

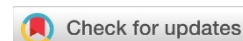


## The Validity of Assessment of Higher Order Thinking Skills (HOTS) About Metabolism

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### ABSTRACT

**Background:** The test results of the higher-order thinking skills assessment instrument of students at several high schools in West Sumatra obtained an average score of 17.88-35.19, which is still low. One way to overcome students' low level of high-order thinking skills is to develop an instrument for assessing higher-order thinking skills. This study aims to produce a valid, practical, and good quality item assessment instrument of students' high order thinking about metabolic material for class XII SMA / MA. **Methods:** This study uses a 4-D development model. The subjects of this study were three validators and 27 students of class XII SMA. The data collection instrument was a validity questionnaire and a practicality test. **Results:** The data obtained are logical validation with an average of 84.90% valid criteria, empirical validity with a correlation between 0.27-0.54 with valid measures. Has an average rate on practical measures of 86.64%, reliability 0.83 with high categories **Conclusions:** Instruments for assessing the ability to think at a high level about metabolic material are logically valid and empirically valid, practical, reliable, moderate difficulty level, distinguishing power and good quality options.

### Validitas Penilaian Keterampilan Berpikir Tingkat Tinggi (HOTS) Tentang Metabolisme

### ABSTRAK

**Background:** Hasil tes instrumen penilaian keterampilan berpikir tingkat tinggi siswa di beberapa SMA di Sumatera Barat memperoleh skor rata-rata di kisaran 17,88-35,19 yang masih rendah. Salah satu cara untuk mengatasi tingkat rendah keterampilan berpikir tingkat tinggi siswa adalah dengan mengembangkan instrumen untuk menilai keterampilan berpikir tingkat tinggi. Penelitian ini bertujuan untuk menghasilkan instrumen penilaian item yang valid, praktis, dan berkualitas baik dari pemikiran tingkat tinggi siswa tentang materi metabolik untuk kelas XII SMA/MA. **Metode:** Penelitian ini menggunakan model pengembangan 4-D. Mata pelajaran penelitian ini adalah 3 validator dan 27 siswa kelas XII SMA. Instrumen pengumpulan data adalah kuesioner validitas dan tes kepraktisan. **Hasil:** Data yang diperoleh adalah validasi logis dengan persentase rata-rata 84,90% kriteria valid, validitas empiris dengan korelasi antara 0,27-0,54 dengan kriteria yang valid. Memiliki persentase rata-rata pada kriteria praktis 86,64%, keandalan 0,83 dengan kategori tinggi. **Kesimpulan:** Instrumen untuk menilai kemampuan untuk berpikir pada tingkat tinggi tentang bahan metabolik secara logis valid dan valid secara empiris, praktis, dapat diandalkan, tingkat kesulitan sedang, membedakan kekuatan dan pilihan kualitas yang baik.

#### Kata kunci:

Higher order thinking skills;

Instrumen penilaian;

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### Introduction

The 2013 curriculum expects learners to play an active role in the learning process in the classroom. The 2013 curriculum is focused on forming competencies and character of learners in the form of a blend of affective, cognitive and psychomotor aspects. According to Jernigan

et al. (2018), the cognitive aspect is a realm that includes mental or brain activities. Based on Bloom's taxonomy revised by (Anderson & Krathwohl, 2001), the cognitive realm consists of six levels: remembering, understanding, applying, analyzing, evaluating, and creating.

According to one of the international studies on the cognitive skills of learners, namely TIMSS (Trends In Mathematics and Science Study) held by the OECD (Organization for Economic Cooperation and Development), TIMSS results in 2015 in the field of science showed Indonesia was ranked 45 out of 48 participating countries. In addition, according to Widana (2017), high-level thinking skills in Indonesian learners are still low in (1) understanding complex information; (2) theory, analysis and problem-solving; (3) the use of tools, procedures and troubleshooting; (4) Conduct an investigation (TIMSS, 2015).

Based on Indonesia's low ranking on TIMSS, (Ariyana 2018) developed a learning program oriented towards high-level thinking skills. This program was created to improve the quality of learning and the quality of graduates. In line with that, as an effort to enhance the high-level thinking skills of learners, Fithriyah et al. (2020); Marlina & Rahmi (2021) develops assessments to increase learners' high-level thinking skills in several biological topics such as heredity, cell division and genetics (Azwar & Anas, 2018).

