



An Investigation into the Assessment of Critical Thinking Skills in Physics Textbooks for Grade X Semester II at Senior High Schools

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Abstract

In the context of the revised 2013 curriculum, critical thinking skills have become essential for students in the 21st century. A survey conducted across public high schools in Padang revealed that various sources authored and published physics textbooks used by these schools. However, it remains unclear whether these printed books incorporate indicators of critical thinking skills. Consequently, researchers analyzed the Higher Order Thinking Skills (HOTS) component, explicitly focusing on critical thinking, in physics textbooks used in high schools. This descriptive study employed a mixed-methods approach, combining quantitative and qualitative analysis. The study population consisted of all Grade X Semester II physics textbooks across 16 public high schools in Padang. The sample comprised widely used printed books from three publishers: Intan Pariwara's 2016 physics textbook, Erlangga's 2016 publication, and Tiga Serangkai's 2016 printed book. Research data were collected using an analysis instrument for HOTS indicators in Grade X Semester II physics textbooks. Findings indicate that the ER book exhibited the highest availability of critical thinking skills indicators within the "quite facilitating" category, while the TS book displayed the lowest availability. The sub-indicator of critical thinking often found in textbooks is the sub-indicator of concluding in IP books, with a percentage of 90%. Meanwhile, the lowest percentage, 0%, is in the deductive and inductive sub-indicators in the TS book. Consequently, it can be concluded that the availability of critical thinking skills indicators in the commonly used printed books in Padang's public high schools is not easy. It is hoped that this research will assist teachers in selecting appropriate learning resources (printed books), particularly in physics, to enhance students' critical thinking skills at the high school level in the 21st century.

Keywords: Analyze, Conclude, Critical thinking skills, Deductive, Evaluate, Inductive, printed books

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INTRODUCTION

In the 21st century, technological progress cannot be avoided until it penetrates all fields, including education. Education is a conscious, planned effort to create a

learning atmosphere that actively motivates students to develop their potential, including religious and spiritual strength, self-control, personality, intelligence, noble character, and skills



needed in life, society, nation, and state (Permendikbud, 2003a). Therefore, the government formed a curriculum to advance education in Indonesia.

The curriculum is a set of plans and systems that include objectives, content, learning materials, and the methods used as guidelines for carrying out learning to achieve certain educational goals (Permendikbud, 2003b). The current curriculum is the revised 2013 curriculum. It has begun to implement an independent curriculum that contains the skills needed to enter the 21st century, one of which is Higher Order Thinking Skills (HOTS). Based on the mindset of the revised 2013 curriculum, modern pedagogic dimensions are applied in the learning process, which is carried out with a scientific approach, namely a scientific approach in the form of observing, questioning, associating,

experimenting, and networking activities or conclude (Jiang, 2022; Nauli & Sinambela, 2013).

Critical thinking is a person's skill in finding relevant information that is accurate and can be used properly. All knowledge and skills are used in solving problems, making decisions, and analyzing assumptions obtained based on accurate information to reach conclusions as a solution to a problem (Alsaleh, 2020; Ariyana, 2019; Misbah et al., 2022; Yani et al., 2021).

Percentage of students' abilities to answer the 2019 UN physics exam questions at public high schools in the city of Padang, based on cognitive levels, namely HOTS, Middle Order Thinking Skills (MOTS), Lower Order Thinking Skills (LOTS) as in Table 1.

Table 1 Percentage of 2019 physics national examination scores for padang city public high schools based on HOTS, MOTS, and LOTS cognitive levels

