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# Development of Online General Chemistry Teaching Materials Integrated with HOTS-Based Media Using the ADDIE Model

Jamalum Purba
Chemistry Education Study Program
Universitas Negeri Medan
Medan, Indonesia

Freddy Tua Musa Panggabean
Chemistry Education Study Program
Universitas Negeri Medan
Medan, Indonesia

Adi Widarma
Computer Technology and Informatics Education Study Program
Universitas Negeri Medan
Medan, Indonesia

Ani Sutiani
Chemistry Education Study Program
Universitas Negeri Medan
Medan, Indonesia

**Abstract**: The 21st century education system prioritizes students to have critical, creative, collaborative thinking skills and communication skills, including higher-order thinking skills. This study aims to develop online teaching materials for HOTS-based integrated General Chemistry courses using the ADDIE model to improve students' higher order thinking skills. This development research resulted in HOTS-based integrated online teaching materials that were feasible and effective in improving students' higher order thinking skills. Through the HOTS-based media integrated online teaching materials produced, students are required and trained to be able to think critically, creatively, analytically towards existing information and data and have the ability to solve problems.

**Keywords:** online teaching materials, media, HOTS, ADDIE

## 1. INTRODUCTION

The principle of 21st century learning uses a learner-centered learning approach where teachers and lecturers act as facilitators. The quality of an education always refers to the results or academic achievements achieved by students, where good quality education is the goal of education itself [1]. The results of the International Program for International Student Assessment (PISA) study show that the achievement of reading literacy, mathematical literacy, and scientific literacy achieved by Indonesian students is very low and can only occupy the bottom 10 of 65 countries. Furthermore, based on the Education for All Global Monitoring Report 2012 issued by UNESCO, Indonesian education is ranked 64th out of 120 countries. This is because many test materials are not included in the Indonesian curriculum, especially those related to technological and information advancements. In addition, education in Indonesia still places too much emphasis on the cognitive aspect which is still limited to finding numbers, not students' critical analysis abilities of events encountered in everyday life [2].

There are many factors that cause the low results of the PISA study and one of the contributing factors is because students in Indonesia are not trained in solving contextual questions, demanding reasoning, argumentation and creativity in solving them, where these questions are characteristic of the TIMS questions [3]. Various efforts have been made by the government to overcome these problems, including efforts to improve the curriculum to become the 2013 curriculum. One of the efforts to improve the 2013 curriculum is to improve the assessment standards, by gradually adapting the international standard assessment model. Improvements in the assessment of learning outcomes are expected to help students improve higher order thinking skills (HOTS) and are expected to encourage students to think broadly and deeply about learning materials. HOTS is part of Bloom's taxonomy revised in the form of operational verbs consisting of analysis (C4), evaluation (C5) and creative (C6) which can be used in preparing questions.

The big challenge for the ideal education process is not only to prepare the nation's generation that is able to live today, but the generation that is equipped with the ability to live in the future. Challenges in the global era are increasingly complex and require problem solving with a critical mindset and full of creativity [4]. Most of the problems faced by higher education institutions are how to transfer knowledge and how to develop and ensure professional and up-to-date practical skills [5].

Each individual's higher order thinking ability is certainly different, depending on the exercises that are often done to develop it. In addition to the use of learning strategies or models by teachers/lecturers, another factor that also determines the success of students in learning is the teaching materials used by students as learning resources. Supporting the implementation of an effective learning process cannot be separated from the use of teaching materials. Improving the quality of the learning process in higher education can be done with various strategies and one alternative that can be taken is the development of teaching materials. The development of teaching materials is carried out by a lecturer to solve learning problems by paying attention to the targets or students and also adjusting to the competencies that must be achieved [6].

Teaching materials that can be used by students as a source of independent learning have an important role in improving and

developing higher order thinking skills. Teaching materials can be packaged in printed and non-printed forms [7].

In addition to the use of teaching materials, another factor that a lecturer also needs to consider is the use of innovative and constructive learning media in reconstructing students' knowledge, abilities and creativity. The development of information and communication technology in today's digital era seems to be unstoppable. Currently the world has entered a digital-based industry 4.0 where technology has become the most basic thing and has brought the current generation into the world of digital literacy which has integrated with the conditions of today's society. This condition causes people to be easier, faster and have greater opportunities in finding various information and being able to overcome the limitations of space and time.

