Do End-of-Chapter Questions of Work and Energy Topic in Grade Ten High School Physics Encourage Higher Order Thinking?

Rara Rahayu, Muhammad Yusup[*], Ismet

Physics and physics education Unviersitas Sriwijaya, Indonesia
Corresponding author Email: m_yusup@fkip.unsri.ac.id

ABSTRACT
This study aims to determine the cognitive levels of thinking that are represented in the end-chapter questions of work and energy units in grade ten high school physics textbooks in Indonesia. The sample included four grade ten high school physics textbooks, which were recommended by the Ministry of Education and Culture of Indonesia. Analyses of 70 items represented in the units indicated that, on average, less than 30% of the items were dedicated to addressing higher order thinking. Referring to Bloom's taxonomy, the highest cognitive level of thinking was at analysis.

Keywords: Higher Order Thinking Skills (HOTS), Textbooks, Work and Energy.

1. INTRODUCTION

Science and technology are some of the important foundations in national development [1]. The National Education Association [2] has identified 21st-century skills as "The 4Cs" skills, including Critical Thinking, Communication, Collaboration, Creativity. 4C skills must be mastered and possessed by every student to face the challenges of the 21st century.

Science learning is expected to deliver students to meet 21st-century skills. Students are required not only to have Lower Order Thinking Skills (LOTS), but also Higher Order Thinking Skills (HOTS) [3]. In the revised Bloom's taxonomy [4], which is a low order thinking skills consisting of remembering (C1), understanding (C2), applying (C3) and high order thinking skills consist of analyzing (C4), evaluating (C5), and creates (C6) [5]. Higher order thinking skills are an approach in learning where students are taught to think critically, logically, reflectively, metacognitively, and think creatively. High-order thinking skills include the ability to solve problems, critical thinking skills, creative thinking, reasoning skills, and decision making skills, so this higher-order thinking ability which should be used in 21st-century learning. These thinking skills will emerge when individuals or students are faced with problems they have not encountered before. Also, higher order thinking skills can encourage students to think broadly and deeply about the subject matter.

The curriculum currently in use requires students to have higher order thinking skills. The demand for the 2013 curriculum is to make students more critical and creative [6]. The 2013 curriculum demands that students not only be able to solve routine problems using standard formulas/algorithms, but also be able to reason and use mathematics to solve non-routine problems encountered in everyday life [7]. Basic competence becomes a reference in the learning process that is adjusted to the demands of the cognitive level in basic competence. Competency demands can be seen through the operational verbs used in basic competence. Operational verbs in basic competence are adjusted to verbs in the cognitive domains C1 to C6. This means that basic competency requires learning from low order thinking skills to higher order thinking skills. In addition, the Minister of Education and Culture also conveyed that the National Examination system in Indonesia applies HOTS category questions. For that, students must be accustomed to practicing working on HOTS category questions.

According to Stake and Easley in [8], 90% of science teachers still use books in the learning and teaching process. So that textbooks have a very important role in the learning process, especially because they are directly related to students and teachers as a source of learning. According to the Bookkeeping Center, textbooks are a source of knowledge for students in

schools which are a very supportive tool for teaching and learning activities. Textbooks are important because they play a role not only as a source but also as a medium of learning, a means of delivering material, providing evaluation instruments, increasing student interest, and motivation [9]. To train students in higher order thinking, the teacher should get students used to working on the HOTS category questions. In providing practice questions, most teachers usually use evaluation questions in the textbook, although there are still some who use questions on student worksheets.

Several textbooks have been published that have adapted to the latest developments in science and technology, and have adapted to the demands of the existing curriculum [10]. However, it cannot be denied that there are quite a number of textbooks in circulation that are not suitable and generally have not shown the HOTS category questions. The Ministry of Education and Culture recommends seven books for class X high school physics. Of the seven books, the researcher will use half or more or less, namely four books for analysis. To review this, an analysis of textbooks is very much needed as a guarantee for improving the quality of education in Indonesia. Research on the textbook

analysis itself has indeed been carried out a lot in Indonesia. However, research on textbook analysis based on HOTS category questions is still rarely done, especially for physics textbooks.

