

A HOTS-Oriented Module: A Valid Biology Teaching Material Innovation for Grade 10 in 21st-Century Learning

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Abstract: A Higher Order Thinking Skills (HOTS)-oriented module is a teaching material designed to develop higher-order thinking skills beyond the mastery of factual knowledge. This study employed a Research and Development approach aimed at developing a valid HOTS-oriented biology module for Grade 10 senior high school students in the even semester. The development process followed the ADDIE model, consisting of Analyze, Design, Development, Implementation, and Evaluation stages. Module validity was evaluated using expert validation sheets covering content feasibility, presentation, graphical components, and language aspects. Data were analyzed using mean scores based on predetermined validity criteria. The results showed high validity scores, with mean values of 4.64 for content, 4.57 for presentation, 4.46 for graphics, and 4.25 for language. The overall validity score was 4.48, categorized as valid. Therefore, the HOTS-oriented biology module is recommended for use in educational settings as an alternative teaching material to support learning that fosters students' higher-order thinking skills.

Keywords: HOTS; Module; 21st-Century Learning.

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Introduction

21st-century education focuses on improving human resources. Education is required to prepare students to face an increasingly competitive world of thought, innovation, and creativity. (Aldi et al., 2022; Lestari & Cintamulya, 2022). In addition, education plays an important role in training and developing the abilities of students (Ramadhana et al., 2023). This brings demands for education providers to have a wise and solutive attitude so as to support the realization of education implementation in the 21st century (Kumalasan & Kusumaningtyas, 2022). The realization of optimal implementation of 21st century education requires several support systems, one of which is the curriculum used (Rosidah, 2020).

The Merdeka Curriculum in Indonesia is part of the efforts of the Ministry of Education and Culture of the Republic of Indonesia to meet the needs of students who are adapted according to the context and characteristics of students in order to build competencies that are in accordance with present and future needs. The Merdeka Curriculum is a rearrangement in the education system in order to welcome the changes and progress of the nation in order to adapt to changing times and produce quality resources that are able to compete in various fields of life (Sibagariang et al., 2021; Yamin & Syahrir, 2020). Therefore, in order for the implementation of the curriculum to run according to expectations, it requires commitment and roles from all parties, especially the role of an educator or teacher.

Teachers have an important role in the learning process; among the teacher's duties are creating a learning atmosphere that actively engages students and providing teaching materials that are relevant to students' needs and support the learning process. The teaching materials used must be in accordance with the characteristics of the target and should be able to guide students to achieve the desired learning objectives (Nurhikmayati & Jatisunda, 2019). Module are one of the teaching materials that are able to support learning in the classroom. Modules are needed as an alternative in bridging problems in the learning process (Arif et al., 2024; Nisa et al., 2022). Module is one of the teaching materials in which the teaching material is arranged in sequence and the language used is easily understood by the user, according to the level of knowledge development and age of the user so that users can learn independently with the help or without guidance by the educator. In addition, modules also have components and structures that are more complete than other teaching materials (Depdiknas, 2008).

Based on the analysis of the modules used by 10 biology teachers, most of the modules already contain titles (100%) and assignments (90%). However, many modules are still incomplete, as only 60% include basic competencies and learning objectives, 40% include assessments, and only 30% contain learning instructions and supporting information. This condition indicates that the modules have not fully met the module

component criteria recommended by the Ministry of National Education, highlighting the need for improvement to align with 21st-century learning demands.

The needs of students are always aligned with education in the 21st century which is challenged to produce resources that have basic abilities known as the 4C (Critical Thinking and Problem Solving, Collaboration, Communication, Creativity) (Adnan et al., 2021; Sinaga, 2020; Kumalasani & Kusumaningtyas, 2022). The implementation of 4C in learning can have a tremendous influence on the next generation in facing the challenges of life in the 21st century (Adnan et al, 2022). These four abilities are part of Higher Order Thinking Skills (HOTS). HOTS is one of the important abilities in education so it must be familiarized for students. Commensurate with this, learning in the curriculum requires students to have higher-order thinking skills (Noviani & Wijaya, 2020; Yayuk et al., 2019; Septikasari & Rendy, 2018; Setiawati et al., 2018). HOTS-oriented learning aims as an effort to improve the quality of learning and the quality of graduates in order to prepare graduates with 21st century competencies. The ability to think higher order thinking skills is one indication of the success of increasing human resources in the field of education (Adnan et al., 2021; Muchsin et al., 2021).