No	School Name	Percentage (%)		
		HOTS	MOTS	LOTS
1	SMA N 1 Padang	84.3 %	87.2 %	87.6 %
2	SMA N 2 Padang	60.3 %	55.0 %	80.0 %
3	SMA N 3 Padang	55.6 %	53.4 %	70.4 %
4	SMA N 4 Padang	47.0%	45.9 %	72.2 %
5	SMA N 5 Padang	45.9 %	43.2 %	60.3 %
6	SMA N 6 Padang	45.9 %	47.1 %	62.3 %
7	SMA N 7 Padang	41.5 %	39.3 %	65.9 %
8	SMA N 8 Padang	52.6 %	43.2 %	65.1 %
9	SMA N 9 Padang	47.4 %	48.1 %	57.1 %
10	SMA N 10 Padang	65.7 %	66.5 %	79.8 %
11	SMA N 11 Padang	40.0 %	29.8 %	51.9 %
12	SMA N 12 Padang	44.0 %	45.6 %	61.4 %
13	SMA N 13 Padang	36.0 %	31.9 %	53.3 %
14	SMA N 14 Padang	50.0 %	39.8 %	71.4 %
15	SMA N 15 Padang	44.3 %	38.1 %	51.0 %
16	SMA N 16 Padang	43.6 %	35.9 %	49.3 %

<https://hasilun.pusmenjar.kemendikbud.go.id>

Based on the analysis results of the Padang City Physics National Examination in 2019 at the 16 public high schools in Padang City, the average proportion of students answering questions with the HOTS level is 50.3% in the medium category.

A good learning process occurs when it is supported by learning resources, namely good quality teaching materials. One example is a book. The quality of a book is reflected in the contents of the book and the way the book is presented,

which can attract students' interest in studying it (Rahim et al., 2020)

Meanwhile, high-level thinking abilities based on Indonesia's Program for International Student Assessment (PISA) ranking and Trends in International Mathematics and Science Study (TIMSS) are still low compared to other countries. (Ariyana, 2019b). Indonesia's ranking on PISA has decreased compared to the 2015 PISA results. In 2018, Indonesia was ranked 72nd out of 77 countries that took the PISA test.

Teachers generally tend to be more active than students in the learning process at school. Teachers do not involve students enough in the learning process to develop critical thinking skills. Because learning is only directed at memorizing and is limited to remembering information, students' critical thinking skills are difficult to develop. Therefore, teachers must have high abilities in teaching as complexly as possible. Therefore, we can add insight into forming a pedagogical approach so that it raises hopes for educational progress (Le, 2013; Nurzakiah et al., 2020)

In previous research in analyzing indicators of critical thinking skills in physics textbooks for class X semester 1 high school used in high schools in Padang, where there are various books used by various authors and publishers. Each textbook contains aspects of critical thinking that are not evenly distributed, so the textbook does not fully improve students' critical thinking skills at school (Purnama et al., 2021). A good learning process occurs when it is supported by learning resources, namely good quality teaching materials. One example is a book. The book's quality is reflected in its contents and its presentation, which can attract students' interest in learning it (Rahim et al., 2020).

Teaching materials, including textbooks and non-textbooks, are vital

tools for teachers and students in facilitating the teaching and learning process (Kosasih, 2021). Print books can also be said to be the main learning resource for achieving basic and core competencies, so the education curriculum is implemented. Print books can assist teachers in teaching and as a source of knowledge for students. So printed books have an important role in learning. Therefore, this study prefers to look at physics textbooks, especially at the senior high school level, class X semester II.

There is a dearth of research investigating the presence and extent of critical thinking indicators within high school physics textbooks. It is crucial to bridge this knowledge gap, as high school students need to be consistently encouraged and equipped with critical thinking abilities, recognized as an essential higher-order thinking skill. To address this gap, a comprehensive analysis is warranted to examine the physics textbooks utilized in schools. This analysis will shed light on the availability and effectiveness of critical thinking indicators within these educational resources, enabling educators and curriculum developers to make informed decisions regarding instructional materials and strategies that promote critical thinking among high school students.

METHOD

The type of research used is descriptive research with quantitative and qualitative approaches. Descriptive research is a form of research conducted based on information obtained and explained in detail about a phenomenon; the objectives achieved include the approach used in the research and data in the form of facts, not opinions (Sugiyono, 2017). The quantitative approach is carried out by processing and analyzing the data obtained with physics textbooks' critical thinking indicator analysis instruments

(Moleong, 2009). Meanwhile, the qualitative approach changes the data analysis results in numerics into written words or sentences (Margono, 2010). This research was conducted to describe the availability of indicators of critical thinking skills in physics textbooks for Class X SMA Semester II.

