills-based module (Fascione, 2011). Critical thinking skills-based module can be developed through several ways including: through open-ended questions, conceptual questions and Socratic questions (Redhana & Liliasari, 2008). Open ended question is the ability to observe the activities of student's thinking in using their knowledge and then applied in daily life (Soeyono, 2013). Conceptual question is used to help students begin the process of solving problems and guide students to master the learned concepts (Redhana & Liliasari, 2008). Socratic questions are critical questions that will help the students to develop ideas on the material which is being studied; therefore, the understanding of the subject becomes more profound (Redhana, 2012).

Critical thinking skills-based modules are developed in the respiratory system study material which earned by the survey by interviewing teachers, student questionnaire and analysis BSNP (BSNP, 2013). Modules or textbooks that used in high school on the Basic Competence of the respiratory system were analysed based on the contents of the module (objectives, materials, activities and evaluation questions) as well as the delivery and use.

The results of module analysis in the biology textbook 2 (Book I) and the biology textbook 2 (Book II), respectively obtained: 1) interpretation 38.2%; 32.9%, 2) analysis 30.7%; 23.9%, 3) inference of 26.2%; 26.2%, 4) evaluation 34.1%; 25.0%, 5) explanation 25.0%; 20.8%, and 6) of self correct 25.0%; 10.4%. Books or instructio-nal materials which are indicators of the contents has not met the six indicators of critical thinking to the fullest necessarily fewer students' critical thinking activities optimally that will give impact to the lack of learning outcomes. Some studies show that students who have the low ability to think critically are tended to get lower learning outcomes if compared with the students who have high ability to think critically (Haseli & Rezai, 2013; Wulandari, Sjarkawi & Damris, 2011).

The results of delivery and application analysis in the book I and the book II are obtained: 1) interpretation 48.7%; 42.1%, 2) analysis 31.8%; 31.8%, 3) inference 40.5%; 26.2%, 4) evaluation 38.6%; 34.1%, 5) explanation 36.1%; 30.6% and 6) self correct 12.5%; 8.3%. Books or instructional materials which have delivery and application still not using the six indicators in critical thinking optimally will cause the lack of student's critical thinking activities, therefore, it's necessary to do more development. The solution is by developing critical thinking skills-based modules.

Module-based critical thinking skills on the material developed respiratory system aim to empower student learning outcomes in the four dimensions of knowledge that include: knowledge of factual, conceptual, procedural, and meta-cognitive (Anderson & Krathwohl, et al., 2010). Module-based critical thinking skills that developed are intended to encourage students to use critical thinking independently indicator and directional. Students who are accustomed to using critical thinking activities have logical thinking and rational and able to build their own critical thinking process through the activities in the module; therefore, it is expected to have a positive impact on student learning outcomes (Darmawan, 2010; Lunenburg, 2011). Yildirim & Ozkahraman (2011) suggested that student learning outcomes in high-level cognitive can be facilitated using critical thinking.

METHOD

Methods of research and development using the Borg & Gall development procedures were modified in nine stages: 1) stages of research and collecting information, 2) planning stage, 3) development of early product stage, 4) stages of design validation, 5) main product revision stage, 6) limited field trial stage, 7) second product revision stage, 8) stages of operational field trials, 9) stages of the revision of the final product (Sugiyono, 2013)

Stage of operational field trial was conducted to determine the effectiveness of critical

thinking skills-based modules developed. Operational field trials using pretest-posttest design test Non-Equivalent Control Group Design (Sugiyono, 2013). The design of operational field trial is using two classes, namely control classes and treatment classes. Operational field subject is class XI IPA SMAN 3 Boyolali. Grades used were two classes of grade XI. The class consists of classes with teaching as usual (existing learning) which XI-2 and grade the effectiveness of the test module (XI-4). Operational field data collection instruments in the form of multiple-choice test questions that represents the factual, conceptual and procedural learning outcomes also essay test that represents the metacognitive learning outcomes in the respiratory systems study material. Metacognitive learning outcomes assessed using the rubric of cognitive and rubrics MAI (Corebima, 2009). Data analysis used anacova preceded prerequisite test sample that is the test of normality and homogeneity test. Statistical analysis programs assisted by SPSS 18 for windows (Yamin & Kurniawan, 2009).