In addition, researchers conducted a preliminary study on March 28 2019, through a trial of high-level thinking skills assessment instruments against class X learners at SMAN 1 Batang Anai. This preliminary study was conducted to determine the average value of high-level thinking skills in learners. The number of students observed as many as 30 people. The instrument used is a high-level thinking ability assessment instrument that has been valid by Jaedun & Hariyanto (2014) as many as 30 questions. The average grade score was 24.62. Based on these values, the ability to think high levels of learners in SMAN 1 Batang Anai is declared still lacking. This follows Prasetyani (2016), which states that student grades in the range of 21-40 are less able.

Based on the interview results, it is known that teachers have difficulty making high-level thinking skills assessment instruments. This is because teachers are less trained in designing high-level thinking skills instruments. There are no guidelines available to make high-level thinking ability assessment instruments on certain materials. Teachers consider the ability of heterogeneous learners and still have difficulty answering high-level problems. The difficulty of teachers in making high-level thinking skills assessment instruments can be seen in the example of daily repeats of Plantae material class X odd semester 2018/2019. The average problem given is still at the level of C2-C3. The problems made 17.4% are still at the level of C1, 43.47% is still at the level of C2, 39.13% at the level of C3 and for the cognitive level C4-C6 is still not achieved.

Several other researchers have conducted trials on high-level thinking skills at several high schools in West

Sumatra. Based on data, the high-level thinking skills of learners in some high schools in West Sumatra are still lacking, for that effort is needed to improve high-level thinking skills. Researchers have made various efforts to improve the high-level thinking skills of learners, including Ariyana (2018) developing learning programs oriented to high-level thinking skills. Rahmi & Alberida (2017) stated that high-level thinking skills also be improved by using portfolio assessments.

The development of this HOTS assessment has been carried out on several biology subject matter; namely, Rahmi et al. (2021) developed the HOTS instrument on fungi, ecosystem materials, and Plantae material. (Budiman & Jailani (2014) states that HOTS capability assessment instruments can be given to all types of Daily Replays. This means that all materials can be developed into HOTS. Researchers are trying to develop a HOTS assessment instrument on the metabolic matter. Basic competence in metabolic material contains KKO in the realm of C2 (Undang et al., 2019).

Cahyono (2017) stated that the assessment instrument is adapted to basic competencies and adapted to core competencies. In addition, metabolic matter addresses the relationship between structures, functions and factors that influence the work of enzymes and the processes of catabolism and anabolism as enzymatic reactions in living things so that KD metabolic matter can be developed as an instrument of assessment of HOTS capabilities. Researchers have researched "Validity of High-Level Thinking Ability Assessment of Metabolic Matter" based on the description above.

## Methods

This type of research is development research. This research aims to produce products using assessment instruments capable of thinking high about metabolic materials for class XII SMA / MA students using the development model 4-D (four-D) designed by Thiagarajan Semmel and Semmel (Thiagarajan, 1974). The research was conducted at Padang State University (UNP) and SMAN 1 2x11 Enam Lingkung. The resulting product is a high-level thinking ability assessment instrument piloted at SMAN 1 2x11 Enam Lingkung in the odd semester of the 2020/2021 school year.

The subjects of this study are validators and learners. The validator consists of two lecturers of the Department of Biology UNP and one biology teacher, SMAN 1 2x11 Enam Lingkung. Practicality test by two biology teachers and class XII students MIPA 1 SMAN 1 2x11 Enam Lingkung. The test subject consisted of 27 students of class XII MIPA 1 SMAN 1 2x11 Enam Lingkung. The object of this study is an instrument of assessment of high-level thinking ability about metabolic material for students of class XII SMA/MA.

## Results

### Logical validity

Logical validity is carried out by three validators: two lecturers of the Department of Biology FMIPA UNP and one biology teacher using validation questionnaires. Validators provide some advice on high-level thinking ability assessment instruments that are used as a basis for consideration for making improvements. Suggestions from validators and follow-ups are displayed in [Table 1](#). After revising the problem based on the advice of the validator,

then the analysis of the results of the logical validity test can be seen in [Table 2](#).