The population of this study was all physics textbooks for class X semester II,

which were used in SMA Negeri in Padang City. Samples were taken with a nonprobability sampling technique, namely purposive sampling. The printed books that were analyzed were the ones that were widely used in 16 public high schools in the city of Padang, and three books were obtained, namely as follows.

Table 2 The identity of the physics textbook analyzed

Book Code	Publisher	Author	Year
IP	Intan Pariwara	Pujianto, Supardianingsih, Risdiyani Chasanah	2016
ER	Erlangga	Ir. Marthen Kanginan, M.Sc	2016
TS	Tiga Serangkai	Muhammad Farchani Rosyid, Eko Firmansyah, Rachmad Resmiyanto, Atsnaita Yasrina	2016

The parts of the book that are analyzed are the presentation of the material, how the book explains the material, and the existing questions to evaluate students' abilities after understanding the material. The research material is limited to class X material in semester 1: particle dynamics, Newtonian gravity, work and energy, impulse-momentum, collisions, and harmonic vibrations.

The instrument used in this research is an analytical instrument sheet containing statements regarding indicators of critical thinking abilities. These indicators include analysis, evaluation, concluding, inductive, and deductive. This is in line

with the opinion of Fajari that critical thinking skills are a thinking process with high cognitive processes through problem analysis, opinion, and evaluation activities (Fajari & Chumdari, 2021). The researcher modified this instrument based on the instrument used by previous researchers and arranged it according to the stages of good compiling the instrument. And has passed the validity and validity stage. Revision. The researchers carried out the analysis themselves. This instrument has five sub-indicators, broken down into nine items related to critical thinking skills. The form of research instrument used can be seen in Table 3.

Table 3 Instrument for analysis of indicators of critical thinking skills in the physics printed books for class x semester ii of senior high schools in padang city

Indicator	Sub Indicator	No	Item
Critical thinking (Djusmaini Djamas, 2015: 38)	Analyze	1.	Print books require students to understand the meaning of an image, graph, diagram, table, and paragraph.
		2.	Print books require students to be able to state the meaning of an image, graph, diagram, table, and paragraph.
		3.	Print books require students to be able to classify data from observations made.

Indicator	Sub Indicator	No	Item
	Evaluate	4.	Print books require students to be able to state the results of their thoughts as a solution to a problem.
		5.	Print books require students to prove the truth of the information found.
		6.	Print books require students to be able to evaluate the truth of the information found.
	Conclude	7.	Print books require students to be able to conclude from the information found.
	Deductive	8.	Print books can measure students' abilities, from general matters to specific conclusions.
	Inductive	9.	Print books can measure students' abilities, starting with specific things and reaching general conclusions.

Development of instrument items based on sub-indicators of critical thinking skills, namely the first includes activities to understand and state the meaning of pictures, graphs, etc., and be able to classify them. Second, evaluating includes activities stating the results of thoughts and proving the truth of the information found. The third conclusion is the activity of concluding, which is based on the information found. The fourth is deductive, namely formulating things that are general to specific, and the fifth is inductive, namely formulating things that are specific to general conclusions. To test the validity of the research instrument used, it was validated by three validators with 11 validation items. To calculate the validity value using the Aiken V formula. The results of the validation of the analysis instrument for the availability of the HOTS indicator in the second-semester high school physics textbooks for class X semester II were 0.73 with the Valid category according to the following Aiken V formula rating index category: Table 4 Aiken V formula rating index category

Intervals	Category
$V \leq 0.4$	Less valid
$0.4 < V < 0.8$	Valid
$V \geq 0.8$	Very valid

(Retnawati, 2016)

The research process consists of three stages, namely the stages of preparation, implementation, and completion. The preparation and validation of analytical instruments are carried out at the preparatory stage. The validation results of the three validators are an average of 0.7 with a valid category. After the instrument is declared valid, it enters the implementation stage, namely analyzing the physics textbook for class X SMA semester II. The third stage is the completion stage, which reports the results and conclusions after completing the analysis.