However, the problems that arise in the world of education are teaching materials, assignments and assessments given by educators are still in the realm of low-order thinking (Low Order Thinking Skills / LOTS) or the cognitive realm of C1-C3, where in the cognitive realm students only rely on their ability to remember, understand, and apply so that they have not been able to reach the cognitive realm of higher-order thinking (Prayogi & Aesthetics, 2019). Based on preliminary research data, out of a total of 10 teachers who use the module, most have not reached the HOTS level. This can be seen from the module components, namely the learning objectives and the assignment part given. Of the 41 learning objectives, as many as 14.63% are in the realm of C1, C2 is 56.10%, C3 and C5 are still 0%, C4 is 19.51%, and C6 is 9.76%. Likewise in the assignment section, after analysis, it was found that of the 96 tasks given, as many as 48.96% were in the realm of C1, C2 by 27.08%, C3 by 17.71%, C4 by 4.17%, C5 by 2.08%, and C6 was still 0%.

Based on the results of this analysis, it is known that biology learning in the cognitive realm of HOTS carried out by teachers in the field is still very low. This can be seen from the accumulated percentage of HOTS content (cognitive level C4-C6) in the aspect of learning objectives of 29.27% and the assignment part is still 6.25%. This is also in line with the results of research by Dini, et al (2022) and Rejeki, et al (2022) which states that the use of cognitive domains LOTS and HOTS is still unbalanced where the use of cognitive domains C1-C3 is still dominant in the learning process in schools. While the Government through the Ministry of Education and Culture expects learning to contain HOTS even learning tools such as RPP, LKPD, teaching materials and other assessments must contain HOTS. In fact, in schools the learning tools that implement HOTS are still very low. While HOTS-oriented learning can be applied to all subjects.

One way to overcome the above problems is to develop HOTS-oriented modules that are integrated with the curriculum and the demands of 21st century learning so that learning becomes active, student-centered, and builds students' higher-order thinking skills. The development of modules equipped with HOTS questions is a solution to meet the learning needs of students (Qoridatullah et al., 2021). The development of teaching materials is very important so that the teaching and learning process is more effective, efficient, does not deviate from the competencies to be achieved, and improves the quality of the learning process (Amaliah et al., 2022). In addition, the use of teaching materials in the form of modules can increase students' learning motivation and higher-order thinking skills and help them learn independently. Therefore, through HOTS-oriented modules, teachers can train learners to think critically, creatively, and deeply about the subject matter (Bahri et al., 2021).

HOTS-oriented modules are training or learning modules that emphasize higher-order thinking skills rather than just presenting information directly. HOTS-oriented modules can help students understand the material more deeply and develop broader thinking skills so that it can be applied to various situations in everyday life (Adnan, 2022). Based on the explanation above, it can be seen that the application of HOTS in learning is still low so that the purpose of this study is to develop HOTS-oriented modules to be able to support the achievement of learning in all cognitive domains to meet curriculum demands. In addition, the development of HOTS-oriented modules is also suitable and relevant to be applied in the learning process in schools.

Methods

This research is a research and development (R&D) that aims to produce a valid High-Order Thinking Skills (HOTS)-oriented biology module for the Even Semester of Grade X SMA/MA. The development model used is ADDIE, which includes the stages of analysis, design, development, implementation, and evaluation, but this research is limited to the development stage (Smith & Ragan, 2004). The research instrument used is a module validation sheet compiled based on aspects of content feasibility, presentation, graphics, and language feasibility.

