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Question Items of Magnitude and Motion Topics in Several High School Physics Textbooks: A Cognitive Level Analysis

Nurlina[1], Deli Anggraeni Lubis[2,*], Dewi Hikmah Marisda[2], & Riskawati[2]

[1]Doctoral Program in Educational Science, Universitas Muhammadiyah Makassar, Indonesia

[2]Department of Physics Education, Universitas Muhammadiyah Makassar, Indonesia

Abstract: This study aims to analyze the percentage of cognitive achievement level questions and compare cognitive level achievement based on thinking stages (LOTs and HOTs) in physics textbooks for class X SMA for the content of magnitude and motion. This type of research is descriptive research with a case study design that is analyzed qualitatively. The source of the data in this study was a class X physics textbook on magnitude and motion. The research subjects were evaluation questions in five books, hereinafter referred to as book A, book B, book C, book D, and book E. The results of this study indicated that the highest proportion of cognitive levels used in the questions from the five physics books was C4 (analyzing). and the lowest is C6 (create). The percentage of questions for each cognitive level are: C1 (remembering) 10%, C2 (understanding) 26.85%, C3 (applying) 18%, C4 (analyzing) 51.2%, C5 (evaluating) 5.75% and C6 (create) with a percentage of 0%. This shows that the percentage of HOTS cognitive level items (56.95%) is higher than the LOTs level (43.05%). It is hoped that the results of this study will provide information to high school teachers and prospective physics teacher students to develop practice questions that are oriented towards high-level skills.

Keywords: textbook analysis, HOTs, LOTs, cognitive level.

Abstrak: *Penelitian ini bertujuan untuk menganalisis persentase pertanyaan level capaian kognitif dan membandingkan capaian level kognitif pertanyaan berdasarkan tahapan berpikir (LOTS dan HOTS) pada buku teks fisika kelas X SMA untuk konten besaran dan gerak. Jenis Penelitian ini adalah penelitian deskriptif dengan desain studi kasus yang dianalisis secara kualitatif. Sumber data dalam penelitian ini adalah buku teks fisika kelas X materi besaran dan gerak. Subjek penelitian adalah pertanyaan evaluasi dalam lima buku, yang selanjutnya ditulis buku A, buku B, buku C, buku D, dan buku E. Hasil penelitian ini menunjukkan bahwa proporsi tingkat kognitif tertinggi yang digunakan dalam soal dari lima buku fisika adalah C4 (menganalisis) dan terendah adalah C6 (mencipta). Persentase pertanyaan untuk setiap tingkat kognitif adalah: C1 (mengingat) 10%, C2 (memahami) 26,85%, C3 (menerapkan) 18%, C4 (menganalisis) 51,2%, C5 (mengevaluasi) 5,75% dan C6 (mencipta) dengan persentase 0%. Hal ini menunjukkan bahwa persentase Tingkat kognitif HOTS soal (56,95%) lebih tinggi daripada tingkat LOTs (43,05%). Hasil penelitian ini selanjutnya diharapkan dapat memberikan informasi kepada guru-guru SMA dan mahasiswa calon guru Fisika untuk mengembangkan soal-soal Latihan yang berorientasi pada keterampilan tingkat tinggi.*

Kata kunci: *analisis buku ajar, HOTs, LOTs, level kognitif.*

▪ INTRODUCTION

The rapid development of technology and information in the 21st century has had a huge impact on the world of education. The transition from the era of industrialization to the age of knowledge requires many areas of life, including education, to change and adapt (Marisda et al., 2020). As expected, the current education sector has undergone significant changes. Education in the 21st century is expected to produce graduates who

Deli Anggraeni Lubis
*Email: delianggraenilubis2003@gmail.com

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are ready to work and able to compete (Astuti et al., 2019). With education, human potential can be optimally developed so that this potential can be useful in solving various life problems. Because the influence of education is so significant, it is not surprising that the education sector receives good attention and care from the government, society and education administrators.