The data collection technique was carried out using a documentation study, namely collecting data that became a research problem to be analyzed, the high school physics textbooks for class X semester II. The data analysis technique uses several techniques, namely 1) calculating the indicators of critical thinking skills that appear in printed books, 2) calculating the percentage of availability of critical thinking skills indicators, 3) Determining the average percentage of all printed books analyzed, 4) determining criteria for the availability of skills indicators critical thinking interpreted in words. Criteria for the availability of critical thinking skills indicators can be seen in Table 5.

Table 5 Criteria for availability of critical thinking skills indicators

Criteria	Category
81%-100%	Very Facilitating
61%-80%	Can Facilitate
41%-60%	Simply Facilitate
21%-40%	Less Facilitating
0%-20%	Not Facilitating

(Riduwan, 2012)

RESULT AND DISCUSSION

The analysis results of the availability of indicators of critical thinking ability in

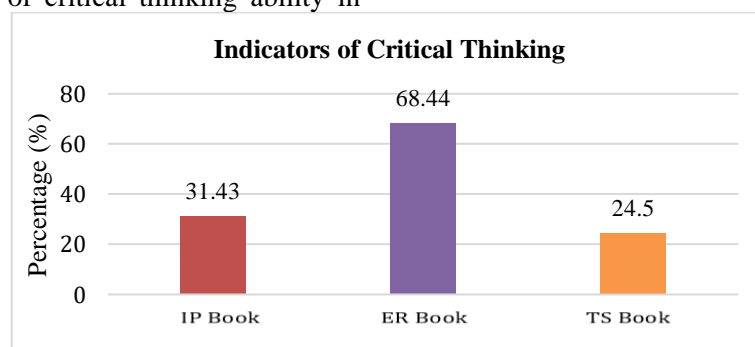


Figure 1 Percentage of critical thinking skills indicators in the three print books

Figure 1 states that the book with the most frequent indicators of critical thinking skills is the ER book, with a percentage of 68,44% in the "Can Facilitate" category. While books with indicators of critical thinking skills that rarely appear are in the TS books, a percentage of 24,5% belongs to the category "Not Enough Facilitate". Presentation of this indicator can hone students' ability to think critically because the characteristics of people who think critically can be seen from their attitude of easily accepting new

ideas/ideas, having the ability to think in different ways about a problem, and encouraging students to be able to make decisions wisely (Djamas, 2015). The percentage of each sub-indicator of critical thinking skills can be described as follows.

Analyze

Analyzing is the ability to break down or divide information into parts and look for links between parts by parts (Sofyatinigrum, 2018). The percentage of sub-indicators analyzing each printed book can be seen in Figure 2.

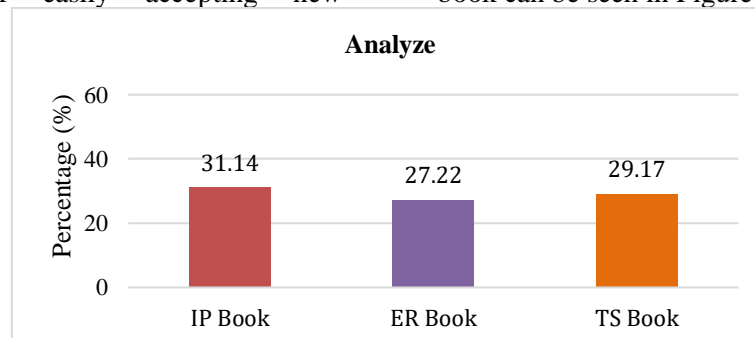


Figure 2 Percentage of sub indicators analyzed on critical thinking skills

Figure 2 states that analysis sub-indicators often appear in IP books with the same percentage of 31.14% in the "Not Enough Facilitate" category. Meanwhile, ER books with the lowest percentage of the three printed books analyzed were 27.22% in the "Not Enough Facilitate" category. The form of presentation of this sub-indicator invites or guides students to be able to hone the ability to identify or analyze various facts, statements, or concepts (Purnama Yani et al., 2021)

At this analysis stage, students can develop skills in explaining concepts, characteristics, and real descriptions as steps in solving problems (Docktor et al., 2012; Faiziyah & Priyambodho, 2022). There are three items presented in this sub-indicator.