Data collection techniques are carried out by providing validation instruments to expert validators to assess the validity of products that have been made by researchers. Validators provide appropriate assessments by providing checklists (v) on each aspect of the assessment and providing suggestions for improvements to parts of the HOTS-oriented module product that still need improvement. Expert validator assessment suggestions and data are used as a reference to revise the developed product until a HOTS-oriented module is obtained that is suitable for use in learning. Data analysis in the study was carried out by interpreting the total average value (Va) obtained from

validators, then referring to the interval for determining the level of validity of learning devices as listed in Table 1.

Table 1.

Module validity level criteria

Interval	Validity Criteria
$Va = 5$	Very valid
$4.00 \leq Va < 5.00$	Valid
$3.00 \leq Va < 4.00$	Quite Valid
$2.00 \leq Va < 3.00$	Less valid
$1.00 \leq Va < 2.00$	Invalid

(Source: Hobri, 2010)

Information:

Va = average validity of all validators

Results & Discussion

This research produces a biology module oriented to High Order Thinking Skills (HOTS) for grade X of even semester of SMA/MA which is developed using the ADDIE model, and the results of the implementation stage are explained as follows.

1. Analyze stage

a. Learner needs analysis

Analysis of student needs was obtained through a survey of 30 students at SMA Negeri 2 Makassar using student needs questionnaires to see problems in learning and student learning needs. The survey of 32 students had various needs and problems in studying biological material. As many as 73.33% of students considered that dominant teachers use the lecture method in the learning process. As many as 63.33% of students experience difficulty understanding the material through teaching materials and methods applied by teachers. As many as 83.33% of students have difficulty understanding biology material and looking for teaching materials other than books from school to help understand biology subject matter. As many as 93.33% of students are motivated to learn if they use interesting modules and need higher-order thinking skills oriented modules for biology learning so that the material is easy to understand and contextual. In addition, as many as 90.00% of students need modules whose questions can be answered based on the results of direct observations/activities, not just copying those in the literature book/package book.

b. Analysis of teacher needs

The analysis of teacher needs was obtained through a survey of 10 teachers of Biology subjects from different schools. Based on a survey of 10 biology teachers, data was obtained that only 30% of teachers have used modules containing HOTS (C4, C5, and C6), 60% of teachers stated that the HOTS module is able to activate students in the learning process, 90% of teachers stated that the HOTS module is able to support students to think higher-order, and 100% of teachers stated that the HOTS module is important and

needed for today's learning. The results of this survey are a reference for developing modules oriented to higher-order thinking skills to support biology learning.

c. Goal analysis

Objective analysis becomes a reference in module development. Activities carried out in the objective analysis are using Learning Outcomes (CP), Learning Objectives (TP), Learning Objectives Achievement Indicators (IKTP), and assessment indicators. The formulation of learning objectives in biology subjects Class X Even Semester is developed in accordance with the Independent Curriculum. The learning objectives of biology subjects Class X Even Semester contain material on biological technology innovations, ecosystems, and environmental changes. The selected learning objectives are then formulated Learning Objective Attainment Indicators (IKTP) and assessment indicators that contain ABCD (Aundance, Behavior, Condition, and Degree) components and are arranged at the cognitive level of HOTS that support the material.

d. Instructional analysis

The instructional analysis stage aims to analyze the structure of the material to be contained in the developed module. Material structure analysis is made so that the material to be contained in the HOTS-oriented module has a clear structure and stages and makes it easier for researchers to make material arrangements so that the material delivered is sequential and does not confuse students when learning each material.

e. Content analysis

Content analysis aims to find out and adjust the content of the material to be presented in the module to be developed. Content analysis is based on the Independent Curriculum and Learning Outcomes (CP) in phase E. Content analysis is in the form of material analysis and activities that will be contained in the module. Content analysis is carried out by researchers by analyzing learning resources such as textbooks, journals, articles, research results, images and other relevant learning resources that support the material to be compiled in the module.

2. Design stage

The design phase contains the design of the HOTS-oriented module to be developed which starts from the stage of creating a format (storyboard). The storyboard format of the developed HOTS-oriented module can be seen in Table 2.