Based on the problems described, the researcher intends to research to obtain information related to the HOTS category question content on work and energy materials in physics textbooks used in senior high school class X.

2. METHOD

This study used a descriptive qualitative method. The purpose of qualitative descriptive in this study is to provide a systematic, factual, and accurate description of HOTS questions on work and energy materials contained in high school physics textbooks for class X. This study analyzed HOTS questions on the work and energy material in the physics textbook recommended by the Ministry of Education and Culture.

The stages in this study began with the selection of tenth-grade physics textbooks recommended by the Ministry of Education and Culture [11].

Table 1. Physics textbook used

	Author	Book title
Book 1	Hari Subagya, and Insih Wilujeng	Buku Siswa Fisika SMA /MA Kelas X Kelompok Peminatan MIPA Kurikulum 2013 Edisi Revisi
Book 2	Aris Prasetyo N, Indarti, and Naila Hilmiyana S	Buku Siswa Fisika 1 untuk SMA / MA Kelas X Kelompok Peminatan Matematika dan Ilmu-Ilmu Alam Kurikulum 2013 Edisi Revisi 2016
Book 3	Reva Yulietta and Dede Sahidin	Buku Siswa Fisika untuk SMA / MA X Peminatan Matematika dan Ilmu Alam Kurikulum 2013 Edisi Revisi
Book 4	Budi Purwanto Muchammad Azam	Buku Siswa Fisika 1 untuk Kelas X SMA dan MA Kelompok Peminatan Matematika dan Ilmu-Ilmu Alam Kurikulum 2013 Edisi Revisi.

The next stage is determining the questions to be studied, namely multiple choice evaluation questions and essays at the end of each chapter of the Work and Energy material in the book. The final stage is to analyze each item of the three HOTS characteristics that are fulfilled in each item, namely indicators consisting of analyzing (C4), evaluating (C5), and creating (C6).

Data collection techniques in this study using documentation data collection techniques. In this study, the documents analyzed were multiple-choice evaluation questions and essays at the end of the chapter on Work and Energy. This document will be analyzed for its suitability with the HOTS question indicator.

The steps taken in analyzing the data from this study are as follows:

1) Data in the form of multiple choice evaluation questions and essays in four books on Work and Energy units are analyzed for their suitability with the HOTS indicator.

2) To see the number of questions under this study, the results of the analysis are written in a Table 2.

3) Adding up the emergence of hots questions for each indicator in each book analyzed.

4) Recapitulate the number of appearances per HOTS category, namely C4, C5, and C6.

5) Calculating the percentage appearance of the HOTS type item characteristics, analyzing (C4), evaluating (C5), and creating (C6) in each textbook analyzed, using the formula:

$$\% = \frac{\Sigma\, questions\, per\, category}{\Sigma\, all\, questions} \times 100\%$$

6) Determine the average percentage composition of each HOTS question category from the analyzed textbooks.

7) The data that has been compiled are compared with each other to draw conclusions as an answer to the existing problems, by providing descriptive analysis based on the processed data.

3. RESULT AND DISCUSSION

3.1. *Research Results of Question Items in the Hots Category*

The results of the data obtained based on the analysis of the items were grouped into four, according to the book that had been analyzed.

Table 2. Number and percentage of HOTS indicator in each book

	Number		LOTS				HOTS			
			C1	C2	C3	%	C4	C5	C6	%
Book 1	Mc	10		3	5	80	2			20
	Essay	5		1	2	60	2			40
Book 2	Mc	10	2	4	2	80	2			10
	Essay	5		3	2	80				0
Book 3	Mc	10		6	3	90	1			10
	Essay	5		3	1	80	1			20
Book 4	Mc	15		3	9	80	3			20
	Essay	10		2	3	50	5			50

Note. Mc = multiple choice. C1; remember, C2: understand, C3: apply, C4: analyze, C5: evaluate, C6: create

In this study, researchers analyzed 70 items from four physics textbooks. Every book on multiple choice questions is still dominated by questions in the LOTS category of 80% - 90% so that only 10% - 20% of questions are in the HOTS category. In the essay questions for Book 4 the questions in the HOTS category are 50%, for Book 1 and Book 3 are still dominated by questions in the LOTS category by 60% - 80% so that the HOTS category questions are 20% - 40% and for Book 2 are not found about HOTS.