Twenty first century education will be more challenging because students need to think more creatively and innovatively (Nakano & Wechsler, 2018), to be able to solve problems and think critically (Khoiriyah & Husamah, 2018). Teachers need to find new methods, approaches, strategies and teaching techniques so that students can better understand the content of teaching and learning delivered by the teacher (Priestnall et al., 2020). However, several studies have shown that not all textbooks distributed and used by schools meet the proportion of questions that support the attainment of basic competencies. The ideal proportion of questions in textbooks that can improve students' cognitive abilities requires 30% to remember and understand, 40% to apply and analyze, and 30% to evaluate and create (Nugraha & Syafi, 2020; Syarifah et al., 2020).

The main characteristics of good questions can be seen from their suitability with indicators (basic competencies) (Ikbal et al., 2021). In addition to the presentation of the questions in each chapter must be in accordance with the material (Nurwahidah, 2018), the level of difficulty must also vary which supports competency achievement (Susanti et al., 2019). A good question is one that is neither too easy nor too difficult. To determine the level of difficulty, the questions must be made according to Bloom's taxonomy of cognitive hierarchies. In Bloom's taxonomy, the easy level category will be developed based on the ability to understand and know something (Brata & Mahatmaharti, 2020). Category questions are being developed based on the ability to apply and analyze, and difficult category questions are developed based on the ability to evaluate or create (Maria et al., 2019).

Taxonomy is a framework for classifying statements that are used to predict students' learning abilities as a result of learning activities (Zorluoğlu & Güven, 2020). The revised Bloom's Taxonomy has three domains, including 1) the cognitive domain, which includes memory or recognition of certain facts, procedural patterns, and concepts that enable the development of intellectual abilities and skills, 2) the affective domain, a domain related to the development of intelligence. feelings, attitudes, values and emotions, and 3) psychomotor domain, which is a domain related to manipulative activity or motor skills (Zorluoğlu et al., 2019).

The cognitive domain in Bloom's taxonomy has been revised so that it is divided into two separate aspects, namely the knowledge dimension and the cognitive process dimension (Seda Koç & Öntaş, 2020). The knowledge dimension consists of factual, conceptual, procedural, and metacognitive knowledge. Meanwhile, the cognitive process dimension consists of remembering, understanding, applying, analyzing, evaluating, and creating (Wiranata et al., 2021).

Textbooks are a type of educational book that contains material descriptions in certain subjects (Sawitri et al., 2019). Textbooks are teaching materials that are compiled based on the applied curriculum or its interpretation and compiled by a writer or a team of writers (Ferywidyastuti, 2019), source books are books that contain various subject matter based on the curriculum and are used as a guide for teachers and students in the process learning . Textbooks are standard books written in a particular field of

study, compiled by experts in the field for learning purposes, and equipped with appropriate and easily accessible teaching aids. which users can easily find in schools or colleges to support teaching programs (Wahdan Wilsa, 2019).

The 2013 curriculum is an effort of simplification and integrative thematic. The 2013 curriculum is prepared to produce a generation that is ready to face the future because the curriculum is built to anticipate future developments (Hawwin Muzakki, 2021). The emphasis of this curriculum is to encourage students to be better at observing, asking, reasoning and communicating (presenting) what is obtained or known after they receive learning. The object of learning in structuring and perfecting the 2013 curriculum focuses on natural, social, artistic and cultural phenomena. Through this approach students are expected to have much better attitude, skill and knowledge competencies. They will be more creative, innovative and more productive (Kholisho & Marfuatun, 2018).

The 2013 curriculum defines Graduate Competency Standards (SKL) as criteria that determine the qualifications of graduate abilities which include attitudes, knowledge and skills (Adisel et al., 2022). The references and principles of developing the 2013 curriculum refer to Article 36 of Law no. 20 of 2003, which states that curriculum development must pay attention to increasing faith, increasing noble character, increasing the potential, intelligence, and interests of students, the diversity of regional and environmental potentials, regional and national development demands; work demands ; development of science, technology, and arts; religion; The dynamics of global development, national unity, and national values.

▪ METHOD

This study used a qualitative design with a descriptive method. Descriptive research This study used a qualitative design with a descriptive method. Descriptive research is research that is intended to investigate circumstances, conditions, or other matters whose results are presented in the form of a research report (Arikunto, 2012). The main characteristic of descriptive research is that the data collected is in the form of data or images that are not in the form of numbers (Zellatifanny & Mudjiyanto, 2018). The variable studied in this study was the analysis of cognitive level achievement in practice questions based on the revised Bloom's taxonomy in the 2013 curriculum 2013 class X SMA Physics book. The descriptions carried out in this study provide an overview, assessment and classification of cognitive level questions based on Anderson's revised Bloom's Taxonomy.

