



Development of Higher Order Thinking Skills (HOTS) Measurement Ability Instruments in Learning High School Biology

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Abstract: This study aims to produce instruments that can measure the level of students' higher order thinking skills that are valid and practical for students of class XI SMA. The developed instrument contains 40 multiple choice questions, and 10 essay questions consisting Taxonomy Levels C4, C5, and C6 with indicators of high-level thinking critical thinking, decision making, problem solving and creative thinking. This research used the Research and Development (R&D) type of Tessmer's modified formative evaluation with the stages of self-evaluation, prototyping (expert review, one-to-one, and small group). The result of this research indicates that the instrument for measuring higher order thinking skills in class XI Biology SMA students developed is categorized as very valid and very practical with the validity value of expert review very valid (89.9%), one-to-one is very valid (87, 5%). And the practical value of teachers is very practical (91.33%), and students are very practical (87.15%).

Abstrak: Penelitian ini bertujuan untuk menghasilkan instrumen yang dapat mengukur tingkat kemampuan berpikir tingkat tinggi siswa yang valid dan praktis untuk siswa kelas XI SMA. Instrumen yang dikembangkan berisi 40 soal pilihan ganda, dan 10 soal uraian terdiri dari Taksonomi Tingkatan C4, C5, dan C6 dengan indikator berpikir tingkat tinggi berpikir kritis, pengambilan keputusan, pemecahan masalah dan berpikir kreatif. Penelitian ini menggunakan Research and Development (R&D) tipe formative evaluation modifikasi Tessmer dengan tahap self evaluation, prototyping (expert review, one-to-one, and small group). Hasil penelitian menunjukkan bahwa instrumen pengukuran kemampuan berpikir tingkat tinggi pada siswa kelas XI Biologi SMA yang dikembangkan dikategorikan sangat valid dan sangat praktis dengan nilai validitas expert review sangat valid (89,9%) , one-to-one sangat valid (87,5%). Serta nilai praktis guru sangat praktis (91,33%), dan siswa sangat praktis (87,15%).

Keywords: Instrument, Higher Order Thinking Skills, critical thinking, decision making, problem solving and creative thinking.

INTRODUCTION

21st century learning requires skills that students can prepare to respond to global challenges. The skills that students must have are thinking critically and rationally to solve problems, creative in creating various solutions and designing new strategies, able to work together in teams (Kemendikbud, 2019:1).

Efforts that can be tried to realize the national learning goals that have been designed are the integration of Higher Order Thinking Skills (HOTS) in the education process and the final evaluation in the form of question instruments that can train students high level thinking skills (Sani, 2019b:1).

Higher order thinking skills is the ability that covers 4C (Creative, Critical thinking, Comumunicative and Colaborative). HOTS skills are useful for training students to think deeply related to the learning material provided, so that the thinking level of students is able to go to a higher level, to answer future challenges (Kemendikbud, 2019:1).

Based on the evaluation conducted by the Program for International Student Assessment (PISA) regarding student skills in the categories of reading achievement, mathematics, and science, Indonesia was in position 74 out of 79 countries for the reading achievement category, position 73 in the mathematics category, and position 71 out of 79 countries for science performance category (Tohir, 2019:1).

The low achievement of students in PISA is due to learning in schools which are generally not based on higher-order thinking skills. Meanwhile, the ability measurement instrument used by educators also does not apply higher-order thinking skills (Sani, 2019b:225).

HOTS will enable students in critical thinking to find solutions to various contextual problems using critical and rational logic, be creative in finding various solutions to one problem and design new strategies, able to work together in teams to achieve common goals, and the ability to

capture ideas/information to argue (Kemendikbud, 2017:10). Information that is learned and processed through higher-order thinking processes will be remembered longer and more clearly than information processed through lower-order thinking processes (Ramos, Dolipas, & Villamor, 2013:57).

The results of observations, teachers at SMAN 3 Solok which were held in February 2020, schools have implemented learning that supports higher-order thinking processes by applying several learning models such as Group Investigation (GI) and the Scientific approach . It is just that the instruments that are usually used by educators to evaluate the understanding of students do not meet the criteria for higher-order thinking, this is based on the analysis of the mid-semester exam questions and the final exam for the second semester of biology subjects, amounting to 64 questions. The results of the analysis obtained that the questions were at the level of remembering (C1) 24 items, understanding (C2) 30 items and applying (C3) 10 items. Instruments with levels C1, C2 and C3 can result in students not getting used to higher-order thinking.