RESULT AND DISCUSSION

The results of the research and development of critical thinking skills-based modules to empower student learning outcomes are consists of:

The results of research and collecting information stage

The results of the needs analysis in this study using critical thinking indicator based instruments and knowledge dimension in respiratory system study materials. The results of the analysis of contents in the book I show the highest average indicator is the interpretation of 38.2% and the lowest average indicators as well as self-regulation is an explanation of 25.0%. The results of the analysis of the delivery and application of books in the book I show the highest average indicator is the interpretation of 48.7% and the lowest average indicators are setting themselves up to 12.5%. The results of the analysis of the delivery and application of the book II shows the highest average indicator is the interpretation by 42.1% and the low average is the best indicator of self-regulation of 8.3%.

The results of planning stage

The results of the planning stage is to analyze the interaction between indicators of critical thinking with the knowledge dimension indicators and adjusted on the basis of competence res-

piratory system outlined in the matrix, to develop indicators of learning, determining a learning tool for the implementation of the module and determine the procedures related to the development of the module.

The results of early product development stage

The results of early product development stage in the form of modules based on the material's ability to think critically respiratory system to empower student learning outcomes. Critical thinking skills-based modules in the learning objectives, materials, activities and evaluation questions are the development of indicators of learning that includes critical thinking indicators and indicators of knowledge in the material dimension of the respiratory system. Module-based indicators of critical thinking skills developed include confirmation book module (module teacher).

The result of design validation stage

The results of the design validation stage as in Figure 1
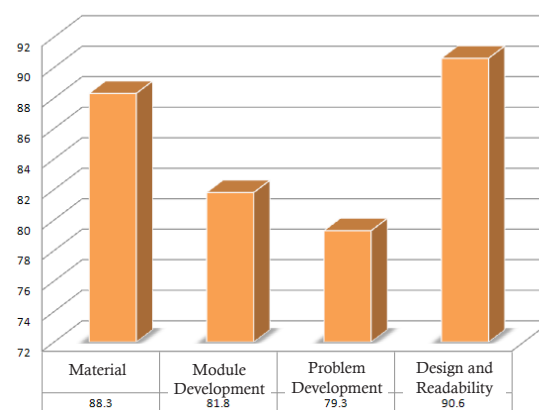

Figure 1. Histogram of Percentage Rate Validation by Experts

Figure 1 shows that the validity of the material, the characteristics of the module, about the characteristics and the design and readability of the early product of critical thinking skills-based modules in respiratory system, is in conformity with the target, as shown by the results of expert validation of material gain value 88.3%, showing a good qualifying, expert validation module development to get the value of 81.8% indicates good qualification, validation expert development a matter of getting the value of 79.3% indicates a good qualification and validation of design experts and legibility get the value of 90.6% indicates excellent qualifications.

The results of main product revision

The result of main product revision stage which made based on suggestions and revisions of the validation of materials experts, module development experts, development specialists and the design experts.

The result of limited field trial stage

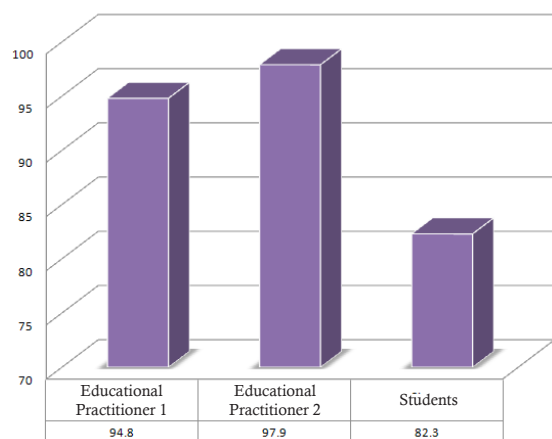The result of limited field trial stage is obtained results as in Figure 2

Figure 2. Histogram of assessment in Limited Field Trial

Figure 2 limited field trial of education practitioners and small groups of users concluded that the critical thinking skills-based modules on the respiratory system materials get value 94.8% and 97.9%, showing excellent qualifications based on ratings educational practitioners and scores 82.3 %, showing good qualification based assessment of small groups; therefore, it can proceed to the stage of operational field trials to determine the effectiveness of the module after fixing the shortcomings of the education practitioners and small groups of users.

The results of second revision stage

The results of the second stage product revision are done based on suggestions and revisions from education practitioners are presented in Table 1 as well as a small group of test users in Table 2.