Data analysis used in this research is descriptive analysis. Data collected in descriptive research can be classified into qualitative and quantitative data. Qualitative data can be described in sentences separated by category, while quantitative data will be in the form of numbers that are calculated through a process to get percentages. The percentage of cognitive process dimensions and knowledge dimensions can be calculated using the equation below.

$$\text{Pi} = \times 100\%\frac{\text{Ni}}{N}$$

Pi = Percentage of questions categorized in the i-th cognitive level based on the Revised Bloom's Taxonomy. (i = cognitive process levels C1, C2, C3, C4, C5, and C6)

cognitive processes based on the Revised Bloom's Taxonomy (i = cognitive process levels C1, C2, C3, C4, C5, and C6).

In the process of analysis, if the item is in the cognitive level category C2 (understanding) and C4 (analyzing), the item is included in category C4 (analyzing) because the questions for category C4 (analyze) are higher than C2 (understand). The questions in category C4 (analyzing) must have gone through the C2 process (understanding), not yet the questions in category C2 (understanding) do not necessarily go through the analysis process.

This research was conducted from March to May 2021. The data were obtained from a high school physics textbook for class X SMA on Magnitude and Motion based on the 2013 curriculum. The research procedure is steps that are followed sequentially and systematically to obtain the data needed to answer the research problem holistically. comprehensive. The research procedure is as follows: Identify material evaluation questions of magnitude and motion in class X physics books based on the 2013 curriculum, Describe each cognitive ability used in the completion process, Classifying the cognitive level for each cognitive ability shown by students in solving problems based on Anderson's revised version of Bloom's Taxonomy, Analyze the categories of cognitive ability levels, Count the number of questions for each cognitive level, Analyze the percentage of questions for each cognitive level, Comparing percentages with proportions that support the achievement of Basic Competency, Make conclusions and suggestions, and generating conclusion.

▪ RESULT AND DISSCUSSION

The Physics books analyzed generally offer two types of questions (questions), namely multiple choice questions and essay questions. These questions consist of various levels of cognitive level achievement. Cognitive level achievement is closely related to the level or quality of questions (questions). The higher the cognitive level (according to Bloom's revised taxonomy), the higher the quality of the questions. The number of questions used in Physics textbooks can affect the number of variations of the questions. Cognitive domain analysis in this study is presented in the form of a combination of cognitive process dimensions and knowledge dimensions as well as the number of questions and percentages obtained from the cognitive level categorization of questions based on the revised Bloom's taxonomy.

The results of data analysis on cognitive level achievement questions in Physics textbooks for class X for the content of magnitude and motion include the dimensional proportions for each book. The following is a description of the cognitive dimensions in the table below.

Table 1. Percentage of Acquisition of Cognitive Dimensions from Five Physics Books

Cognitive Dimensions	Book A	Book B	Book C	Book D	Book E	Average
Remember (C1)	5%	8%	10%	8.5%	13.5%	9%
Understanding (C2)	17.5%	24%	35%	25%	32.75%	26.85%
Apply (C3)	5%	10%	8.5%	10%	2.5%	7.2%
Analysis (C4)	70%	44%	44.5%	56.5%	41%	51.2%

Evaluation (C5)	2.5%	14%	2%	0%	10.25%	5.75%
Create (C6)	0%	0%	0%	0%	0%	0%

Table 1 above shows that the highest average percentage of cognitive achievement of the five physics textbooks analyzed was 51.2% at the level of analysis (C4). This is different from research conducted by Muktar (2022) which found cognitive level achievement in Class X high school books, the highest percentage was at the cognitive level of Applying (C3) (Panjaitan & Silalahi, 2022). However, the dominant outcome finding, namely Analysis (C4) in this study, is in accordance with the analysis of School Final Exam questions in several schools in Surabaya that have been HOTs oriented, to be precise at the level of cognitive analysis (C4). The form of questions to achieve the level of cognitive analysis is that most of them ask students to calculate based on an analysis of images/graphs and tables (Fahyuni et al., 2020). While the lowest cognitive level is creating (C6) of 0%. The results of this study are in line with Erniyanti's research (2020) which found that from the analysis of the cognitive domain of practice questions based on the revised bloom taxonomy for motion content also gives a percentage of 0% for the level of creation (C6) (Erniyanti et al., 2020). This shows that the implementation of cognitive level achievement according to the revised Bloom's taxonomy in five textbooks has not been carried out thoroughly.