Higher order thinking skills are a necessity in the implementation of learning. Learning using HOTS skills will be useful in training students' thinking skills, while giving higher order thinking skills questions will be useful in measuring students' knowledge of basic competencies and to achieve learning goals (Fitriani & Sari 2019:9). Assessment with integrated HOTS can make an important contribution in improving students' critical thinking skills such as problem solving skills, decision making, concluding, divergent thinking skills and creative skills (Widana, et al, 2018:28)

Based on the problems above, researchers have developed an instrument for measuring the ability of higher order thinking skills with the aim of making students have thinking skills to a higher level adapted to the needs and development of students who have 4C skills (Creative, critical thinking, communication, and communication).

collaboration) according to the demands of 21st century learning.

METHOD

Research Locations and Development Model

This research was conducted in October-December 2020 and January 2021 at SMAN 3 Solok Class XI Academic Year 2020/2021. This study used a formative evaluation type of development research or Development Research (R&D) model modified to produce a valid and practical Higher Order Thinking Skills (HOTS) measurement instrument for Class XI SMAN 3 Solok. This research refers to the development model by Tessmer.

Stages of Research Development

The following were several stages in this development research:

Preliminary Stage

This stage begins with the researchers determining the place and subject of the research by contacting the principal and the teacher of class XI biology studies. Furthermore, the researchers distributed a questionnaire on teachers' perceptions of Higher Order Thinking Skills (HOTS) and arranged research work schedules and procedures.

Formative Evaluation Stage

Self Evaluation

a. Analysis

This stage was the beginning of the researchers doing the development. Researchers in this step conducted curriculum analysis, KD analysis, and analysis of exam questions commonly used in schools.

b. Design

At this stage, the researchers designed the instrument cover, grid and HOTS ability measurement instrument questions based on 4 indicators of higher-order thinking skills, namely critical thinking, creative thinking, problem solving, and decision making. The design at this stage were the first prototype (self evaluation results).

Expert Review dan One-to-one

The first prototype that has been designed is then given to the experts and 3 students.

a. *Expert review*

At the expert review stage, an assessment is carried out and evaluated by 3 experts consisting of 2 evaluation expert lecturers, and 1 material expert lecturer.

b. *One-to-one*

In the one-to-one stage, the first prototype test of the HOTS ability measurement instrument was carried out to 3 students in class XI of SMAN 3 Solok. The results of student comments were used as the revision material.

Small Group

The results of the revision of the expert review and the one-to-one trial conducted by the students became the second prototype, then tested in a small group assessed by 2 biology teachers and 7 students as research subjects.

At this stage, the 7 students were asked to work on the questions. Based on the test results and student comments will be used as revision material.

RESULTS AND DISCUSSION

RESULTS

Self Evaluation

This stage aims to determine and design an instrument for measuring higher-order thinking skills by conducting curriculum analysis, KD analysis and analysis of student exam questions. The results of this self-evaluation stage obtained 5 learning materials, namely the respiratory system, excretion, coordination, reproduction and the body's defense system. There are 6 basic competencies from 5 materials for Class XI in even semesters, namely KD 3.8, 3.9, 3.10, 3.12, 3.13, and KD 3.14. To achieve these basic competencies, there are 25 indicators spread over 40 multiple choice questions and 10 essay questions.

This analysis of curriculum and questions was used as the initial stage to design an instrument for measuring higher order

thinking skills (prototype 1) to be tested on an expert review and one-to-one.

Expert Review dan One-to-one

At this stage the prototype was tested in the following groups:

a. *Expert review*

The first prototype was observed, assessed and evaluated by experts consisting of 3 lecturers. Experts were asked to provide suggestions and responses through a validity questionnaire which was used as material for revising the first prototype and stated that the first prototype was called valid. The results of the experts review show that there were several errors in the question sentence, the stimulus for the question, the determination of the cognitive level, and the determination of indicators for higher-order thinking. To find out the level of validity of the questions developed by the experts, they were asked to fill out a validity questionnaire.