The following is a comparison chart of all the items, namely multiple choice and essays in the LOTS category and the HOTS category in each book.
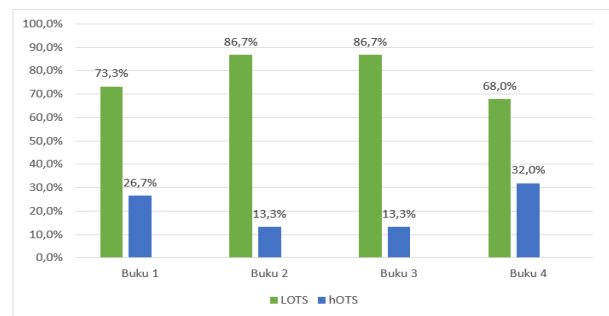

Figure 1. Comparison of LOTS and HOTS Questions in each Book

Figure 1 shows that each book is still dominated by questions in the LOTS category rather than questions in the HOTS category. The comparison of HOTS questions contained in each book, namely Books 2 and 3 had the same percentage of only 13.3% HOTS questions, Book 1 had 26.7% HOTS questions and Book 4 had 32.0% HOTS questions. Of the four books, Book 4 has more questions, namely 25 questions in

total, while the other three books have 15 questions in total.

Figure 2 shows an examples of "undestand" level, To answer the questions, students not only remember the information that has been obtained previously, but students need to process the information and integrate it with the information obtained so that a solution is obtained in solving the problem.

The 20 m high waterfall is used for hydroelectric power (PLTA). Every second the water flows $10 \; m^3$. If the generator efficiency is 55% and g = 10 m/s, the average power produced (in kW)...

A. 110
B. 1.100
C. 2.200
D. 2.500
E. 5.500

Figure 2. An example of end-of-chapter at understanding level,

Students must be able to analyze the business relationship and potential energy first, namely W = mgh, then apply the water discharge formula to the power formula.

3.2. Discussion

This study aims to obtain information related to the contents of HOTS category questions on Work and Energy materials in physics textbooks used in high school class X. Based on the data that has been obtained, from this research there are only 4 cognitive levels in the questions, namely C1, C2, C3, and C4. This shows that the researcher found results that were in line with previous research on the quality analysis of high school grade X high school physics items, namely 2 questions referring to the cognitive domain of C1, 2 questions of C2, 28 of C3, 8 of C4. questions, and C5 and C6 are not included in the problem [12].

HOTS has an important role in improving the quality of education, one of which is to prepare the competence of 21st century students [13]. By training students to answer HOTS questions, it is hoped that students can think critically and creatively, in accordance with the 4C skills that each student must master and possess in order to face the challenges of the 21st century. The application of the HOTS approach to the 2013 curriculum can also improve student learning outcomes on all subject matter [14]. Increased student learning outcomes are obtained through the daily learning process.

Textbooks have a very important role in the learning process, mainly because they are directly related to students and teachers as a source of learning. Textbooks are important because they play a role not only as a source, but also as a provider of student evaluation instruments [9]. As a provider of evaluation instruments, questions in textbooks are still relatively low because there are not many HOTS category questions found, especially at levels C5 and C6. This can result in students taking exams.

The Minister of Education and Culture said that in 2018, the National Examination system in Indonesia applied HOTS category questions. For this reason, students must be accustomed to practicing working on HOTS category questions. The results of the SMA / MA Physics National Examination on Work and Energy material taken from 2018, namely: National Examination for the 2017/2018 school year shows the value of student absorption for work material 43.42 and energy material 50.62, and National Examination for the 2018/2019 academic year shows the value of student absorption for work material 47.87 and energy material 35.37 (Puspendik UN results). The value of absorption that should be achieved by students is less than the same as 55.00, this shows that the students' understanding of the work and energy material is still low.

Based on the National Exam questions that have been released from the education assessment center in 2018 and 2019, the questions for the National Examination for Senior High School Physics on Work and Energy are at the application and reasoning level. Problems at the reasoning level are questions that can encourage the growth of students' higher order thinking skills. In the questions released, it was explained that for the reasoning level as much as 71% of students could not do the questions correctly. These results are consistent with research on the identification of students 'mastery of concepts in work and energy, which indicates that students' mastery of physics concepts on work and energy is very low [15]. Therefore, students should be more trained in working on HOTS questions.

