

The Development of HOTS Instruments in Biology Learning

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ABSTRACT

This study aims to produce valid and reliable HOTS instruments in Biology Learning. The research is a Research and Development study with the ADDIE model. The research was conducted at SMA Negeri 12 Kerinci. The sample in the study came from 2 biology education lecturers and 3 biology teachers. The instruments in this study were a 20-item multiple-choice HOTS test sheet and a validation questionnaire. Data collection techniques are tests and validation questionnaires. Indicators of higher-order thinking Skills are the ability to analyze, evaluate and create. Data analysis is quantitative and qualitative data analysis with the help of the SPSS version 16 application. The results showed that the Higher Order Thinking Skills instrument had a validation value of 0.724 with decent criteria and reliability of 0.972 with high criteria. These findings explain that the Higher Order Thinking Skills(HOTS) instrument is very valid and reliable for use in ecology and environmental materials

ARTICLE INFO

Keywords

Assessment, higher-order thinking skills, Education, Biology

Received

June 8, 2023

Revised

July 13, 2023

Accepted

July 28, 2023

Published

July 31, 2023

How to cite

Santosa, T.A., Festiyed., Zulyusri & Razak, A. 2023. The Development of HOTS Instruments in Biology Learning. *Jurnal Mangifera Edu*, 8(1), 62-69. <https://doi.org/10.31943/mangiferaedu.v7i1.166>

INTRODUCTION

Higher Order Thinking Skills (HOTS) is a type of high-level thinking ability that students must have to solve problems (Almelweth, 2022). Puspitasari et al., (2020) higher-order thinking skills encourage students to more easily understand complex subject matter. Students who have higher-order thinking Skills think critically and creatively in learning (Ong et al., 2020; Kim et al., 2022; Susanti et al., 2020; Rintayati et al., 2021). HOTS plays a very important role for students to make the right decisions and solutions in learning (Susanto & Retnawati, 2016; Utami et al., 2020; Syafryadin et al., 2022). Furthermore, HOTS encourages students to have 21st-century skills, namely Critical Thinking and Problem-solving, Creative, Collaborative, and Communicative (Haniah et al., 2020; Kim et al., , 2020).

Students' Higher Order Thinking Skills (HOTS) level in Indonesia is still low (Ahmad et al., 2018; Setiawan et al., 2018). This can be seen from the PISA Study in 2018, the quality of Higher Order Thinking Skills (HOTS) of Indonesian students obtained a score of 396, ranked 72 out of 78 member countries (Rahmi et al., 2021; Suharyat et al., 2023). In addition, the 2011 TIMSS results



explained that Indonesian students' math and science scores obtained a score of 386 far behind the international average score of 500 (Cahyaningsih & Roektingroem, 2018). The low level of Higher Order Thinking Skills (HOTS) is influenced by teacher-centered teaching and learning activities (Ramirez & Ganaden, 2008; Ichsan et al., 2019; Alharbi et al., 2022; Putranta & Supahar, 2019), making the learning process less enjoyable Hanifah (2019) stated that teachers have not been able to create questions that encourage Higher Order Thinking Skills (HOTS). In addition, students have difficulty in understanding those related to analysis, evaluation and creation in biology learning (Umami & Rusdi, 2021).

Biology is one of the compulsory subjects in class X SMA Negeri 12 Kerinci which must be completed by students in accordance with the Teaching Completeness Criteria (KKM) of 75. In learning biology students have many difficulties in learning (Dama, 2021). Research results (Avina & Winarsih, 2014) stated that not many teachers have developed instruments for Higher Order Thinking Skill questions in learning biology in ecology and environmental materials. Furthermore, the material of ecology and the environment many students get scores below KKM. Therefore, there is a Higher Order Thinking Skills (HOTS) instrument in ecology and environment material. Research results (Rahmawati & Trimulyono, 2021) stated that the development of HOTS instruments in biology learning encourages students to think critically and scientifically.

Research Setiawan *et al.*, (2021) stated that the development of HOTS instruments in learning encourages students to be more active in learning. Valid and reliable learning instruments help the quality of students' learning in HOTS questions (Rahmi *et al.*, 2021). Research results Suprpto *et al.*, (2020) Explaining that giving the right questions will stimulate students' Higher Order Thinking Skills in solving problems. Not only that, the right HOTS instrument will encourage students to think critically, innovatively and creatively in learning (Poppy *et al.*, 2020; Supriyatin *et al.*, 2020). Furthermore, research results Pratiwi *et al.*, (2015) stated that the development of HOTS instruments can improve student discipline in learning. Based on this problem, this research aims to produce a valid and reliable Higher Order Thinking Skills instrument in learning biology.

METHOD

This research is a type of Research & Development research with the ADDIE model developed by Dick & Carry in the ADDIE model Boyman *et al.*, (2020). In the ADDIE model there are five stages of development namely Analysis, Development, Implementation, and evaluation. This research was conducted at SMA Negeri 12 Kerinci. The research sample came from 2 biology education lecturers and 3 biology teachers. Data collection in this study through tests and validation questionnaires. The test aims to determine the Higher Order Thinking Skills (HOTS) of students in learning biology. The questionnaire aims to determine the feasibility of Higher Order Thinking Skills (HOTS) questions. The instrument used in the validation questionnaire consisted of 20 statement items which were analyzed with the Minitab version 18 application.