Table 1. Results of Expert Review Validity Assessment

Aspect	Validity Value	Criteria
Material	93,3 %	Very valid
Construction	88,1 %	Very valid
Language	85,0 %	Very valid
Additional Rules	93,3 %	Very valid
Amount	359,70	
Average	89,9 %	Very valid

b. *One-to-one*

The one-to-one stage was carried out by 3 students who were asked to provide an assessment by filling out a questionnaire, giving suggestions or comments. From the questionnaire analysis, there were several questions that have been corrected, namely number 43, and the results of the validity values are as follows:

Table 2. One-to-one Validity Assessment Results

Aspect	Validity Value	Criteria
Material	90 %	Very Valid
Construction	91 %	Very Valid
Language	95,6 %	Very Valid
Additional Rules	73,3%	Valid
Amount	349,9	
Average	87,5 %	Very Valid

Small Group

The second prototype was tested on two teachers and seven students. Teachers and students were asked to read the questions on the higher order thinking skills (HOTS) measuring instrument and provide advice and assess in terms of the attractiveness and ease of use of the instrument. The comments and scores given at the small group stage for the higher order thinking skills instrument are presented as follows:

Table 3. Comments on the Small Group Stage

No	Suggestions/Comments
1	Melfi Elinda, S.Pd, M.Si -The percentage of cognitive level in each KD is not balanced -The question bank that has been created is worthy of being given to students at UH and US
2	Herawati Rahayu, S.Pd. Thank God it's good, just for the discourse it needs wider development
3	Zayyana Qurratul Aini Too difficult, questions like this are rarely given by the teacher. Pretty challenged
4.	Lianka Vanya Fadila This collection of questions is very helpful for us grade 12 students because it is in accordance with the material we are studying, if possible, the questions will be multiplied and further improved
5	Gilang Adji Maulana In my opinion, the questions are interesting and creative, some questions are accompanied by pictures and they are very interesting. But the questions are a little difficult to do
6	Ika Putri Amanda Hopefully many students will be challenged to answer difficult questions and review together
7	Jemmi Revina Caprisa Everything has been provided as well as

- 8 possible and the appearance is very attractive
Rina Rahmadona
Problems are rarely found and a little difficult to work on need more serious thinking
- 9 Nailatul Fdhilah Yurizal
I'm challenged to work on it because I've never discussed anything like this. I am required to really understand the material.
Good right

The assessment of the questionnaire by a small group with 2 teachers and 7 students for the developed instrument product can be seen as follows:

Table 4. Results of Teacher Practicality Assessment Instruments for Higer Order Thinking Skills .
Measurement Instruments

Aspect	Practical Value	Criteria
Attractiveness	90 %	Very Practical
Convenience	94%	Very Practical
Time Efficiency	90%	Very Practical
Amount	274	
Average	91.33%	Very Practical

Table 5. Results of Student Practicality Assessment Instruments for Higer Order Thinking Skills
Measurement

Aspek	Nilai Praktikalitas	Kriteria
Attractiveness	89,1 %	Very Practical
Convenience	89,5%	Very Practical
Time Efficiency	82,86%	Very Practical
Amount	261,46	
Average	87,15%	Very Practical

DISCUSSION

The Validity of the Higher Order Thinking Skills (HOTS) measurement instrument in Biology Learning Class XI SMA

The results of the material aspect validity test are 93.3% (very valid) on expert review and 90% (very valid) on one-to-one . This instrument is designed based on the suitability of students needed in the 21st

century and the goals of national education, so that it can help and facilitate teachers and students in evaluating thinking skills, especially HOTS thinking skills. The material for this instrument is in accordance with the Kemendikbud (2019:9) namely, HOTS-based measurement questions require the characteristics of being able to improve critical thinking skills, creative thinking, decision-making abilities, and problem solving. Hanifah (2019:6) states that a good stimulus should be contextual or raised from problems in the surrounding environment. In writing questions related to the material to be tested, it should be noted that questions can be classified as Lower Order Thinking Skills (LOTS) questions if students have found similar questions in previous questions (Tsaparlis, 2020:476)