There are many factors that influence and play a role in achieving educational goals, one of which is the technology used in educational and learning activities. Utilization of processes and products of communication and information technology to solve educational problems has many benefits or advantages. Various kinds of technology should have been able to be applied in learning activities in the classroom.

An educator, both teachers and lecturers, needs to plan innovative and creative strategies, teaching materials and learning media by utilizing technology-based learning. One of the media that can be applied in the learning process is Adobe Flash media. The use of interactive learning media with Adobe Flash can be used as an alternative learning media and is able to make learning more varied, attract student learning interest, and get a positive response from students [8], it is hoped that students can directly see simulations/images that resemble actual phenomena, so that students are able to understand at once [9].

The development of teaching materials by utilizing online-based computer technology using the internet network and integrated HOTS-based media, it is necessary to pay attention to the development model to ensure the quality of teaching materials in supporting the efficiency and effectiveness of learning, because the development of online teaching materials is basically a linear process with the learning process. In addition, the teaching materials that are prepared and developed must also be adapted to the needs of the learning objectives.

One of the teaching materials development models that is often used is the ADDIE model through five stages of activities, namely Analysis, Design, Development, Implementation and Evaluation. The development process requires several times of testing a team of experts, individual research subjects, on a limited scale and on a wide scale (in the field) and revisions to improve the final product so that although the development procedure is shortened, it includes a testing and revision process so that the product developed has met the product criteria. good, empirically tested and no more mistakes [10].

## 2. METHOD

This research belongs to the type of research and development (R&D), and the results of this development research are online teaching materials or digital books integrated with Adobe Flash media based on Higher Order Thinking Skills (HOTS) in General Chemistry courses (Stoichiometry material, Inorganic Compounds and Organic Compounds). The development model used refers to the ADDIE development model which is a more generic learning design model, namely as one of its functions to build tools and infrastructure for training programs that are effective, dynamic and support the performance of the training itself [11].

The ADDIE development model uses 5 stages as the name implies, namely: Analysis, Design, Development, Implementation, and Evaluation. The idea of the ADDIE model is to receive feedback continuously and continuously while building learning materials. The existence of this model is expected to save time and costs by capturing problems when these problems can still be fixed [12].

The procedure for developing online teaching materials integrated with HOTS-based media is carried out through several stages, including: (a) Analysis, namely conducting an analysis to collect information related to student needs and reviewing literature related to the product being developed; (b) Design, is the stage carried out to identify goals and design teaching materials and learning media to be developed; (c) Development, is the stage to realize the design into a product that is ready to be implemented; (d) Implementation, namely implementing the developed product in the form of online teaching materials integrated with HOTS-based Adobe Flash media; and (e) Evaluation, which is to evaluate by analyzing the effectiveness of online teaching materials that are integrated with HOTS-based Adobe Flash media on students' higher order thinking skills (HOTS).

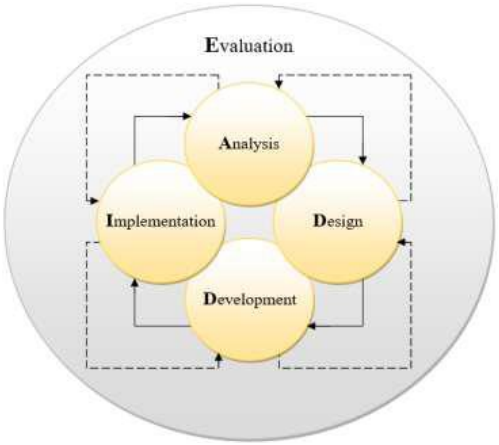


Figure 1. ADDIE Development Model

The techniques and instruments used in this study include (a) interviews used for data collection when conducting research as a preliminary study material to look for problems to be studied and used in product trials both during validation to experts and product trials in the field as considerations in improving the teaching materials developed; (b) the validation sheet used to obtain data on the results of the expert's validation of HOTS-based integrated media teaching materials developed to test their feasibility or validity; and (c) a test instrument designed to obtain data on students' higher order thinking skills. The test is structured and developed according to the HOTS indicators including C4, C5 and C6.

