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DEVELOPMENT OF HIGHER ORDER THINKING SKILL (HOTS) TEST INSTRUMENTS BASED ON STUDENTS' CRITICAL THINKING SKILLS ON MOMENTUM AND IMPULSE MATERIAL

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Abstract

This study aims to determine the development process, feasibility test results and the results of students' critical thinking skills on critical thinking skills test instruments on momentum and impulse material. This type of development research uses the ADDIE model (Analysis, Design, Development, Evaluation, and Implementation). The test instrument was developed based on indicators of critical thinking skills by Facione. The research was conducted at SMA Negeri 6 Medan which amounted to 10 students on a small scale trial and 30 students on a large scale trial. Data results obtained from content validation using a Guttman scale. Content validation subjects consisted of 2 physics lecturers and 1 physics teacher. Small-scale trials obtained 8 valid questions and 2 invalid questions, reliability value of 0.929 very high category, level of difficulty obtained 1 question with easy criteria and 9 medium questions, differentiating power obtained 1 question category is not good, 1 question category is sufficient, and 8 questions category is good. Large-scale trials obtained 8 valid questions, a reliability value of 0.907 very high category, the level of difficulty obtained 2 questions with easy criteria and 6 medium questions, the differentiating power obtained 8 good category questions. The results of students' critical thinking skills obtained an average of 67.83% with crisis criteria.

Keyword: Test instrument, critical thinking skills, momentum and impulse, ADDIE

Abstrak

Penelitian ini bertujuan untuk mengetahui proses pengembangan, hasil uji kelayakan dan hasil keterampilan berpikir kritis peserta didik terhadap instrumen tes keterampilan berpikir kritis pada materi momentum dan impuls. Jenis penelitian pengembangan dengan model ADDIE (*Analysis, Design, Development, Evaluation, and Implementation*). Instrumen tes dikembangkan berdasarkan indikator keterampilan berpikir kritis oleh Facione. Penelitian dilakukan di SMA Negeri 6 Medan yang berjumlah 10 peserta didik pada uji coba skala kecil dan 30 peserta didik pada uji coba skala besar. Hasil data yang diperoleh dari validasi isi menggunakan skala Guttman. Subjek validasi isi terdiri dari 2 dosen fisika dan 1 guru fisika. Uji coba skala kecil diperoleh 8 soal valid dan 2 soal tidak valid, nilai reliabilitas sebesar 0,929 kategori sangat tinggi, tingkat kesukaran diperoleh 1 soal dengan kriteria mudah dan 9 soal sedang, daya beda diperoleh 1 soal kategori tidak baik, 1 soal kategori cukup, dan 8 soal kategori baik. Uji coba skala besar diperoleh 8 soal valid, nilai reliabilitas sebesar 0,907 kategori sangat tinggi, tingkat kesukaran diperoleh 2 soal dengan kriteria mudah dan 6 soal sedang, daya beda diperoleh 8 soal kategori baik. Hasil keterampilan berpikir kritis peserta didik memperoleh rata-rata 67,83% dengan kriteria kritis.

Kata Kunci: Instrumen tes, keterampilan berpikir kritis, momentum dan impuls, ADDIE

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1. INTRODUCTION

The ability to think critically, think creatively and solve problems are necessary skills for 21st century learning. These skills are known as higher order thinking skills (HOTS). These abilities are essential to face the increasingly complex and fast-changing challenges of the 21st century. Critical and creative thinking enables a person to analyze, evaluate and conclude information obtained, as well as solve problems in innovative and effective ways. The K-13 curriculum is focused on developing this HOTS ability by increasing students' activities and participation in the learning process and improving students' skills in critical thinking, creativity and problem solving (Febrianti et al., 2021).

The national average score for physics in Indonesia is still low, not reaching 50 on a scale of 100. This shows that the cognitive ability of physics possessed by students is still low. In studying physics, it requires the ability to understand concepts and how to apply them in problem solving. To achieve this, it requires changing the concept of prior knowledge in accordance with the real conditions. Higher order thinking skills are needed to transform the concept of prior knowledge into long-term knowledge.

