

Development of HOTS-based biology learning documents using ADDIE Model

Enies Nabila Fithri Tiara Sari ^{a,1}, M. Amin ^{b,2}, Atok Mittachul Hudha ^{a,3}, Diani Fatmawati ^{a,4}, Ahmad Fauzi ^{a,5,*}

^a Department of Biology Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Malang, Jl. Raya Tlogomas No. 246, Malang, East Java 65144, Indonesia

^b Department of Biology, Faculty of Mathematics and Natural Science, Universitas Negeri Malang, Jl. Semarang No. 5, Malang 65145, Indonesia

¹ enies0nabila@gmail.com; ² mohamad.amin.fmipa@um.ac.id; ³ dianifatmawati87@umm.ac.id; ⁴ atok@umm.ac.id; ⁵ ahmad_fauzi@umm.ac.id*

* Corresponding author

Abstract: Empowerment of Higher-Order Thinking Skills (HOTS) is often not optimal due to the lack of availability of HOTS-based learning documents. The purpose of this development research was to produce HOTS-based biology learning tools on movement system material for class XI high school. This development research uses the ADDIE model which has five stages: analyze, design, develop, implement and evaluate. The product development was validated by learning experts and material experts and then tested on students. The validation sheet was used as a data collection instrument. The validation results from learning experts stated that the learning syllabus was very feasible (84.3%), lesson plans were very feasible (80.2%), student worksheets were feasible (72.2%), and evaluation tool were very feasible (83%). Meanwhile, the validation results from material experts stated that all learning documents were feasible (the percentage of eligibility for syllabus, lesson plans, student worksheets, and evaluation tool were 77%, 70%, 80%, and 80%, respectively). After being tested on students, student responses and the results of their evaluation scores indicate that the learning documents that have been developed are suitable for use. In addition, the HOTS learning documents developed are practical and effective in the learning process, so as to create a student-centered learning process and be able to improve students' HOTS.

Keywords: assessment; higher-order thinking skills; lesson plan

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1. Introduction

Nowadays, science teachers are asked to not only teach basic concepts and develop basic skills in their classrooms. In the 21st century, science teachers are required could to empower higher order thinking skills (HOTS) of their students. HOTS includes thinking skills that are needed when someone faces an unfamiliar problem or situation (Supeno et al., 2019). By mastering HOTS, a person will become critical, creative, and accustomed to solving the problems they face (King et al., 2011). Through mastering HOTS, students are also expected could to analyze and evaluate a phenomenon based on the concepts they have learned. Therefore, responding to the importance of mastering this competency, the commitment to promote HOTS has also spread to various countries, such as Malaysia. (Adnan et al., 2017; Yen & Halili, 2015), Australia (Fensham & Bellocchi, 2013), North Ireland (Murphy et al., 2013), and United States. Curriculum designs from these countries clearly position HOTS as the basis for designing learning processes and learning outcomes.

Increasing students' HOTS cannot be separated from the learning process carried out by the teacher in the classroom. All facilities and resources must also support the achievement of HOTS-based learning. Teachers must also be accustomed to applying various lessons that can empower students' HOTS, such as problem-based learning (Ramdiah et al.,

2018), project-based learning (Suherman et al., 2020), and inquiry-based learning (Tindangen, 2018). Furthermore, the availability of appropriate learning documents will support the learning process, including HOTS-based learning. Therefore, the development of learning documents needs to be done to implement HOTS-based learning.

Unfortunately, HOTS empowerment is one of the problems faced in Indonesia. Previous research reports that the HOTS competence of high school students in Indonesia is still not optimal (Fauzi & Wicaksono, 2021). The learning applied in various schools is also not HOTS-oriented (Ramdiah et al., 2019). In addition, the evaluation tools used by teachers are also often based on Lower-Order Thinking Skills (LOTS) (Netri et al., 2018). Therefore, reformulation of the form and implementation of learning needs to be carried out in schools so that HOTS empowerment can be realized optimally.