The research indicators of Higher Order Thinking Skills (HOTS) consist of students' ability to analyze (C4), evaluate (C5) and create (C6). Data analysis was obtained by analyzing the validity of the instrument and the reliability of the instrument. Instrument validity consists of content,

language and material validity tests. To perform content validity using the Gregory formula with criteria can be seen in table (1). Furthermore, the reliability of the instrument is calculated by the Cronbach's Alpha formula with the criteria can be seen in Table 2.

RESULTS AND DISCUSSION

The results of the development of Higher Order Thinking Skills (HOTS) instruments in learning biology. The first stage is needs analysis, curriculum analysis and analysis of student evaluation. The second stage is to design the Higher Order Thinking Skills instrument in accordance with the Basic Competencies (KD) and Core Competencies (KI) of ecological and environmental materials. Furthermore, the third stage is Develop. At this stage, the instrument was validated by content validation, language validation, and material validation by lecturers and biology teachers. The results of the validation of the Higher Order Thinking Skills (HOTS) Instrument in learning biology of ecology and environmental material can be seen in Table.3.

Table. 3 HOTS Instrument Validation Results

No	Validasi	Skor	Peresentase (%)	Kriteria
1	Content	40	83 %	Valid
2	Language	49	87 %	Valid
3	Material	48	90 %	Very Valid
Mean		45.67		Valid

Based on Table. 3 explains that the content validation value obtained a score of 42 with valid criteria, language validation score 45, material validation score 47 and the average value of the validity test obtained a score of 45.67 with valid criteria. This shows that the Higher Order Thinking Skills instrument is suitable for use in learning class X biology. The next stage is implementation. At this stage, the instruments that have been validated by experts and revised are then carried out limited trials on students by giving Higher Order Thinking Skills (HOTS) questions. The results of the limited trial validation can be seen in Table 4. The development of Higher Order Thinking Skills instrument in learning biology ecology and environment material is very feasible to be developed. HOTS instruments are very important for teachers in developing students' higher order thinking skills in learning (Rahmawati et al., 2022; Razak et al., 2021). The development of valid and reliable HOTS instruments will encourage students' critical and creative thinking skills in learning (Wantoro et al., 2019; Utama, 2020; Ahmad & Syafii, 2020; Ratna et al., 2018; Elfira et al., 2023). In developing HOTS instruments for biology learning, questions must refer to indicators of analyzing, evaluating and creating (Hidayatullah et al., 2022), so that students can think critically in learning.

Table 4. Results of HOTS Instrument Validation for Limited Tests

Index	Criteria	Limited Product Trial	
		Item Frequency	%
0.81 - 1.00	Very Hight	7	35
0.61 - 0.80	Hight	8	40
0.41 - 0.60	Simply	4	20
0.21 - 0.40	Low	1	5
0.00 - 0.20	Very Low	0	0
Total		20	100

Based on Table 4. Shows the results of a limited trial of Higher Order Thinking Skill instruments in learning biology of ecological and environmental material there are 7 (35%) questions that have very high validation, 8 (40%) questions have high validity, 4 (20%) questions have sufficient validity and 1 (5%) has low validity. From the results of the limited trial, the Higher Order Thinking Skills (HOTS) instrument in biology learning is very feasible to be used in learning ecology and environmental materials. Furthermore, from the limited test results of the HOTS instrument, the lowest rcount was 0.270 with low criteria while the highest rcount was 0.958 with very high validity. With an average score of 0.724 with valid criteria. Furthermore, the results of the HOTS instrument reliability test in learning biology of ecology and environment material can be seen in Table 5. Avina & Winarsih (2014) stated that HOTS instruments that have good validity, reliability and difficulty index values will result in appropriate use to measure students' higher order thinking skills. The validity test results obtained an average score of 0.724 and reliability of 0.972 with very high criteria. The use of appropriate HOTS instruments in biology learning will be able to be used in evaluating the quality of student learning (Tanujaya, 2016; Dungsungnoen, 2016; Supriyatin et al., 2020; Ramadhan et al., 2019). Baidlowi et al., (2019) stated that the development of HOTS instruments can encourage students to solve problems related to HOTS-based questions in biology learning more easily.

Table 5. Reliability Test Results

Product Trial	α	Criteria
Limited Product Trial	0.972	Very Hight

Based on Table 5. Explaining the results of the HOTS instrument reliability test in the limited product trial obtained $\alpha = 0.972$ with very high criteria. This shows that this HOTS instrument is very valid and reliable to be developed in learning biology of ecology and environment material. Higher Order Thinking Skills (HOTS) help students in solving difficult questions in ecology and environment materials. A valid and reliable HOTS instrument will be able to measure students' science literacy level in biology learning (Kahar et al., 2021; Riswanda, 2018). Ansori (2020) stated that the development of HOTS instruments improved the cognitive dimension and thinking characteristics of students in biology learning. Therefore, the development of this instrument has a positive impact on teachers and students in ecology and environmental materials (Setiani et al., 2022)

CONCLUSION

Based on this research, it can be concluded that the Higher Order Thinking Skilss instrument has a validation value of 0.724 with decent criteria, reliability of 0.972 high criteria. This finding explains that the Higher Order Thinking Skilss (HOTS) instrument is very valid and reliable for use in ecology and environmental materials. So, the HOTS instrument is very feasible to be developed in biology learning in ecology and environment materials in schools

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