The K-13 curriculum focuses on developing learners' competencies by increasing activities and students in the learning process. The role of the teacher is as a facilitator in the learning process and learners are required to develop their own knowledge. The K-13 curriculum integrates technology and information media in the learning process to improve learners' skills in using technology and information media. It aims to improve learners' ability to think critically, creatively, and innovatively, and help learners develop the skills needed in an ever-changing world (Desilva et al., 2020).

Bloom's Taxonomy is a system used to classify the level of difficulty and errors of students in learning, which is developed based on the level of thinking ability of students. Anderson et al. (2001) divided the cognitive dimensions in Bloom's taxonomy into six categories, namely: remember, understand, apply, analyze, evaluate, and create.

HOTS questions are measurement instruments used to measure high-level thinking skills, which are thinking skills that go beyond remembering, restating, or referring without processing. HOTS questions in the assessment context measure the ability to: 1) transfer one concept to another, 2) process and apply information, 3) find connections between different information, 4) use information to solve problems, and 5) critically examine ideas and

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information. However, HOTS-based questions are not necessarily more difficult than recall questions.

According to Barnett and Francis, HOTS questions can make learners understand the material more deeply. In the context of assessment, HOTS questions can be used to measure skills such as: (1) understanding between concepts, (2) integrating and processing information, (3) finding information linkages, (4) problem solving, and (5) the ability to find new ideas from the information obtained. Therefore, the use of HOTS assessment instruments can be used as a means to improve students' ability to understand the material and can be used by teachers to evaluate the learning process (Desiriah & Setyarsih, 2021).

The reality in one of the schools based on the results of preliminary observations and interviews with one of the physics teachers at SMA Negeri 6 Medan found that the school has implemented the 2013 curriculum. In evaluating learning, teachers still use simple question test instruments to measure students' abilities. The types of instruments commonly used in the implementation of learning evaluations are multiple choice and essay to measure students' low-level thinking skills. Teachers only make questions based on books and the internet then modify the questions. Teachers still use questions that are only oriented towards the ability to remember, understand and apply. Therefore, physics teachers at SMA Negeri 6 Medan have not applied HOTS-based questions in accordance with Curriculum 2013 in the preparation of questions. Teachers also have not applied assessment instruments in accordance with critical thinking skills indicators.

Based on these problems, researchers argue that some HOTS questions still need to be developed so that students can often be trained to work on HOTS questions and physics learning abilities, especially critical thinking, can be improved. This is in line with Hanifah (2019) opinion that the application and development of HOTS is very important in learning. Students will be able to use problem-solving techniques correctly, precisely, and confidently if they have high-level thinking skills. In evaluation, teachers must always prepare questions that cannot be answered simply by students, which will certainly have an impact on improving the quality of education. When learning activities are focused on HOTS development targets, it has a significant impact on more effective learning activities, the intellectual skills of teachers and students become more trained, and the evaluation process itself becomes more efficient. However, it is necessary to develop HOTS-based test instruments in Physics learning to train

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critical thinking skills because there is no test instrument designed to train and improve students' higher order thinking skills (HOTS).

Essay tests are often used to evaluate a person's critical thinking skills (Nuridha & Hardianti, 2022). Critical thinking ability is one aspect of HOTS. The following are the steps for writing HOTS items : a) analyze KD that can be converted into HOTS items; b) create a question grid; c) choose interesting and contextual stimuli; d) write question items in accordance with the grid; e) create scoring guidelines (rubrics) or answer keys (Sari et al., 2023).

Based on the background description above, the researcher needs to conduct a test instrument development study entitled Development of Higher Order Thinking Skill (HOTS) Test Instruments Based on Students' Critical Thinking Skills on Momentum and Impulse Materials. This is because researchers believe that the results of this study can provide benefits in HOTS-based physics learning for high school students.