The results of operational field trial stage

The results of operational field trials stage using Anacova is F count = 180.4 and a significance level of 0.00 <0.05 on factual, conceptual, procedural, learning outcomes which is visualized in the form of multiple choice questions, as well as the F count = 40.2 and a significance level of 0.00 <0.05 in metacognitive learning results are visualized in the form of essays. Anacova test

results showed a significant difference between the control classes that uses teaching materials grade school with treatment using critical thinking skills-based modules demonstrated the significance level of less than 0.05. The difference between the control classes and the treatment classes showed that the modules based on the material's ability to think the critically respiratory system is more effective to empower the learning outcomes if compared with school teaching materials.

Table 1. Revision of Suggestion and Correction by Education Practitioners

Suggestion	Correction
Colour contrast of the image is created in every part of organ structure, therefore, it is obvious.	Replace the image more obvious in every part of the organ structure
Question to the student activity is much overlap; it should be combined; therefore, it does not overlap.	The questions in the activity have been integrated with the activities of the students, therefore, it does not overlap.
Margin limit of the module is needed to be trimming.	Margin limit has been trimmed.

Table 2. The Results of Suggestion Correction and Small Group User Revision

Suggestion	Correction
It is recommended to use the clear explanation to ease students' understanding	Difficult language should be changed by general terms; such as affinity to be binding. The terms used must be explained by a glossary.
The purpose of learning must be described.	Learning outcome is not described as already described in general to materials, activities and problems.
It is recommended to simplify the study material.	The material has not simplified because it explains the learning objectives.
It is better to use the general terms instead of Latin language.	The use of Latin language has a purpose of acquainting the students to Latin terms to improve the students' knowledge.

The results of final product revision stage

The result of the revision stage of the final product from critical thinking skills- based modules gained from qualitative information and results of the analysis of operational field test stage in order to obtain proper modules are used. The results of the operational field test stage known that nothing needs to be revised; therefore, the final product revision is not done.

The development of critical thinking skills-based modules on the study material discussed on the respiratory system is about: the development of critical thinking skills-based modules on the respiratory system study materials, the feasibility critical thinking skills-based modules and effectiveness critical thinking skills-based modules on the respiratory system study materials.

Development of critical thinking skills-based modules on the respiratory system study materials

Critical thinking skills-based modules on the respiratory system study materials is a module that developed according to the model development procedure Borg & Gall which has been modified into nine stages (Sugiyono, 2013). The module aims to trained critical thinking skills that will impact on increasing learning outcomes. Module-based critical thinking skills are developed based on the analysis of textbooks used in the schools.

Critical thinking skills-based modules on the respiratory system study materials were developed based on indicators of critical thinking and knowledge dimension. Indicators of critical thinking and knowledge dimension outlined in the matrix are visualised in the form of indicators. Indicators developed in the form of objectives, materials, activities, and about the evaluation of the module in the sub-subject of the respiratory system are arranged in a systematic, operational and directional (Mulyasa, 2005).

Products of critical thinking skills- based modules developed has advantages compared with the teaching materials in schools, because it is based on content analysis module which includes objectives, materials, activities and evaluation questions based modules critical thinking skills obtain a higher percentage as described in Table 3 and presented in Figure 3.

Table 3 shows that the indicators on the critical thinking critical thinking skills-based module more than in the teaching materials in schools. In the book I found in the smallest increase of 54.6 interpretation indicators and the biggest increase in the indicator explanation contained 70.8;

59.1 followed by analysis indicators; conclusions indicator amounted to 65.5; evaluation indicators amounted to 63.6 and 68.8 indicators of self-regulation. In book II smallest increase contained in the interpretation of indicator reached 59.9 and the biggest increase self-regulation contained in the indicator amounted to 83.4 followed indicator analysis of 65.9; conclusions indicator amounted to 65.5; evaluation indicators of 72.7 and 75.0 for the explanation.

Table 3. Histogram of Comparison of Compliance on Critical Thinking Indicators by module

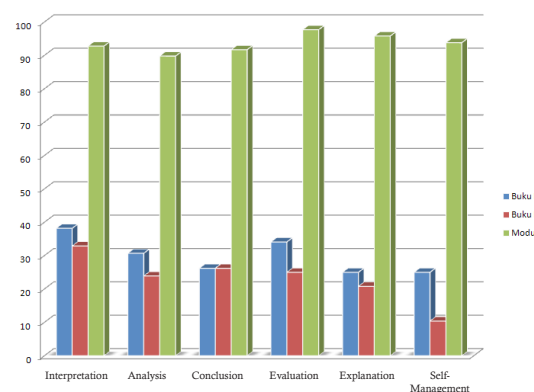| Critical Thinking Indicators	Comparison of Module Component Percentage (%)	
	School Teaching Materials	Module of Critical Thinking
Book I		
Interpretation	38.2	92.8
Analysis	30.7	89.8
Conclusion	26.2	91.7
Evaluation	34.1	97.7
Explanation	25.0	95.8
Self-Regulation	25.0	93.8
Book II		
Interpretation	32.9	92.8
Analysis	23.9	89.8
Conclusion	26,2	91.7
Evaluation	25.0	97.7
Explanation	20.8	95.8
Self-Regulation	10.4	93.8