**Table 1.** Validator Suggestion

Validator	Suggestion
Zulyusri	Revisions to cognitive problems
Rahmawati	Revisions to the aesthetics of option writing on the problem
Rosye Rita	Revisions to irrelevant problem indicators

**Table 2.** Result of Validity Test

Evaluation component	Validator			Sum	Validity Value	Criterion
	1	2	3			
Material	30	33	33	96	88,88%	Valid
Language	29	33	30	92	85,18%	Valid
Construction	9	11	9	29	80,55%	Valid
High-level thinking ability	15	19	17	51	85%	Valid
Total validity value					339,61%	Valid
Average validity value					84,90%	Valid

The validation results in the table above show an average validity value of 84.90% with valid criteria. This suggests that high-level instrument assessment of thinking skills has been valid from material aspects, construction, language and high-level thinking skills.

### Empirical Validity

The empirical validity value of the assessment instrument is obtained through the analysis of the problem item. Analysis of the problem item was obtained after being tested on August 7, 2020, at SMAN 1 2x11 Enam Lingkungan to obtain empirical validity. The analysis was conducted using ANATES 4.0.9 to get reliability, difficulty level, differentiating power and options quality. Reliability is 0.83 with very high criteria. The empirical validity data analysis results got 35 valid questions from 50 problems with a moderate difficulty level with an index of 0.26-0.67, a differentiating power of 59.44 with good categories and 52% option quality with good criteria.

## Discussion

### Logical validity

The results of data analysis from the instrument's validity questionnaire of high-level thinking ability assessment showed that the instrument had a validity value of 84.90% with valid criteria. The instrument is valid based on material aspects, construction, language and high-level thinking skills. The results of data analysis on material aspects, high-level thinking ability assessment instruments have a validity value of 88.88%. It is stated that the higher-level thinking ability assessment instrument developed has been valid and following the material in the 2013 Curriculum. The material was developed based on Core

Competencies and Basic Competencies ([Depdiknas, 2017](#)), so that it can be used to measure the ability to think at high levels about the metabolic matter.

In terms of construction, the high-level thinking ability assessment instrument was declared valid with a validity value of 85.18%. The construction of the problem relates to how the situation is formulated correctly to understand what is being asked. The structure of the developed problem is equipped with quality instructions and answer keys. This aligns with [Depdiknas \(2017\)](#) that good problems are formulated.

In terms of language, the high-level thinking ability assessment instrument was declared valid with a validity value of 80.55%. This proves that the needed problem is following the rules of good and correct Indonesian. The assessment instrument must use easy-to-understand language, and the formulation of the question does not give rise to a double interpretation ([Depdiknas, 2017](#)). So that the problem can be answered well by learners because they have used the correct rules of Indonesian.

In terms of high-level thinking ability, high-level thinking ability assessment instruments are declared valid with validity values of 85%. This shows that the assessment instruments developed can measure and train the learning learners' high-level thinking skills. High-level thinking ability assessment instruments developed using contextual stimulus (using images, graphs, tables, discourses and so on) and required learners to find answers based on an implied stimulus. In line with [Afifah et al. \(2013\)](#), the high-level thinking ability assessment instrument is an instrument that requires learners to think critically so that they can analyze the stimulus and not just be at the cognitive level of remembering.

Overall, the assessment instrument of high-level thinking skills about metabolic material for class XII SMA/MA students has an average of 84.90%. According to Ngalim (2009), the value belongs to the correct category. Based on the above data analysis results, this high-level thinking ability assessment instrument about metabolic material has been logically valid. Teachers can use it as a guideline to create high-level thinking ability assessment instruments. Before use, it is necessary to conduct empirical validity tests and practicality tests so that the instrument is valid logically and empirically and practically.

### Empirical validity

Empirical validity aims to determine the reliability of the assessment instrument developed in line with Arikunto (2018) that an instrument has empirical validity when tested from experience. The trial was conducted on 27 students of SMAN 1 2x11 Enam Lingkung. Empirical validity using ANATES 4.0.9 from the analysis results of 50 questions obtained 35 valid questions based on empirical validity. There are 15 invalid questions based on the correlation put forward by Arikunto (2018). If the value  $r$  is located between 0.00-0.20, it is declared low reliability and does not show significant or invalid.

### Conclusion

Based on the study results, it can be concluded that the instrument of assessment of high-level thinking ability about metabolic material is logically and empirically valid, practical, reliable, moderate difficulty level, differentiating power and good quality of options.

### Declaration statement

The authors reported no potential conflict of interest.

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