2. METHOD

The development of test instruments will be carried out at SMA Negeri 6 Medan which is located at Jalan Ansari No.34, Medan Kota District, Medan City, North Sumatra. The time of this research was carried out in the odd semester of the 2023/2024 school year, the initial observation data collection was carried out on January 12, 2023. The subjects in this study were 10 students of class XI MIA 2 as a small group test and 30 students of class XI MIA 1 as a large group test. The object in this study is a physics test instrument used in momentum and impulse material in class XI.

3. RESULT AND DISCUSSION

3.1 RESULT

The result of this research is a critical thinking skills-based physics test instrument on momentum and impulse material. This study was conducted to determine the feasibility process of each item of critical thinking skills on momentum and impulse material. The test instrument has met the feasibility of test instruments including aspects of material, construction, and language, as well as validity, reliability, differentiability, and difficulty level. The test instrument was developed using the ADDIE model stages, namely Analyze, Design, Develop, Implement, and Evaluate. The results obtained at each stage of the development process are as follows. Analyze

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(Analysis Stage)

The analysis stage is the initial stage of research to obtain information related to the problems that occur. At this stage the analysis was conducted at SMAN 6 Medan. This analysis stage is carried out several analyzes, namely needs analysis, curriculum analysis, material analysis, learner analysis, and literature studies that support the preparation of instruments.

1) Needs analysis, activities carried out at this stage to obtain information about what learning tools need to be developed. In this case, the need for a test instrument was found. Based on the results of observations and interviews, it was found that students did not have the ability to answer HOTS questions. Observations were also made when the researchers conducted PLP II at the school. What was found was that students could only work on remembering (C1), understanding (C2), and applying (C3) questions. Students are only given questions to measure low-level thinking skills so it is necessary to have a test instrument to measure high-level skills, one of which is critical thinking skills.

2) Curriculum analysis was conducted by analyzing the application of the revised 2013 curriculum, especially on momentum and impulse material at SMA Negeri 6 Medan. At this stage, researchers conducted interviews with teachers regarding the curriculum used in schools and the application in learning. It was found that the school had implemented the K-13 Curriculum.

3) Material analysis is done by analyzing the material in the syllabus based on the revised 2013 curriculum. It was found that the teacher only provided material based on the package book so that an analysis was needed to find out the basic competencies of momentum and impulse which would then be adjusted to the indicators to be able to design appropriate questions. It was found that the teacher only provided material based on the textbook so that an analysis was needed to find out the basic competencies of momentum and impulse which would then be adjusted to the indicators to be able to design appropriate questions.

4) Learner analysis was conducted on the pilot test subjects, which in this study were grade XI students. Based on the results of interviews with physics teachers at the school, it is stated that many students still have difficulty in understanding learning concepts.

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5) Literature study was conducted to find concepts or theoretical foundations that strengthen the critical thinking skills-based HOTS test instrument. In this research, the literature study was conducted by collecting information from various books, journals, and articles.

Design (Planning Stage)

This stage is the planning stage of the test instrument including planning the type of test instrument, making a lattice of test instruments, making critical thinking skills-based HOTS test instruments, designing validity questionnaires, and designing test instrument scoring guidelines.

Planning the Type of Test Instrument, the researcher determines the type of test instrument in this study is an essay test instrument type (description). Essay-shaped test instruments can measure students' critical thinking skills. The test instrument is included in the Higher Order Thinking Skills (HOTS) questions which contain indicators of critical thinking skills on momentum and impulse material as many as 10 questions.