Higher order thinking skills can be trained in the learning process in the classroom. The books used by students should be providers of learning instruments for HOTS category questions, because on the National Examination there are HOTS category questions. Students must be accustomed to working on HOTS questions in order to solve questions well. In addition, working on HOTS questions can also train students to think critically and creatively.

4. CONCLUSION

Based on the results of research and discussion as a whole it can be concluded that the content of the HOTS category questions in each book analyzed is still low, with the percentage of HOTS questions in Book 1 of 26.7%, Book 2 and Book 3 of 13.3%, and Book 4 of 32%. The HOTS category problem is only at the C4 level (analyzing) in each book. Which at the level of analysis emphasizes connecting, differentiating and organizing each material contained in the problem.

REFERENCES

[1] Kemendikbud, Silabus mata pelajaran Sekolah Menengah Atas/Madrasah Aliyah (SMA/MA), Jakarta, 2016.

[2] Nasional Education Association (NEA), Preparing 21st century students for a global society: An educator's guide to the "Four Cs", National Education Association., Alexandria, 2012.

[3] E. Istiyono, D. Mardapati, Suparno. Pengembangan tes kemampuan berpikir tingkat tinggi Fisika (PysTHOTS) peserta didik SMA. *Jurnal Penelitian dan Evaluasi Pendidikan*. vol. 18 no.1, 2014, pp. 1-12.

[4] D. R. Krathwohl, A revision of bloom ' s taxonomy : an overview, *Elementary Education Online*, vol. 41 no.4, 2012, pp. 212–219.

[5] L.W. Anderson, D.R. Krathwohl, A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives, Addiso Wesley Longman, New York, 2001.

[6] A.U. Hidayati, Melatih keterampilan berpikir tingkat tinggi dalam pembelajaran matematika pada siswa sekolah dasar. *Terampil: Jurnal Pendidikan dan Pembelajaran Dasar*, vol. 4 no. 2, 2017, pp. 143–156.

[7] A.H. Sani, Pembelajaran matematika berbasis pendekatan saintifik dan kaitannya dengan menumbuhkan keterampilan berpikir tingkat tinggi, *Jurnal Pendidikan*, 2015.

[8] Y.H. Adisendjaja, Analisis buku ajar biologi sma kelas x di kota bandung berdasarkan literasi sains. *Jurusan Pendidikan Biologi, FMIPA Universitas Pendidikan Indonesia*, Bandung, 2008.

[9] D. Darwati, Pemanfaatan buku teks oleh guru dalam pembelajaran sejarah: studi kasus di SMA Negeri Kabupaten Semarang. *Paramita: Historical Studies Journal*, vol. *21 no.* 1, 2011.

[10] N. Nurdini, I.M. Sari, I. Suryana, Analisis buku ajar fisika SMA kelas XI semester 1 di kota Bandung berdasarkan keseimbangan aspek literasi sains, *Wahana Pendidikan Fisika*, vol. 3 no. 1, 2018, pp 96–102.

[11] Kepmendikbud, Penetapan judul buku teks pelajaran peminatan untuk SMA/MA. Jakarta, 2016.

[12] A. Anita, S. Tyowati, Z. Zuldafrial, Analisis kualitas butir soal fisika kelas X sekolah menengah atas. *Edukasi: Jurnal Pendidikan*, vol. 16 no. 1, 2018, pp. 35–47.

[13] I.W. Widana, Modul penyusunan soal higher order thinking skill (HOTS), Direktorat Pembinaan SMA Kemdikbud, Jakarta, 2017.

[14] F.A. Sofyan, Implementasi HOTS pada kurikulum 2013. *INVENTA: Jurnal Pendidikan Guru Sekolah Dasar*, vol. 3 no. 1, 2019, pp. 1–9.

[15] F.B.B. Sukma, S. Koes, S. Kusairi, Identifikasi penguasaan konsep siswa pada materi usaha dan energi. In*: Pros. Semnas Pend. IPA Pascasarjana UM, 1*, 2016, pp. 208–212.