One form of the item in the analyzing sub-indicator is in the third point. Namely, printed books can help students classify data from observations made. An example of point 3 can be seen in Figure 3.

3. Place a wooden block on an inclined plane and measure the angle θ . Record the angle θ and the condition of the beam in the observation
4. Increase the angle θ little by little until the block moves exactly and record the observation in the table

Figure 3 Presentation of point 3 on analyzing sub-indicators on critical thinking skills

A presentation of point 3 is found in the IP book on particle dynamics on page 151, which is contained in the sentence: "..... record the results of observations into the table". From this sentence, it can be seen that printed books facilitate students to classify data resulting from observations made by making tables so that they can retrieve the information needed from the problems given. According to (Kwangmuang et al., 2021), one of the critical thinking learning missions has

been accomplished by training students to carry out data source analysis to solve a problem.

Evaluate

Evaluating is an assessment or opinion activity carried out based on certain criteria or standards that can be accounted for. Evaluating activities include checking. The percentage of evaluating sub-indicators in each physics textbook analyzed can be seen in Figure 4.

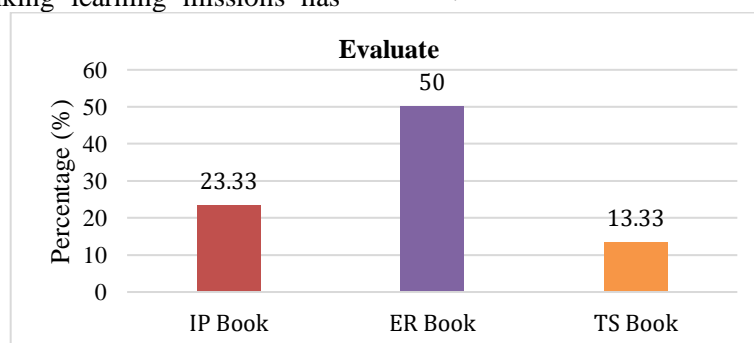


Figure 4 Percentage of sub-indicators evaluating critical thinking skills

Figure 4 states that the evaluating indicators often appear in ER books, with a percentage of 50% falling into the "Enough Facilitate" category. Meanwhile, the lowest evaluating sub-indicator is in the TS book, with a percentage of 13.33% in the "Not Facilitate" category. Based on the analysis of the sub-indicator evaluating the physics textbook analyzed, this sub-indicator has a relationship with the previous sub-indicator, namely the sub-indicator analysis. In this sub-item,

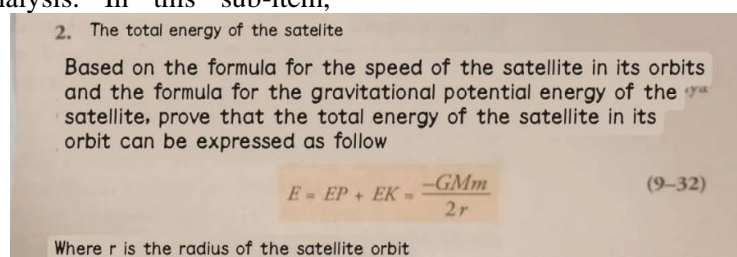


Figure 5 Presentation of point 5 on evaluating sub-indicators on critical thinking skills

Based on Figure 5, the presentation of point 3 is contained in the sentence: "Prove that the total energy of the satellite in its orbit can be expressed as follows..". From this sentence, it can be seen that printed books facilitate students to prove or research information/statements previously given. This is in line with Rahmi's opinion (Rahmi & Suparman, 2019) that critical

students are required to be able to criticize, namely looking back or examining whether the results obtained are correct or not (Susilowati & Sumaji, 2020)

An example is found in point 5 in the form of a printed book that can facilitate students to prove the truth of the information found. An example of point 5 is found in the ER book on work and energy, page 383, which can be seen in Figure 5.

thinking is a cognitive process that can be used to prove existing facts.