The following describes the results of textbook analysis for each cognitive level achievement according to Bloom's taxonomy which has been revised.

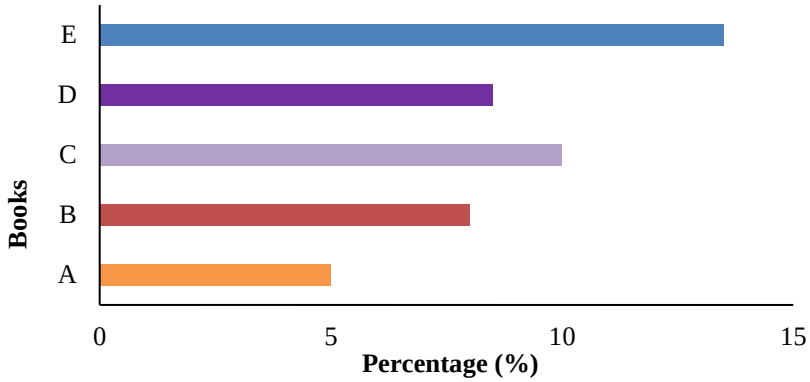

Figure 1. Percentage of cognitive achievement at the knowledge level

From Figure 1 it can be seen the percentage of cognitive achievement at the knowledge level (C1). The highest percentage of knowledge level (C1) is in book E. Book E presents three questions for knowledge level (C1) with a percentage of 17% for magnitude content and two questions for knowledge level (C1) with a percentage of 10% for motion content. Book A presents two questions with a percentage of 10% for magnitude content, and 0 questions for motion content. Book B presents four questions with a percentage of 16% for magnitude material and 0 questions for motion material. Book C presents four questions with a percentage of 16% for magnitude material and 1 item for motion material with a percentage of 4%. And Book D presents one item with a percentage of 7% on magnitude material and one item with a percentage of 10% on

motion material. Knowledge is the lowest level in the revised bloom taxonomy, usually indicated by questions that ask for definitions, reads the laws of Physics (Juhanda, 2016).

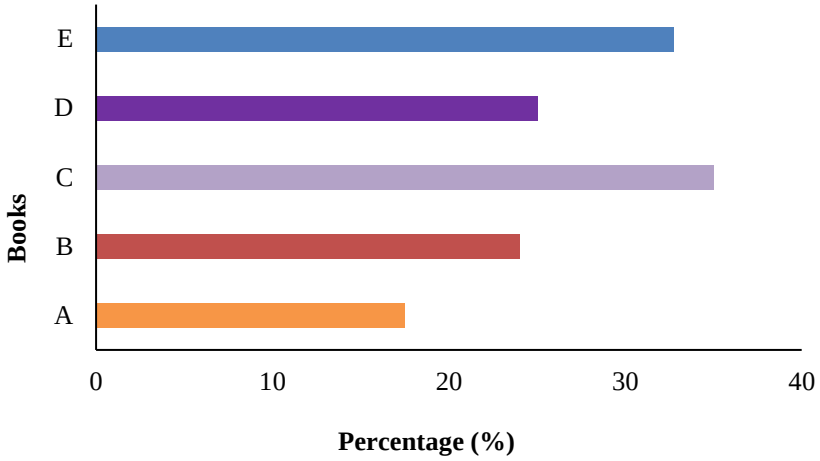

Figure 2. Percentage of cognitive achievement at the understanding level

In Figure 2 it can be seen that the highest achievement for the cognitive level of understanding is in book C. Book C presents 12 questions with a percentage of 48% in the matter of magnitude and 15 items with a percentage of 22% for the material of motion. As for book A, it presents 7 questions with a percentage of 35% on the material of magnitude and 0 items for the material of motion. Book B presents 12 questions with a percentage of 48% for magnitude material and 0 questions for motion material. Book D presents 6 questions with a percentage of 40% for magnitude material, and 1 item with a percentage of 10% for motion material. Book E presents 10 questions with a percentage of 55.5% for magnitude material and 2 questions with a percentage of 10% for motion material. The cognitive domain of understanding (C2) consists of questions that ask students to define and explain Newton's laws (Nabilah et al., 2020).