In making the lattice of test instruments, it is prepared by looking at the basic competencies and indicators of competency achievement in the syllabus based on the 2013 revised curriculum on momentum and impulse material and then adjusted to the indicators of critical thinking skills according to (Facione, 2015). The lattice of test instruments presents indicators of questions along with momentum and impulse sub-materials. In each question number also presented cognitive aspects that include C4, C5, or C6 that will be used in the question. The test instrument grids are presented in the table

Table 1. Critical Thinking Skills Test Instrument Grid

Basic Competencies	**Competency Achievement Indicators**	**Critical Thinking Skills Indicator (Facione)**	**Problem Indicator**	**Materi**al	**Number**	**Cognitive Aspects**
1.6. Analyze the concepts of momentum and impulse, the relationship between momentum	4.6.1 Analyze the concept of momentum in an event 4.6.2 Analyze the concept of	*a. Interpretation* *b. Analysis* *c. Evaluation* *d. Inference* *e. Explanation*	Given two colliding objects that have initial velocities, learners can explain the kinetic energy lost based on the law of conservation of momentum.	Law of conservation of momentum	1	C5

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and impulse, the law of conservation of momentum, the concept of collision, and its application in everyday events.	impulse on an event 4.6.3 Analyze the relationship between momentum and impulse 4.6.4 Analyze the motion of an object to solve problems related to collision events 4.6.5 Analyzing an experiment to measure average momentum	f. *Self regulation*	Given a soccer player kicking a ball that is moving towards him, learners can explain the speed of the ball after it is kicked.	Relationship between momentum and impulse	2	C4
			Presented with the event of two angkots crashing into a road divider, learners are able to give/draw conclusions from the event that occurred.	Momentum	3	C4
			Presented with a car accident, learners are able to analyze the cause of the car damage.	Impuls	4	C4
			Given a ball that hits a wall with an angle, learners can determine the value of the impulse given by the wall.	Relationship between momentum and impulse	5	C4
			Given a billiard ball that collides with an initial velocity, students can determine the velocity of the ball after the collision.	Law of conservation of momentum	6	C4
			Given students carry out a practicum to measure the average momentum, learners can explain and decide the difference in the average value of momentum.	Average momentum	7	C6

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	Presented with an event of a child practicing soccer, learners are able to assess the claims and arguments of the event.	Relationship between momentum and impulse	8	C4
	Presented with an incident of a child kicking a stone and kicking a ball, learners are able to compare based on the events that occurred.	Momentum	9	C4
	Presented with students playing volleyball, learners are able to analyze the ball stops bouncing.	Collision	10	C4

Designing HOTS Test Instruments Based on Critical Thinking Skills, In this study, the test instruments were prepared based on the grids of test instruments that had been previously made. The test instruments developed included HOTS test instruments with critical thinking skills indicators consisting of 10 essay questions (descriptions).

Designing a validity questionnaire is carried out to measure the validity of the test instrument from the material aspect, construction aspect, and language aspect. Each aspect has criteria that have a value of 1 if Yes (test items match the criteria) and a value of 0 if No (test items do not match the criteria). This validity questionnaire will then be given to the validator to assess whether the items developed are valid or not.

Designing Test Instrument Scoring Guidelines, Designing test instrument scoring guidelines is carried out to assess the results of student answers to test instruments. The test instrument scoring guidelines are made by adjusting the sub-indicators of critical thinking according to Facione. The scoring guidelines will be used in analyzing students' answers to the test instruments that have been developed.

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Development Stage (Develop)

Expert Validation, the validation stage aims to improve the instruments that have been developed based on suggestions for improvement from the expert team. At this stage the test instrument that will be validated by experts consists of 10 essay questions with a grid that has been determined at the previous stage. The validation technique is carried out using a validation sheet as an assessment and input from the expert which will then be revised.

The validation sheet contains questions covering material, construction, and language aspects. The validator is asked to assess by giving a value of 1 = Yes (if the test item matches the criteria) and 0 = No (if the test item does not match the criteria). The results of the expert validation can be seen based on the following table.

Table 2. Content Validation Test Results

Question Item	Content Validation Aspects			V'Aiken	Validation Level
	Material	Construction	Language		
1	1	1	1.00	1.00	High
2	1	1	1.00	1.00	High
3	1	1	1.00	1.00	High
4	1	1	1.00	1.00	High
5	1	1.00	1.00	1.00	High
6	0.88	0.94	1.00	0.94	High
7	1	1.00	1.00	1.00	High
8	1	1.00	1.00	1.00	High
9	1	0.94	1.00	0.98	High
10	1	1	0.87	0.96	High

Based on the analysis of the feasibility level of each item by the validator, it was found that all items were classified as high validation level. The experts agreed that the critical thinking skills test instrument on momentum and impulse material was tested on a small scale with minor revisions. The revised test instrument given by the experts is presented in Table 3 below.