Conclude

Summarizing is an activity that leads students to decipher and understand something to reach a new idea, namely a conclusion. The percentage of sub-indicators concluding in the three books can be seen in Figure 6.

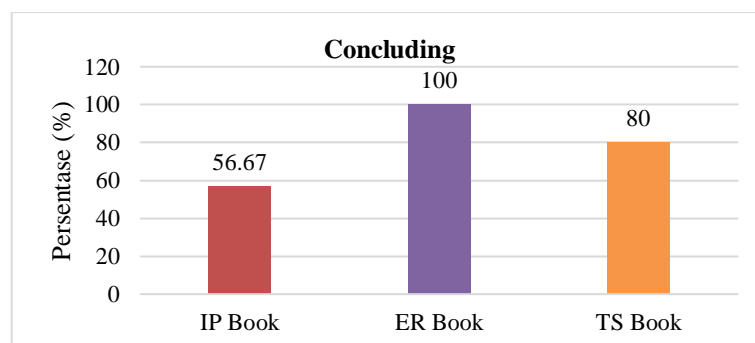


Figure 6 Percentage of sub-indicators concluding on critical thinking skills

Figure 6 states that the sub-indicator concludes the highest in the ER book with a percentage of 100% in the "Highly Facilitate" category. Meanwhile, the sub-indicators concluded the lowest in the IP

book of 56,67% in the "Enough Facilitate" category. This is because, in the ER book, there are many observational or experimental activities that make conclusions and reports based

on the observations made at the end of the activity. Students are required to conclude from the information they find. This sub-indicator has one instrument item, namely point 7, in the form of a

printed book that can facilitate students to conclude from the information found. An example of point 7 can be found in the IP book on energy business material, page 208, which can be seen in Figure 7.

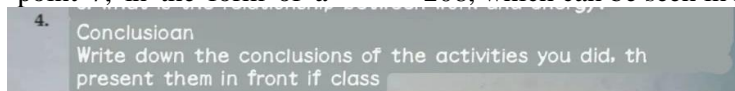


Figure 7 Presentation of point 7 in the sub-indicators concluding on critical thinking skills

Based on the Figure 7, point 7 is found in the sentence: "Write down the conclusions of the activities you did, then present them in front of the class". From this sentence, it can be seen that printed books facilitate students to conclude the information obtained after

carrying out the experimental activities given.

Deductive

Deductive is the activity of formulating things, from general nature to specific conclusions. The percentage of deductive sub-indicators can be seen in Figure 8.

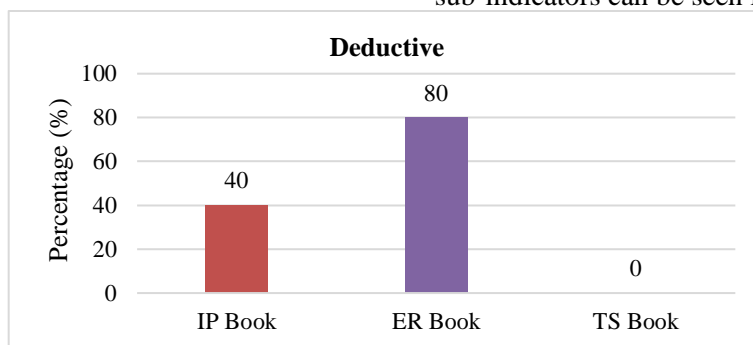


Figure 8 Percentage of deductive sub-indicators on critical thinking skills

Figure 8 shows that the book with the highest percentage on the deductive sub-indicator is an ER book of 80% in the "Can Facilitate" category. The lowest percentage for the deductive sub-indicator is the TS book, which has 0% in the "Not Facilitate" category. This sub-indicator has one instrument item, rarely

found in the three physics textbooks analyzed. This sub-indicator has one instrument item, namely point 8, in the form of a printed book that can facilitate students to formulate things that start from a general nature to specific conclusions. One example of item 8 can be seen in Figure 9.