Based on the background that has been presented, it is necessary to modify the learning documents developed by the teacher. In line with these conditions, several researchers tried to evaluate the HOTS of students in Indonesia, both junior high school (Budiarti et al., 2017; Diputera et al., 2018) and senior high school (Fauzi & Wicaksono, 2021). Several other studies have attempted to develop HOTS-based teaching materials, such as modules (Feriyanto & Putri, 2020; Yusuf et al., 2020), textbooks (Margana & Widyantoro, 2017), student worksheets (Kusuma et al., 2018), to evaluation tool (Serevina et al., 2019). However, from these various development studies, there is no research that aimed to develop a complete learning document. Therefore, the purpose of this development research was to produce HOTS-based biology learning documents, which include syllabus, lesson plans, student worksheets, and evaluation tools.

2. Materials and Methods

This development research used the ADDIE model. The ADDIE model has five stages, i.e., Analyze, Design, Develop, Implement, and Evaluate (Branch, 2009). In detail, each sub-step carried out in the first four stages is presented in Figure 1 (the Evaluate stage is not shown because this stage is carried out during the process and after the development process).

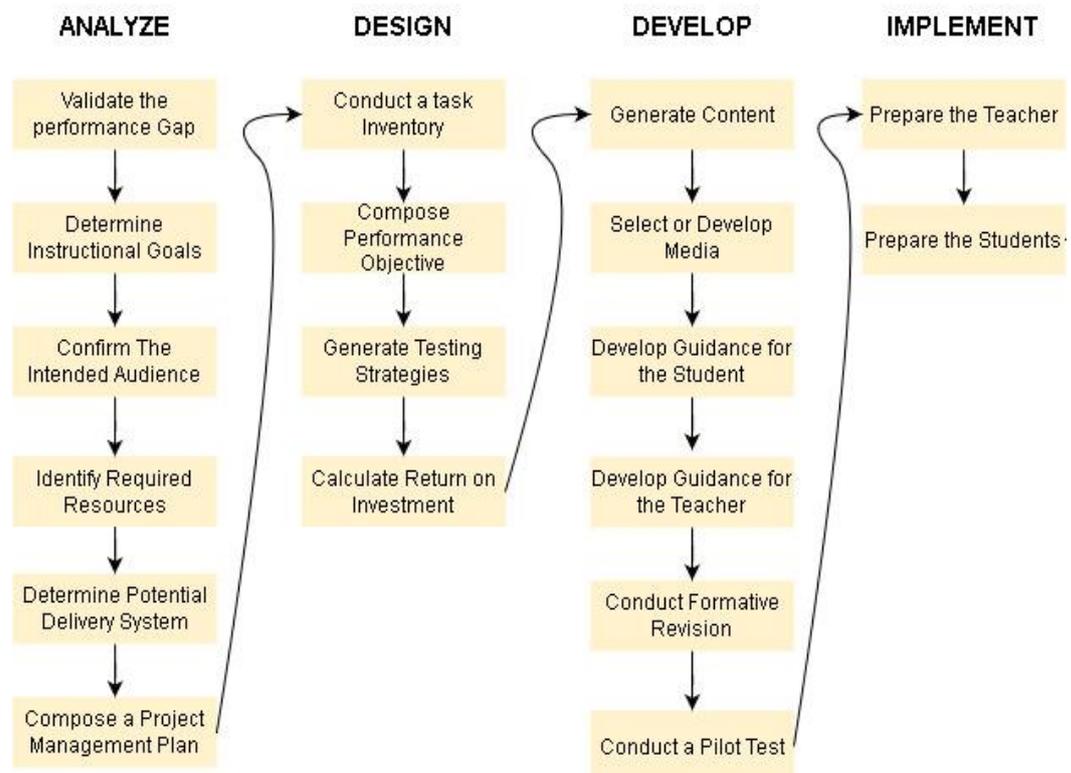


Figure 1. The first four stages of the ADDIE model

The research was conducted during 2019. The needs analysis stage was carried out in February - March 2019. This stage aims to identify the causes of existing problems and the appropriate solutions to these learning problems. Based on the identification results, it is necessary to design a HOTS-based biology learning document. In this study, the learning documents that will be made include the syllabus, lesson plans, students' worksheet and evaluation tools. The next stage of the design stage was development. The purpose of this stage is to generate and validate learning tools that have been made.

The implementation stage was carried out after the learning documents developed have been revised and have been declared valid by experts. The implementation stage was carried out at SMA Muhammadiyah 1 Malang. The aimed of this stage was to apply HOTS-based biology learning documents in the teaching and learning process for Class XI Movement system Materials. With this implementation stage, it will be known the effectiveness of the learning tools developed in the lesson, by looking at student responses and scores. The other stage is the evaluation stage. The purpose of this stage was to measure and determine the quality of products and processes before and after implementation.