Figure 3. Histogram of Comparison of Compliance on Critical Thinking Indicators

Based on the content interpretation analysis of books I and II books are known have the

smallest increase. The small increase is due to the textbooks used in the schools own interpretation indicators despite the highest value are not optimal, more in Table 1 and Table 2. Indicators of the interpretation are the ability to understand, explain the meaning of a situation, experience, incident data and decisions (Widiyowati, 2015), which is usually found in many textbooks at school; therefore, the addition of the interpretation indicator is not as much as another indicator of critical thinking.

Analysis of Book I and II books experienced the largest increase in the explanation indicator and self-regulation. Explanations indicators and self-regulation in the book I get an average of the lowest indicators by 25%, whereas in the second book of self-regulation indicators earn on average 10.4%. The largest increase in the book I was an explanation indicator from 25% to 95.8%, the module is based on critical thinking skills to add an explanation indicator by 70.8%. Explanation indicator is not just a description but include explanations that related to a connecting descriptions process and logically relationships and using empirical data as the basis of explanation (Wu and Hsieh, 2006). The largest increase in book II is an indicator of self-regulation from 10.4% to 93.8% module is based on critical thinking skills to add indicators of self-regulation by 83.4%. Indicators of self-regulation (self-regulation) are to monitor a person's consciousness cognition process personally to ensure themselves are already involved in critical thinking activities or not (Ricketts & Rudd, 2004).

The indicators of critical thinking on critical thinking skills-based module indicate the success of research in improving teaching materials in schools are related to the fulfilment of the teaching materials to train critical thinking activities. Module-based critical thinking skills did not reach the percentage of 100%, because the indicator material is not all indicators derived from indicators of critical thinking and indicators of dimensions of knowledge can be visualized on the module as indicators of observing an experiment, identifying experiment, designing experiment, rewrite, create, prove, determine, analyze, evaluate, distinguish between the experimental results and summarize the results.

Module-based critical thinking skills is one form of literature reading with instruction activities focused on learning and not just focus on the content, developed with a variety of instructions and practices through technical questions that encourages students to analyze, shortly synthesis, and evaluate information to solve problems and make decisions (Snyder & Snyder, 2008; Darmawan, 2010; Thomas, 2011). Module-based critical thinking skills not only developed on specific learning objectives, but also on indicators of the capacity to think (Kartimi & Liliasari, 2012).

Feasibility of critical thinking skills-based modules in respiratory system has been tested through the steps of a) validation test by the experts includes: materials experts, module development experts, development specialists and experts about the design and legibility, more is presented in Figure 1; b) a limited field test consisting of an education practitioner and teacher by a small group of test users by students, more is presented in Figure 2.

Based on Figure 1, it shows that the results of the feasibility test on critical thinking skills-based modules based on the expert validation are qualified as good until very good. Qualifications were obtained from materials experts; module development and development experts about as well as excellent qualifications are shown by the expert design and readability.

Based on Figure 2 shows the average assessment by education practitioners acquires excellent qualifications and a small group of test users by students gain good qualifications. Based on the due diligence obtained from expert validation and limited field tests concluded that the module-based critical thinking skills in the respiratory system study materials fit for use because it has been through expert validation stage, the assessment of education practitioners and the small group of test users.

The effectiveness of critical thinking skills based modules in the respiratory systems study material.

The effectiveness of the module-based critical thinking skills on the material respiratory system to empower student learning outcomes, grouped into two, covering the learning outcomes of factual, conceptual and procedural uses multiple choice questions, and learning outcomes metacognitive uses essay (test metacognitive) (Anderson & Krathwohl, et al., 2010).

Effectiveness in terms of factual, conceptual and procedural learning outcomes using Multiple Choice Questions (MCQs)

MCQs represent the factual, conceptual and procedural learning outcomes which analysed using Anacova test and more at present in Table 4.