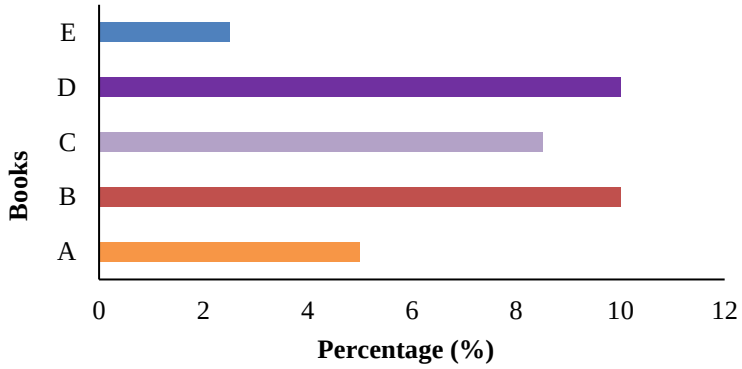

Figure 3. Percentage of cognitive achievement at the application level

In Figure 3 it can be seen that the highest achievement for the cognitive level of application is found in books B and D. Book B presents 2 questions with a percentage

of 8% on the matter of magnitude and 3 questions with a percentage of 12% for the material of motion. Book D presents 0 items on the matter of magnitude and 2 questions on the material of motion with a percentage of 20%. Book A presents 0 questions for quantity material and 2 questions with a percentage of 8% for magnitude material and 3 questions with a percentage of 12% for motion material. Book E presents 2 questions with a percentage of 8% for magnitude material, and 2 questions with a percentage of 9% for motion material.

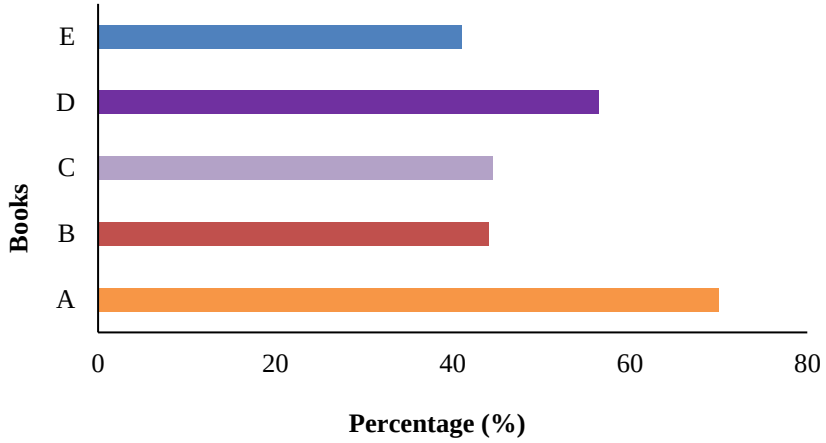

Figure 4. Percentage of cognitive achievement at the application level

In Figure 4 it can be seen that the highest achievement for the level of cognitive analysis (C4) is found in book A. Book A presents 11 items with a percentage of 55% in the matter of magnitude and 17 items with a percentage of 85% for the material of motion. As for book B, it presents 5 questions with a percentage of 20% on the material of magnitude and 17 questions for the material of motion with a percentage of 68%. Book C presents 7 questions with a percentage of 28% for the material of magnitude and 14 questions for the material of motion, with a percentage of 61%. Book D presents 8 questions with a percentage of 53% for magnitude material, and 6 questions with a percentage of 60% for motion material. Book E presents 4 questions with a percentage of 22% for magnitude material and 12 questions with a percentage of 60% for motion material.