3. Results

3.1. Analyze

The ideal condition that is expected to occur in schools is student-centered learning. In addition, learning is expected to be able to empower students' HOTS. However, based on the results of the analysis, the two ideal conditions do not appear. In more detail, the results of each Analyze sub-step are presented in [Table 1](#).

Table 1. Results of the Analyze stage

Sub-stage	Results
Validate the Performance Gap and Determine Instructional Goals	The purpose of this development was to produce HOTS-based learning tools for class movement system materials
Confirm The Intended Audience	The level of student understanding was from good enough to very good. Some students were classified as lazy students, lack of concentration when learning, to be diligent, smart, and pay attention to the teacher's explanation
Identify Required Resource	Sources of material needed to overcome learning problems, including student books, relevant reference books, classrooms, laboratory rooms, teachers, and researchers.
Determine Potential Delivery System	The estimated cost required for the development process was Rp. 937,500.00

3.2. Design

There were four sub-stages in Design stages, i.e., compiling a task inventory that aimed to determine learning objectives and learning activities that will be carried out by students to fulfill basic competencies. The second stage in this design stage was compose performance objectives or stages of compiling work objectives, at this stage there are three things that must be determined, namely performance, conditions, and criteria. The next step is to generate testing strategies. The strategy of testing this biology learning device is carried out in the presence of a validator. Validation will be carried out in several stages including the learning device expert test and the material expert test. At this design stage, the preparation of syllabus validation instruments, lesson plans, students' worksheet, and test questions as well as student responses were carried out. In more detail, the results of each Design sub-stage are presented in [Table 2](#).

Table 2. Results of the Design stage

Sub-stage	Results
Conduct a task inventory	The recommended tasks were carried out by students, i.e., conducting experiments, reviewing information, identifying movement tools, to compiling papers containing ideas that have been discussed with the group.
Compose performance objective	There were 11 performances formulated. Each performance has its own conditions and criteria
Generate testing strategies	The strategy of testing this biology learning document was carried out with a validator. Validation will be carried out in several stages including the learning device expert test and the material expert test. At this design stage, the preparation of syllabus validation instruments, lesson plans, students' worksheet and test questions and student responses is carried out
Calculate return on investment	After recalculation, the development cost was around Rp. 500,000 – 1,000,000

3.3. Develop

The product will be produced in this study was a HOTS-based biology learning document. HOTS-based biology learning document was developed using 80-gram A4 paper with font size 12 multiple spacing 1.5, portrait/landscape, color. The layout was made using Microsoft Word software. So, at the develop stage, learning tools will begin to be developed. The HOTS-based syllabus was developed with the formulation of learning activities that can support the achievement of basic competencies by being oriented to students' higher-order thinking skills in analyzing, evaluating and creating.

The lesson plan was developed based on the HOTS syllabus that has been made, consisting of several components, namely the education unit or school identity, subjects, classes/semesters, subject matter, sub-materials, time allocation, names of lesson plan compilers, core competencies, basic competencies, indicators achievement of competence, learning objectives, learning materials (facts, concepts, principles, procedures and meta-cognitive), learning methods, media, learning tools and materials, learning resources, learning activities and assessment of learning outcomes. The learning approaches, strategies, and methods outlined in the lesson plans reflect the empowerment of HOTS. The approach used in the learning process is a scientific approach. The learning strategy implemented uses a problem-based learning model. The learning method used is the question-and-answer method, discussion, experiment, presentation and assignment.

Student worksheets consist of three parts, namely identity, concept maps and learning activities. Identity Student worksheets consist of subject names, semesters, main materials, time allocation, basic competencies, learning objectives, learning materials and learning resources. The concept map displays the structural chart of the material to be studied in one subject. There are three learning activities in the learning process, namely preliminary activities, core activities and closing activities. Student worksheets are arranged based on the learning resources used, namely biology textbooks used by teachers and other supporting books. Making student worksheets using Microsoft Word, landscape orientation with variations in the type and size of writing and images that support the display aspect of student worksheets to make them more attractive to students. Student worksheets are made to facilitate students to be more active in class, both individually and in groups.