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Table 3. Content Validation Test Results

No.	Rated aspect	Number of Questions Required Repair	Validator comments
1	**Material**		
	Questions can be translated into indicators of critical thinking skills (interpretation, analysis, evaluation, conclusion, explanation, self-organization)	1,6	The questions are not yet included in the critical thinking indicators The questions given must be clear and understandable to students. Learners must be diligent in working on the questions given by the teacher.
	The content of the questions is appropriate for level, school type, and grade level	6	
2	**Construction**		
	Stimulus in the form of tables, figures, graphs, diagrams, or the like are presented clearly, legible and functional (related to the problem that asked)	6	Students must be diligent in asking the teacher every time there is a problem that is not clear.
	The notes, symbols, and icons presented in the questions are correct according to the conventions used in the field/science physics	9	
3	**Bahasa**		
	The sentences in the questions use language that is communicative or easy to understand	10	Teachers must be able to describe each problem that is done and developed for students

Revision of Expert Validation Test, Revision of critical thinking skills test instruments on momentum and impulse material based on validator comments and suggestions which include material, construct, and language aspects. In the material aspect, revisions need to be made to

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questions that do not include critical thinking questions and questions that are not clear. In the construction aspect, revisions need to be made to questions that are not clear and there are no pictures or instructions for questions. In the language aspect, it needs to be done on the use of language that is not yet communicative and less described. The following table shows the results of the revision of the critical thinking skills test instrument on momentum and impulse material based on validator comments and suggestions.

Table 4. Revised Results of Expert Validation Test

No	Initial Question	Correction Question
1	Dewi and Sinta are looking at two objects that are colliding. Object A and object B have a mass of 2 kg. The velocities before the collision are $Va = 15i + 30j$ (m/s) and $Vb = -10i + 5j$ (m/s). The speed of object A after the collision is $-5i + 20j$ (m/s). Dewi and Sinta want to calculate the percentage of kinetic energy lost after the collision. Dewi thinks the kinetic energy lost is 20% while Sinta thinks the kinetic energy lost is 40%. Which statement do you think is correct between Dewi and Sinta? Explain why you chose that statement!	Dewi and Sinta are looking at two objects that are colliding. Object A and object B have a mass of 2 kg. The velocities before the collision are $Va = 15i + 30j$ (m/s) and $Vb = -10i + 5j$ (m/s). The speed of object A after the collision is $-5i + 20j$ (m/s). Dewi and Sinta want to calculate the percentage of kinetic energy lost after the collision. **Argument:** Dewi thinks the kinetic energy lost is 20% while Sinta thinks the kinetic energy lost is 40%. Which statement do you think is correct between Dewi and Sinta? Explain why you chose that statement!
6	Fandi and Dika are playing billiards. The white ball is placed in the center of the table at rest. The black billiard ball (h) is prepared to hit the white billiard ball (p) with a speed of 20 m/s.	Fandi and Dika are playing billiards. The white ball is placed in the center of the table at rest. The black billiard ball (h) is prepared to hit the white billiard ball (p) with a speed of 20 m/s. The two balls then collide and move as shown in the figure. The black and