The results of student's learning using critical thinking skills-based modules are higher if

compared to the results of student learning using teaching materials in schools. The results of anacova test is a rejection decision of Ho for obtaining sig value of 0.00 (<0.05). Parameter estimation results obtained results -29.13 (Trihendradi, 2013), which means that classes that do not use the module-based critical thinking skills score 29.13 posttests lower than the class that uses the think critically modules.

Table 4. Anacova test in multiple choice questions

Variabel	Pre test Average	Post test Average	F	Sig	Partial Eta Squared
Control Classes	42.6	61.2	180.42	0.00 (sig < 0.05)	0.723 Estimation parameter (-29.13)
Treatment Classes	33.2	88.0			

The difference between the results of posttest in control classes and the treatment classes showed that the module based on the material's ability to think critically of the respiratory system is more effective in empowering learning outcomes on the dimensions of factual knowledge, conceptual and procedural. The results are supported by research Lunenburg (2011) that indicators of critical thinking are contained in learning, one module contributes to the achievement of student learning outcomes. Rosana (2014) adds that students with critical thinking skills are tend to get higher learning results if compared with students who have the ability to think critically low, since students who have the ability to think critically high use thought to feed on comprehending the material well, analysing and able to solve their problems.

Effectiveness of student's metacognition skills using essay questions

Metacognition test using essay questions that were analysed by Anacova and more served in Table 5.

Table 5 shows that the learning outcomes of students who use critical thinking skills-based modules higher than the results of student learning using teaching materials in schools.

Table 5. Anacova test in metacognitive questions

Variabel	Pre test Average	Post test Average	F	Sig	Partial Eta Squared
Control Classes	45.1	58.2	40.18	0.00 (sig < 0.05)	0.368 Estimation parameter (-10.72)
Treatment Classes	39.1	68,7			

The results of Anacova test is a rejection decision of Ho for obtaining sig value of 0.00 (<0.05). Estimation parameter results obtained results -10.72 (Trihendradi, 2013), which means that classes that do not use the module-based critical thinking skills score 10.72 posttests lower than the class that uses the modules of think critically.

The difference between the results of posttest in control group and the treatment classes showed that the modules based on the material's ability to think critically respiratory system are effective in empowering learning outcomes on the dimensions of metacognitive knowledge. The results obtained are supported Kusumaningtias, Zubaidah & Indriwati (2013) which suggests that critical thinking in learning is able to empower metacognitive skills that aim to form students become independent learners (self-regulated). Critical thinking which contains in the module helps students to develop their metacognitive skills, argue, self-confidence, have independence in learning and scientific honesty (Murtadho, 2013).

Effectiveness of critical thinking skills-based modules in learning outcomes

Critical thinking skills-based modules are generally more effective than teaching materials in schools in empowering learning results because it has a purpose and a clear material, valid evaluation questions and activities are more targeted because it is using critical thinking indicator and knowledge dimension indicator. Critical thinking skills-based modules have some variants of learning activity which equipped with the supporting questions to improve the critical thinking skills. Learning activities are summarised in the module that consists of a practicum, simulation, observation, self-reformation and administration issues. Learning activities and questions in the compiled modules are interrelated and organized. It supports to have a deep understanding (Johnson,

2009).

Indicator in thinking critically that trained by the use of module are potential to supports in thinking empowering because the six indicators are cognitive skills which able to accommodate the students' cognitive development (Yildirim dan Ozkahraman, 2011). Cognitive skills that empowered through critical thinking activities in the module, helps students to gain an increase in learning, because students who are trained as critical thinkers are capable of working on all high-level thinking on the cognitive processes dimensions (Mandernach *et al.*, 2009; Thomas, 2011). Students who have good critical thinking skills are expected to have an understanding, confidence and a new perspective that potential to have good learning outcomes.

CONCLUSION

The conclusion of the research and development are critical thinking skills-based modules in respiration system material was developed according to the indicators of critical thinking skills and knowledge dimension that visualised on the objectives, materials, activities and evaluation questions. Feasibility of the module which obtained by the expert's validation are shown good qualifications until very good; based on education practitioners are showing excellent qualifications and based on a small group of users test show good qualification. Effectiveness of the module was shown by the results of Anacova test which obtained F count = 180.4 on factual, conceptual and procedural learning outcomes which represented by Multiple choice question and F count = 40.2 metacognitive learning outcomes which represented by essay, stating there are significant differences between the results of students which using critical thinking skills-based modules on learning with teaching materials in schools; therefore, that the critical thinking skills-based module are more effective than teaching materials in schools.

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