The evaluation questions developed were aimed at measuring students' HOTS. There are two types of questions, namely multiple choice and true-false. The number of multiple-choice questions is 15 items and the number of true-false questions is 10 items.

The aspects assessed by learning experts and material experts in each product developed were different. The aspects that were assessed in the syllabus were the feasibility of

formulation, the feasibility of preparation and presentation, and the suitability of the language. The aspects assessed in the lesson plan were clarity of subject identity, suitability of the formulation of indicators and learning objectives, clarity of learning topics and materials, suitability of learning methods/strategies/approaches/steps with learning topics and students, suitability of tool selection, media, and learning resources with topics and learning strategies and students, suitability of the assessment with indicators and learning objectives and linguistic feasibility. The aspects that are assessed in students' worksheet and questions were the feasibility of the content, the feasibility of presentation and the feasibility of language. In more detail, the results of each sub-step of Develop are presented in [Table 3](#).

Table 3. Results of the Develop stage

Sub-stage	Results
Generate content	There were five learning activities that were formulated and will be implemented in four learning meetings
Develop supporting media	A set of learning documents was developed, which includes a syllabus, lesson plan, student worksheets, and evaluation tools
Develop guidance for the student	The developed syllabus and lesson plans are positioned as a teacher's guide
Develop guidance for the teacher	Student worksheets are positioned as student guides
Conduct formative revisions	The revision of the learning document was carried out after the validators provided comments on the developed learning document. A summary of the validation results is presented in Table 4 and Table 5 .
Conduct a pilot test	The pilot test was conducted at SMA Muhammadiyah 1 Malang.

Table 4. Summary of validity test results before revision

Documents	Learning expert		Content expert	
	Percentage of feasibility (%)	Category	Percentage of feasibility (%)	Category
Syllabus	57	Enough	61	feasible
Lesson plan	64	feasible	64	feasible
Students' worksheet	53	Enough	60.4	feasible
Evaluation tool	61	feasible	61	feasible

In the development stage, product revision activities were also carried out. Improvements are made based on the suggestions given. Suggestions for improvement in the syllabus are to clarify what aspects of the assessment will be carried out in the learning process, previously in this aspect the syllabus only mentioned the types of assessments but could not provide a comprehensive picture of how research will be carried out during learning.

Table 5. Summary of validity test results after revision

Documents	Learning expert		Content expert	
	Percentage of feasibility (%)	Category	Percentage of feasibility (%)	Category
Syllabus	80.2	Very feasible	70	feasible
Lesson plan	84.3	Very feasible	77	feasible
Students' worksheet	72.2	feasible	80	feasible
Evaluation tool	83	Very feasible	80	feasible

3.4 Implement

Due to limitations during the study, the pilot test was also positioned as the implementation stage. In more detail, the results of each sub-step of Develop are presented in [Table 6](#). After the learning was implemented, students were also asked to provide responses to the learning that has been followed. A summary of the students' responses is presented in [Table 7](#).

Table 6. Results of the Implement stage

Sub-stage	Results
Prepare the teacher	One teacher from SMA Muhammadiyah 1 Malang was appointed as a teacher who implements the learning documents that have been developed
Prepare the students	14 students were involved in the implementation stage

Table 7. Summary of student responses

Aspects	Response percentage (%)	Category
Interest	87	Very good
Serving eligibility	87	Very good
Linguistic eligibility	89	Very good

3.4. Evaluate

Some of evaluation results have been presented in [Table 4](#), [Table 5](#), [Table 6](#), and [Table 7](#). Beside the evaluation results of the validators, one form of evaluation used was student scores. The evaluation of students' HOTS was measured after they worked on the HOTS questions. The average score obtained by students was 83, with the highest score obtained 92 and the lowest score was 76. Thus, all students have scores below the minimum completeness score of 75.

4. Discussion

The results at the Analysis stage revealed that the learning applied in schools was still not oriented to HOTS empowerment. This finding is in line with several other studies that report that HOTS-oriented learning has not been implemented optimally in various schools in Indonesia ([Fatimahtuzzahroh et al., 2021](#); [Ramdiah et al., 2019](#)). The lack of implementation of HOTS-based learning in Indonesia can be caused by several causes. One of the main causes of this condition is the low ability of teachers to design HOTS-based learning ([Ramdiah et al., 2019](#)). The low knowledge of teachers regarding HOTS is also the cause of this condition ([Afifah & Retnawati, 2019](#)). In addition, another cause is the teacher's lack of awareness of the importance of empowering HOTS during learning.