Table 2.

Design overview (storyboard) of HOTS-oriented biology module

Module Components	Module Sub Components
Sampul	1. Logo Kementerian Pendidikan dan Kebudayaan 2. Logo Kurikulum Merdeka 3. Logo Universitas Negeri Makassar 4. Nama Penulis



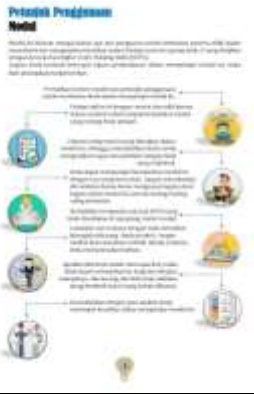

Module Components	Module Sub Components
	5. Judul modul secara umum
	6. Ilustrasi
	7. Tingkatan Kelas
	8. Editor
Kata pengantar	-
Daftar isi	-
Konten modul	-
Petunjuk penggunaan modul	-
Capaian pembelajaran	-
Modul	<ol style="list-style-type: none"> 1. Tujuan Pembelajaran (TP) 2. Deskripsi Singkat Materi 3. Kegiatan Belajar 1 <ol style="list-style-type: none"> a. Indikator Ketercapaian Tujuan Pembelajaran (IKTP) b. Indikator asesmen c. Uraian materi d. Kata Kunci e. Tugas HOTS (Bio-HOTS) f. Konsep Bio g. Rangkuman h. Penilaian Mandiri i. Evaluasi Diri 4. Kegiatan Belajar 2 <ol style="list-style-type: none"> a. Indikator Ketercapaian Tujuan Pembelajaran (IKTP) b. Indikator asesmen c. Uraian materi d. Kata Kunci e. Tugas HOTS (Bio-HOTS) f. Konsep Bio g. Rangkuman h. Penilaian Mandiri i. Evaluasi Diri 5. Tes Formatif 6. Refleksi Diri
Daftar Pustaka	-
Glosarium	-
Kunci Jawaban	-

3. Development stage

Module development is carried out based on the results of analysis and design that have been drawn through storyboards. The HOTS-oriented module developed contains 3 biological materials in the Even Semester of Class X Senior High School / MA, namely module 1 biological technology innovation, module 2 ecosystem, and module 3 environmental change. The description of some of the components of the HOTS-oriented module developed can be seen in Table 3.

Table 3.
Description of HOTS-oriented module specification

Module Components	Display
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Module Components	Display
Cover	
Module content	
Instructions for using the module	
Module 1 Cover	

Module Components	Display
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Material description



Bio-HOTS
(C4 – Analyze)

The worksheet contains a diagram of a bird's digestive system with labels: 'Makanan', 'Mulut', 'Esophagus', 'Crop', 'Proventriculus', 'Gizzard', 'Small Intestine', 'Large Intestine', and 'Rectum'. Below the diagram is a table for recording observations:

No.	Organ yang diamati	Aspek yang diamati
1.		
2.		
3.		
4.		
5.		

Below the table, there is a section for a written response:

Jelaskan yang paling menarik di atas, analisis kemampuan kaitan yang lain, beraciklah pada kegunaan tersebut di dalam proses metabolisme!

Jawab:

Bio-HOTS
(C5 – Evaluate)

The worksheet contains a diagram of a cow's digestive system with labels: 'Makanan', 'Mulut', 'Esophagus', 'Rumen', 'Reticulum', 'Omas', 'Abomasum', 'Small Intestine', 'Large Intestine', and 'Rectum'. Below the diagram is a section for a written response:

Manfaat diolah untuk menggantikan proses kencing manusia ini pada kambing? Jelaskan! Perilaku ini akan berlaku pada kambing yang diolah dengan proses ini!