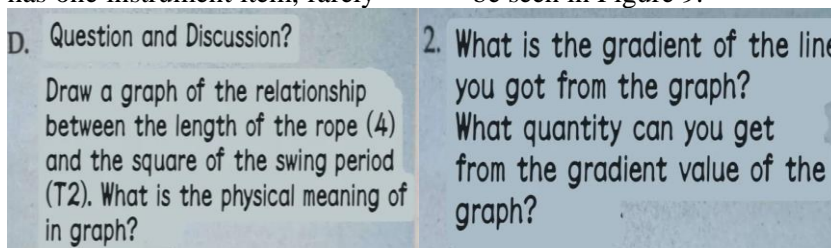


Figure 9 Presentation of point 8 on deductive sub-indicators on critical thinking skills

The presentation of point 8 is in the IP book on the dynamics of harmonic vibrations, page 259. It can be seen that

in the picture above, the exposure to points one and two guides students to formulate answers to general questions

and specific conclusions. This item is rarely found in the three physics printed books analyzed.

Inductive

Inductive is the opposite of deductive,

namely the activity of formulating things that start from being specific to general conclusions. The percentage of deductive sub-indicators in the three physics textbooks analyzed can be seen in Figure 10.

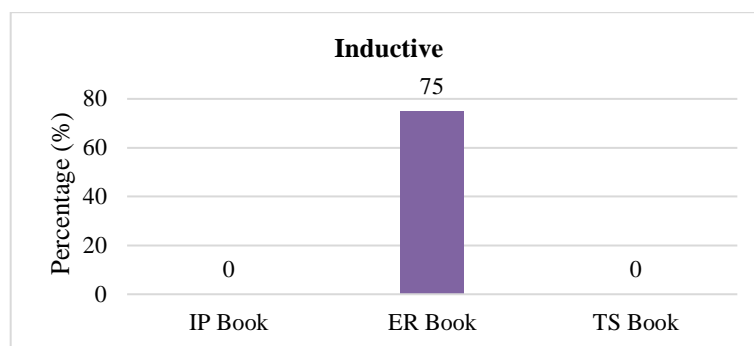


Figure 10 Percentage of inductive sub-indicators on critical thinking skills

Based on the information presented in Figure 10, it is evident that the inductive sub-indicator exhibits a low percentage across all analyzed physics textbooks. The percentages can be arranged in ascending order, with ER books having 75% in the "Can Facilitate" category. Meanwhile, IP and TS books also have 0%, all falling within the "Not Facilitate" category. These percentages indicate that the availability of critical thinking skills indicators in several printed books used

for learning is not uniformly distributed, thereby affecting students' critical thinking abilities. This finding aligns with Yusliani's research, which highlights that most textbooks utilized in the learning process do not align with the requirements of the 2013 curriculum, consequently impacting the attainment of desired learning objectives (Yusliani et al., 2019). An example of point 9 is found on harmonic vibration on page 481 of the ER book, which can be seen in Figure 11.

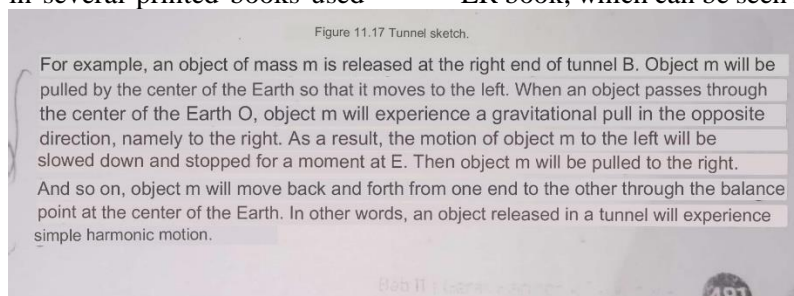


Figure 11 Presentation of point 9 on the deductive sub indicator on critical thinking skills

Based on the Figure 11, the presentation of this item can be seen as the explanation of answers to the problems given, which are explained from specific things to get general conclusions. This indirectly guides students in formulating specific things to get general conclusions.