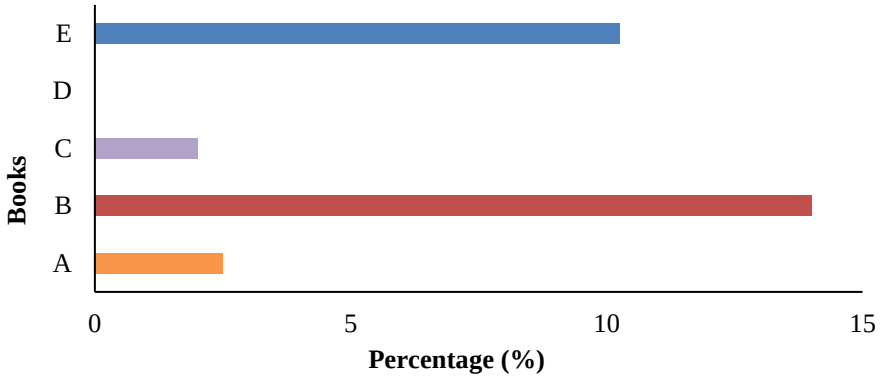

Figure 5. Percentage of cognitive achievement at the application level

In Figure 5 it can be seen that the highest achievement for the Cognitive Evaluation level (C5) is found in book B. Book B presents 2 questions with a percentage of 8% on the matter of magnitude and 5 items with a percentage of 20% for the material of motion. As for book A, it presents 1 item for motion material with a percentage of 55%. Book C presents 1 item for motion material with a percentage of 4%. Book D presents 0 items for the matter of magnitude and motion. Book E presents 1 item with a percentage of 5.5% for magnitude material and 3 questions with a percentage of 15% for motion material. In the questions for the cognitive evaluation domain (C5), students are asked to connect applicable laws, concepts, and Physics principles (Dahlan et al., 2021).

Of the five Physics textbooks for class X on the subject of magnitude and motion analyzed there are no questions for the cognitive domain of creation (C6), this is because class X students are considered to have just started thinking towards higher order thinking skills (HOTs), so they have not been able to achieve the Apart from that, question C6 is also not suitable for questions in the form of multiple choices because it is more suitable for questions in the form of essay tests (Anita et al., 2018).

Overall of the five books that have been analyzed, the cognitive dimension of analysis (C4) has the highest percentage of occurrence of questions compared to the other five cognitive dimensions, and is in the dimension of procedural knowledge. At cognitive level C4 student activities include completing routine procedures, distinguishing, organizing, and contributing methods to solve a problem. As for the cognitive dimension of creating (C6), there is not a single book that presents questions on this dimension. Furthermore, the questions (questions) are spread over several cognitive dimensions, namely at C1 to C5. Questions that are in the knowledge dimension for lower-order thinking (LOTs) are at cognitive levels C1-C3 (Afriani et al., 2017).

Analysis of the achievement of the cognitive level of physics questions in each book can be seen in table 2 below.

Book No.	**Book Identity**		**Percentage of Cognitive Level**	
	Writer	Publisher	LOTS	HOTS
A	Pujianto et al. (2016)	Intan Advertising	27.50	72.50
B	Sudar et al. (2016)	Erlangga	42.00	58.00
C	Purwanto (2016)	PT. House of Jatra Lestari	53.50	46.50
D	Nugroho et al (2016)	Mediatama	43.50	56.50
E	Ruwanto (2016)	Yudhishthira	48.75	51.25

From table 2 above it can be seen that of the five books analyzed, there were four books that had applied HOTS questions with percentages above 50%, namely books A, B, D, and E. Book C presented questions still more on the achievement of LOTs. This is in

line with the demands of the 2013 curriculum which requires the development of higher-order thinking skills in high school, especially for Physics subjects (Ikhsan et al., 2019; Nurfillaili et al., 2016).

▪ CONCLUSION

From the results of the research and the description of the discussion, it can be concluded that the dominant cognitive level achievement of the five physics textbooks analyzed is at the analytical level achievement (C4). In addition, the question knowledge dimension in the Physics textbook is dominant in higher-order thinking skills (HOTs) in accordance with the demands of the 2013 curriculum for Physics lessons in secondary schools.

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