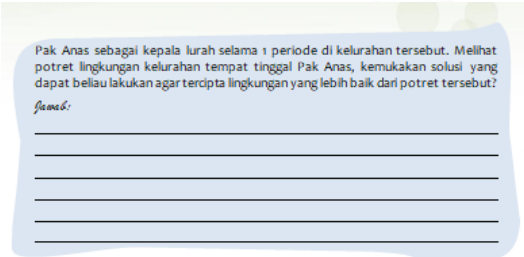
Manfaat: Anda, apakah jawaban beserta click tersebut sudah benar? Diskusikan jawaban yang benar dan salah beserta click tersebut!

Jawab:

Module Components

Bio-HOTS
(C6 – Create)

Display



Self-Assessment



Self Reflection



The modules that have been developed are then validated by two expert validators. Corrections and suggestions from expert validators as material for revision of the developed modules can be seen in Table 4.

Table 4.
Corrections and advice from expert validators

No.	Corrections and Suggestions from Expert Validators
1.	Replace cartoon images with real images on the problem
2.	Replace the contents of Bio-Info with matters related to previous material
3.	Clarify the relationship of the image to the material
4.	Replace an incorrect image on a problem
5.	Fix the subject matter. The subject matter available before the revision has not allowed students to answer questions and has not supported students to think higher-order.

Suggestions from validators are used as a basis for making improvements to the module so that it is feasible to be implemented in the learning process in schools. After that, the assessment of expert validators is analyzed to obtain validation data as a reference that the product developed has met the criteria for valid and feasible use in the learning process. The results of the validity analysis of HOTS-oriented modules can be seen in Table 5.

Table 5.
HOTS-oriented module validation results

No.	Aspects	$\bar{x} \pm \text{SEM}$	Category
1.	Eligibility of contents	4.64 ± 0.11	Valid
2.	Eligibility of presentation	4.57 ± 0.27	Valid
3.	Graphic components	4.46 ± 0.14	Valid
4.	Language feasibility	4.25 ± 0.11	Valid
	Average	4.48 ± 0.08	Valid

Table 5 shows that the HOTS-oriented module is said to be valid and feasible to use because the results of validity data analysis show an average value of 2 validators which is 4.48 with a valid category because it is in the interval 4.00 Va 5.00. This means that the HOTS-oriented modules developed are suitable for use as teaching materials in the biology learning process. However, still pay attention to the criticism and suggestions given to be further revised so that appropriate learning modules are obtained. Quality teaching materials that are feasible to be applied in the learning process if they have met the validity standards in predetermined aspects which are then assessed by experts or experts (Banjarani et al., 2020).

Constructivistic theory became the cornerstone in the development of HOTS-oriented modules. Constructivistic theory indicates that students play an active role in learning activities and actively think. In other words, learners construct their knowledge, conceptualize, and give meaning to the things learned. Teachers only provide optimal opportunities for the learning process to occur (Arif et al., 2025). The increase in student learning interest, understanding, and application of concepts can be supported in classes

based on constructivistic theory (Subaidah, 2019). Ausubel's theory was also a cornerstone in the development of HOTS-oriented modules. The theory leads learners to associate new experiences, phenomena, and facts into their knowledge structure. Thus, students get a meaningful learning experience (Arif et al., 2024; Aldi et al., 2022; Wicaksono & Ahmad, 2015).

Research on module development was also conducted by Abdullah, et al (2021) obtained an average score for module validation of 3.30 which means that all components are in the valid category so that the module is suitable for use. A similar study was also conducted by Faridah, et al (2022) obtained an average score for module validation of 3.87 which means that all components are in the very valid category so that the module is suitable for use.

Conclusion & Recommendation

Based on the results and discussion, it can be concluded that the HOTS-oriented module on biology material for the Even Semester of Class X Senior High School / MA developed is valid based on aspects of content feasibility, presentation feasibility, graphic components, and language feasibility. Based on these conclusions, researchers hope that the HOTS-oriented module that has been developed can be used by teachers as teaching materials in the biology learning process because it has been validated and declared valid. Besides that, researchers should then be able to develop HOTS-oriented modules on other materials so that there are more choices of teaching materials that can be used by teachers, especially biology teachers.

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