Students' low thinking ability can occur due to various factors. One of the factors causing the low ability to think critically is that students do not know what to bring to school in the teaching and learning process. However, they have fragmented knowledge, especially in physics subjects, which students

consider difficult. Hence, connecting one concept to another is difficult, especially in physics learning (Benyamin et al., 2021).

For the three books, the material's presentation starts with the chapters that represent each material. At the beginning, the material is explained, followed by examples of questions and their discussion. Then, there are various questions, from multiple choice questions to essays. In general, the description of indicators of critical thinking skills in the three books is spread unevenly and is less structured. It would be better if the book's preparation was followed by steps to improve critical thinking skills.

This is a student's learning habit, which is a result of their critical thinking skills not developing because students are used to learning that still uses the lecture method, so students are not yet active in finding problems and solutions to solving these problems following the demands of the 2013 curriculum (Fernando et al., 2021). One of the factors that can improve students' critical thinking skills is creating a safe environment. A safe environment is a place where students feel safe without threats in expressing their opinions and ideas (Rahim et al., 2019). Therefore, teacher awareness is needed to develop students' critical thinking skills. One of them is by diverting indicators of critical thinking skills in learning. Teachers should be able to design innovative learning processes to develop students' critical thinking skills.

Teachers in the 21st century must prepare students to have 21st-century skills, including critical thinking skills. The teacher guides students by motivating students to strengthen their intellectual skills in identifying problems and building new ideas/ideas (Zubaidah, 2010). Then, students should be encouraged to conduct or propose case studies where they can use previously

obtained information in new situations. When students express their ideas, they must be able to justify their contributions and critically assess other students' contributions. To achieve this goal, students must train their critical thinking skills (Al-Husban, 2020)

Therefore, the teacher should be able to overcome this in the learning process by selecting learning resources that contain indicators of critical thinking skills. The use of teaching materials such as textbooks also needs to be considered because there are many textbooks, especially physics lessons, which many publishers circulate. Therefore, this study aims to examine which physics textbooks contain indicators of critical thinking skills so that relevant physics textbooks are obtained and contain indicators of critical thinking skills.

Using books that facilitate students' development of critical thinking skills has several benefits. The first is to improve analytical skills. Students will learn to analyze information more carefully and critically. They will learn to identify relevant and irrelevant information and consider different perspectives.

Second, the book can improve problem-solving abilities. Students will learn how to solve problems more effectively by practicing critical thinking skills. They will consider many possible solutions and select the most effective one.

Third, students can improve their argumentative skills. Books that facilitate critical thinking skills will help students understand how to make logical and coherent arguments. They will learn to use evidence and facts to support their arguments and to avoid bias and fallacies.

Finally, students can increase their understanding of concepts. With critical thinking skills, students can develop a deeper understanding of concepts. They will learn to consider how concepts relate

to one another and how they impact different situations or problems.

CONCLUSION

Based on the analysis of the three physics textbooks, it was found that the availability of critical thinking ability indicators in the three physics textbooks was included in the "Facilitating Not Enough" category. The highest percentage of critical thinking skills indicators is in the ER book, at 68,44%. The lowest is in the TS book, with a proportion of 24,5%.

From the analysis carried out, the availability of indicators of critical thinking ability in presenting the contents of the book was found to be inconsistent according to the critical thinking sub-indicator itself. It is better if textbooks are displayed in a sequence of instrument items that can direct the mastery of critical thinking indicator skills. Therefore, use textbooks that contain indicators of critical thinking skills that can support students in developing higher-order thinking skills following the demands of the 2013 curriculum.

To develop students' critical thinking skills, books that facilitate these abilities can be used as effective learning resources.

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