The research data were analyzed in stages to determine the feasibility (validity) and effectiveness of the teaching materials in the developed network. The data from the validation results of the experts were analyzed by considering the input, comments, and suggestions from the validator. The results of the analysis are used as guidelines for revising the developed teaching materials. The validity of the teaching materials that have been made can be analyzed from the

validation sheet filled in by the expert validator and the results of questions and answers during the validation process. The effectiveness of the developed teaching material products is obtained from the results of the students' higher order thinking ability (HOTS) test. The effectiveness test of the teaching materials developed was analyzed from the increase in HOTS with a t-test with a paired sample t-test approach with the help of the SPSS program.

# 3. RESEARCH RESULTS

## 3.1 Feasibility of online teaching materials

The feasibility (validity) of online teaching materials in General Chemistry courses (Stoichiometry materials, Inorganic Compounds and Organic Compounds) developed, evaluated and assessed by expert validators.

**Table 1. Online teaching materials validation results**

| Asessment Aspect | Validator (Mean Score) | | | Total Mean | Criteria |
|---|---|---|---|---|---|
| | I | II | III | | |
| Contents | 4.22 | 4.39 | 4.20 | 4.27 | Valid |
| Presentation | 4.13 | 4.30 | 4.20 | 4.21 | Valid |
| Language | 4.07 | 4.33 | 4.22 | 4.21 | Valid |
| Graphics | 4.09 | 4.33 | 4.33 | 4.25 | Valid |
| Mean total | | | | 4.23 | Valid |

Table 1 shows the results of the expert validator's assessment on online teaching materials for the General Chemistry course, which obtained an average total score of 4.23 or declared valid. on the aspect of the feasibility of the content obtained an average score of 4.27 (valid); on the aspect of feasibility of presentation obtained an average score of 4.21 (valid); on the aspect of language feasibility obtained an average score of 4.21 (valid); and in the aspect of graphics obtained an average score of 4.23 (valid). Overall, the results of the assessment by expert validators concluded that the online teaching materials in General Chemistry courses (materials on Stoichiometry, Inorganic Compounds and Organic Compounds) that were developed had met the valid criteria.

## 3.2 HOTS-based media feasibility

The feasibility (validity) of the HOTS-based media in the General Chemistry course (Stoichiometry, Inorganic Compounds and Organic Compounds) developed, was evaluated by expert validators based on the material and media aspects.

**Table 2. Results of HOTS-based media validation on material aspects**

| Assessment Aspect | Validator (Mean Score) | | | Total Mean | Criteria |
|---|---|---|---|---|---|
| | I | II | III | | |
| Coverage and depth of material | 4.18 | 4.17 | 4.42 | 4.25 | Valid |
| Accuracy of presentation (systematic) material | 3.59 | 3.95 | 4.36 | 3.96 | Valid |
| Suitability and clarity of animation | 3.78 | 4.06 | 4.24 | 4.02 | Valid |
| Clarity of formulas/symbols | 4.00 | 4.13 | 4.24 | 4.12 | Valid |
| The accuracy of the sample questions in each learning activity | 4.00 | 4.00 | 4.59 | 4.20 | Valid |
| The accuracy of the answers to the evaluation questions in each learning activity | 4.00 | 4.00 | 4.00 | 4.00 | Valid |
| HOTS Rating | 4.40 | 4.30 | 4.90 | 4.53 | Valid |
| Mean total | | | | 4.16 | Valid |

Table 2, shows the results of the material expert validator's assessment on HOTS-based media, obtained an average total score of 4.12 or declared valid. In the aspect of coverage and depth of material obtained an average score of 4.25 (valid); on the aspect of presentation accuracy (systematic) the material obtained an average score of 3.96 (valid); on the aspect of suitability and clarity of animation obtained an average score of 4.02 (valid); on the aspect of clarity of formulas/symbols obtained an average score of 4.12 (valid); on the aspect of the accuracy of the sample questions in each learning activity obtained an average score of 4.20 (valid); on the aspect of the accuracy of the answers to the evaluation questions in each learning activity obtained an average score of 4.00 (valid); and in the HOTS rating assessment aspect, an average score of 4.53 (valid) was obtained. Overall, the results of the assessment by expert validators on the material aspect concluded that the HOTS-based media developed had met the valid criteria and could be applied to learning.