The result of the validity of the expert review construction aspect is 88.1% (very valid) while the one-to-one stage is 91% (very valid). This is because the instrument for measuring the ability of higher order thinking skills is very good, seen from the arrangement of questions and answers that have fulfilled the construction. Basuki & Hariyanto (2015: 131-132) state that the construction of the questions includes (a) The core of the questions is made clear, concise and firm, (b) the core formulation of the questions and answers are required statements, (c) the answer key is not found in the core of the questions. and avoid double negative questions, (d) graphs, tables, pictures, diagrams and so on are functional, (e) the length of the answer choices is relatively the same, (f) the answer choices do not use the statement "all answers are wrong" or " all answers are correct" , (g) Items are not related to the answers to other questions.

From the linguistic aspect, the developed instrument was stated with a value of 85.0% (very valid) and for the one-to-one stage it is 95.6% (very valid). This shows that the developed instrument has used communicative and unambiguous language. According to Safari (2005: 64-65) the use of spelling, use of words and use of sentences is

a determinant that the question uses language in accordance with Indonesian rules. And Jawariah (2017:89) states that if the questions are used nationally, then the questions do not use the local language.

The last aspect of validity is an additional rule that gets an expert review score of 93.3% (very valid) and one-to-one 73.3% (valid). This shows that the instrument developed does not contain racist sentences in the subject matter. Basuki & Hariyanto (2015:131-132) state that the sentence in the subject matter is not allowed with regard to, race, ethnicity, religion or a person's personality.

In general, the overall instrument for measuring the ability of higher order thinking skills can be declared very valid with a value of 89.9% at the expert review stage carried out by 3 experts consisting of 1 material expert and 2 evaluation experts. As for the one-to-one stage, this instrument was declared very valid with a value of 87.5% which was carried out by 3 students. Thus, this HOTS ability measurement instrument can be said to be feasible for teachers to use in evaluating student learning and training higher-order thinking skills. This is in line with Yani (2019:5) who stated that HOTS questions can improve students' analytical, synthesis and evaluation skills.

Practicality of the instrument for measuring Higer Order Thinking Skills in Class XI High School Biology Learning

Based on the results of the practicality test of the instrument with material on the respiratory, excretory, coordination, reproductive and body defense systems carried out by teacher practitioners and students, it was found that the instrument developed had very practical criteria of 91.33% and 87.15%. This means that the instrument for measuring the ability of higher order thinking skills has fulfilled practical aspects which include aspects of attractiveness, convenience, and time efficiency.

The attractiveness aspect in the higher order thinking skills measurement instrument

was stated to be very practical by teachers with a value of 90% and students with a value of 89.1%. This shows that the instrument is in accordance with the specified aspects, interesting in terms of content and appearance and does not confuse students. Kemendikbud (2019:6) states that higher order thinking skills must be able to present some information and be able to motivate students to interpret information.

In terms of ease of use, the instrument for measuring higher order thinking skills was stated to be very practical by teachers with a score of 89.5% and students with a score of 89.5%. This indicates that in the use of the higher order thinking skills instrument, they already have question instructions, scoring guidelines and the material in the questions in accordance with what is taught to students. Kemendikbud (2019:6) states that contextual assessment is one that is integrated with learning. Moreover, Munir (2015) advocates that a good instrument should present easy to use.

The time efficiency of the instrument for measuring the ability of higher order thinking skills obtained very practical criteria with a value given by teachers of 90% and students of 82.86%. This is very practical criterion shows that the developed instrument has good time efficiency. This is supported by Purwanto (2009:141) stating a good question seen from the length of time the test takes. Atos (2015:783) asserts that time efficiency is obtained with good time management so that students can achieve the desired results within a predetermined time period. Finally, Munir (2015) states that the standardized instrument would be helpful to make the evaluation process more efficient and reliable.

CONCLUSION

The instrument for measuring the ability of higher order thinking skills in Biology learning in Class XI SMA which was categorized as very valid and very practical with a very valid expert rivew validity value (89.9%), one-to-one very valid (87.5%). And the practicality value of teachers is very

practical (91.33%), and students are very practical (87.15%). This HOTS capability measurement instrument is expected to be continued at the field test stage to test the effectiveness of the instrument.

Based on this finding, this instrument can be used for measuring the ability of HOTS in Class XI SMA.

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