In addition, from the analysis stage, it was also revealed that many students apply biology learning in their daily lives. This finding is also in line with other studies that have also revealed the low learning outcomes and HOTS of students in Indonesia ([Diputera et al., 2018](#); [Fauzi & Wicaksono, 2021](#)). The low competence of students' HOTS can be caused by several causes. One of the main causes of this condition is the learning conditions that do not support HOTS empowerment. To optimize students' thinking skills, students must be continuously exposed to an educational process that is oriented towards empowering thinking skills ([Roets & Maritz, 2017](#)). However, many schools have not implemented such learning. The unavailability of HOTS-oriented learning documents in schools was also revealed in the Analysis stage. Finally, the students' lack of familiarity with solving HOTS-based questions is also the cause of the low HOTS of students ([Kusaeri et al., 2019](#)).

At the Design stage, learning documents that are oriented to the development of HOTS began to be designed. The design of learning documents needs to be done so that the implementation of HOTS-oriented learning can be realized optimally. Based on several previous reports, the existence of textbooks ([Margana & Widyantoro, 2017](#)), modules

(Feriyanto & Putri, 2020; Yusuf et al., 2020), or learning documents (Kusuma et al., 2018) is needed as a solution to increase student HOTS. In this study, the learning documents developed were not only student worksheets, but also the other learning documents, from the syllabus to evaluation tools. The presence of a HOTS-based evaluation tool is also urgent because there are still many teachers in Indonesia using an assessment where the majority of the questions are still LOTS (Arif, 2019; Musliha et al., 2021).

In the Develop stage, HOTS-oriented learning documents begin to be developed. In developing the lesson plan, problem-based learning was chosen as the learning model. The choice of this model is based on various research findings that report the positive effect of problem-based learning on the empowerment of students' thinking skills (Birgili, 2015; Ramdiah et al., 2018). When students take part in learning that applies problem-based learning, they will be trained to solve problems presented in class. These problems are problems that come from the daily lives of students but are related to the learning materials they learn. Therefore, apart from being contextual, the application of problem-based learning will familiarize students with using their thinking skills.

In line with the chosen learning model, the evaluation tool developed is also HOTS-oriented. The evaluation tool developed consists of two types of questions because one of the characteristics of the HOTS-based evaluation is to use various forms of questions. With students getting used to working on HOTS questions, their thinking skills will also increase. Therefore, the presence of HOTS-based evaluation tools not only acts as an evaluation instrument by teachers but also plays a role in optimizing the empowerment of students' HOTS.

After all learning documents were developed, the learning documents were validated by learning experts and material experts. After the learning document was revised, the implementation stage was carried out. At this stage, the teacher implements learning using the learning documents that have been developed. After learning is implemented, students fill out an instrument that measures student responses. As a result, the students gave a positive response to the lessons they had participated in. The positive response of students to learning can be used as an indicator of student interest in learning. Interest in learning is one of the important factors for success in learning because interest is related to learning motivation. Learning motivation is reported to have a positive influence on student learning outcomes (Albrecht & Karabenick, 2018; Gbollie & Keamu, 2017). Learning motivation is also a predictor that affects their learning outcomes (Alhadi & Saputra, 2017). In addition, learning motivation also have a correlation effect on improving students' thinking skills (Rizky et al., 2020).

In addition to filling out the learning response instrument, students also took the test. The test uses HOTS questions that have been developed. The test results inform that all students have scores above the minimum completeness score. These results indicate that the learning that has been followed by students has a positive impact on their HOTS. Therefore, the learning documents that have been developed in this research are expected to be used in many schools in Indonesia.

5. Conclusions

The HOTS-based biology learning document for the movement system material developed in this study is feasible to use. The results of the learning expert validation for the syllabus are 80.2% (very feasible), for lesson plans it is 84.3% (very feasible), for student worksheets it is 72.2% (feasible), and for test questions it is 83% (very feasible). The results of the material expert validation for the syllabus, lesson plans, student worksheets, and test questions respectively were 77% (feasible), 70% (feasible), 80% (feasible), and 80% (adequate). Based on student responses, learning documents are also practical and effective to use. In addition, after they take part in the lesson, all students are also able to complete the HOTS-based test above the minimum completeness score,

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