**Table 3. Results of HOTS-based media validation on the media aspect**

| Assessment Aspect | Validator (Mean Score) | | | Total Mean | Criteria |
|---|---|---|---|---|---|
| | I | II | III | | |
| Software engineering | 4.15 | 3.85 | 4.30 | 4.10 | Valid |
| Interface display | 4.11 | 4.23 | 4.22 | 4.19 | Valid |
| Visual communication | 4.19 | 4.20 | 4.05 | 4.15 | Valid |
| Mean total | | | | 4.14 | Valid |

Table 3, shows the results of the media expert validator's assessment on HOTS-based media, obtained an average total score of 4.14 or declared valid. In the software engineering aspect, the average score is 4.10 (valid); on the aspect of the interface display an average score of 4.19 (valid); and in the

aspect of visual communication obtained an average score of 4.15 (valid). Overall, the results of the expert validator assessment on the media aspect concluded that the HOTS-based media developed had met the valid criteria and could be applied in learning.

## 3.3 Student HOTS achievements

The achievement of student learning outcomes is obtained through the HOTS test given before and after utilizing the HOTS-based integrated online teaching materials produced. This stage is carried out on 30 students and each material is carried out in 3 (three) stages including: (1) the initial stage, namely giving an initial HOTS test (pretest) before students are given action using the resulting HOTS-based online teaching materials, (2) the second stage , namely the learning process in which students learn online with online teaching materials integrated with HOTS-based media that can be accessed and downloaded using a laptop or computer on the Chemistry Education Department's e-learning site, and (3) the third stage, namely giving the final HOTS test (posttest).

**Table 4. Achievement of student HOTS results**

| HOTS | Min | Max | Mean | Std. Dev. | K-S Test | Sig |
|---|---|---|---|---|---|---|
| Pretest | 44 | 70 | 58.87 | 5.794 | .972 | .301 |
| Posttest | 72 | 98 | 88.67 | 7.227 | .973 | .300 |

Table 4 shows the achievement of students' initial HOTS test results (pretest) before being given the action, the lowest score was 44, the highest score was 70 with an average value of 58.87 and a standard deviation of 5.79 and the data had a normal distribution with a Kolmogorov-Smirnov test value of 0.972. with a probability or Sig of 0.301 > 0.05. After taking action through learning using online teaching materials integrated with HOTS-based media, the posttest results obtained the lowest score of 72, the highest score of 98 with an average HOTS value of 88.67 and a standard deviation of 7.227 and the data has a normal distribution with the Kolmogorov-Smirnov value. test is 0.973 and the probability or Sig is 0.300 > 0.05.

## 3.4 Product effectiveness

The effectiveness of teaching material products in the network (online) integrated HOTS-based media that was developed was analyzed based on the increase in learning outcomes obtained by students in completing the HOTS test using a pretest-posttest design.

**Table 5. Product effectiveness test results**

| | Paired Differences | | t | df | Sig (2-tailed) |
|---|---|---|---|---|---|
| | Mean | Std. Deviation | | | |
| Pair 1 Posttest -pretest | 29.800 | 7.919 | 20.610 | 29 | .000 |

Table 5 shows the results of the t-test with the paired sample t-test approach and the average difference or difference in the posttest-prestest HOTS scores of students is 29.800 with a standard deviation of 7.919 and a t-value of 20.610 with probability or Sig. of 0.000 < 0.05. Thus, it is concluded that the application of integrated online teaching materials based on HOTS-based media that has been developed has proven to be effective in increasing student HOTS in General Chemistry courses (Stoichiometry, Inorganic Compounds and Organic Compounds material).

# 4. CONCLUSION

This research and development resulted in online teaching materials integrated with HOTS-based media in General Chemistry courses (Stoichiometry material, Inorganic Compounds and Organic Compounds) through the ADDIE development model. Teaching materials are developed and designed in an integrated manner with HOTS-based media that trains students to think critically, creatively, analytically towards information and data to solve problems that exist in the teaching materials and media developed. The HOTS-based integrated online teaching materials produced can also be accessed by students online and have met valid criteria and have been proven effective in improving students' HOTS abilities.

# 5. ACKNOWLEDGEMENTS

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