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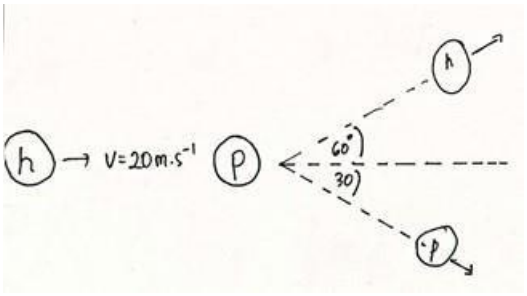
	The two balls then collide and move. The black and white balls are identical. What is the speed of the white ball after impact (v')?	white balls are identical. Argument: Fandi and Dika think that the speed of the white ball after impact is no more than 10 m/s. What is the speed of the white ball after the collision (v' p)? Is Fandi and Dika's statement correct? Explain your reasoning! 
9	While walking to the soccer field, Bobi accidentally kicked a 0.5 kg stone with a force of 25 N so that the stone, which was initially stationary, moved 1 m/s. Because the stone was hard, Bobi's foot hurt. Then arriving at the soccer field, Bobi kicks a football that also has a mass of 0.5 kg with a force of 25 N so that the ball moves at a speed of 5 m/s. Why did Bobi's foot hurt when he kicked the stone? Based on these events, what can you compare?	While walking to the soccer field, Bobi accidentally kicked a 0.5 kg stone with a force of 25 N so that the stone, which was initially stationary, moved 1 m/s. Because the stone was hard, Bobi's foot hurt. Then arriving at the soccer field, Bobi kicks a football that also has a mass of 0.5 kg with a force of 25 N so that the ball moves at a speed of 5 m/s. Why did Bobi's foot hurt when he kicked the stone? Based on these events, what can you compare?
10	On the school field some students are playing volleyball. Because of the small size of the volleyball court, if the hit is too hard, the ball will easily leave the field. One day one of the	On the school field, some students have a small volleyball court, so if they hit too hard, the ball will easily leave the field. One day one of the smashers hit the ball too hard which caused the ball to leave the field and hit the floor of the school corridor. The ball

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smashers hit the ball too hard which caused the ball to leave the field and hit the floor of the school corridor. The ball that hit the floor bounced several times so that the ball stopped (silent). Why did the ball stop when no one stopped it?	that hit the floor bounced several times so that the ball stopped (still). Argument: The ball stopped because it had bounced off the floor several times. Why did the ball stop when no one stopped it?

Implementation Stage

At this stage, product trials will be carried out. This is done to determine the validity, reliability, difficulty level and distinguishing power of the questions that have been developed. Based on the feasibility test of test instruments consisting of item validity tests, reliability tests, difficulty levels, and differentiation, the results of the analysis of 10 items are as follows:

Table 5. Recapitulation of Small Group Trial Results

Question Number	Question Validity	Reliability	Differentiation	Difficulty level	Conclusion
1	Valid		Good	Medium	Accepted
2	Valid		Good	Medium	Accepted
3	Invalid		Enough	Easy	Rejected
4	Valid		Good	Medium	Accepted
5	Valid		Good	Medium	Accepted
6	Valid		Good	Medium	Accepted
7	Valid		Good	Medium	Accepted
8	Invalid	Reliable	Enough	Medium	Rejected
9	Valid		Good	Medium	Accepted
10	Valid		Good	Medium	Accepted

Based on the table above, it is known that of the 10 critical thinking test items that have been developed, there are 8 questions that are accepted and can be directly used in large group trials and 2 questions that are rejected because they do not meet the eligibility criteria for test instruments, so that the questions cannot be used when conducting large group trials. In addition, according to Marwan et al. (2020) that a reliable test instrument based on reliability

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analysis when used in other schools, the results will not be much different. Question items in the bad category cannot be used or discarded because they cannot distinguish the abilities of students (Fitrianty et al., 2022).

Based on the feasibility test of the test instrument consisting of item validity test, reliability test, difficulty level, and differentiation, the results of the analysis of 8 items are as follows:

Table 6. Recapitulation of Big Group Trial Results

Question Number	Question Validity	Reliability	Differentiation	Difficulty level	Conclusion
1	Valid	Reliable	Good	Easy	Revised
2	Valid		Good	Medium	Accepted
3	Valid		Good	Medium	Accepted
4	Valid		Good	Medium	Accepted
5	Valid		Good	Medium	Accepted
6	Valid		Good	Medium	Accepted
7	Valid		Good	Easy	Revised
8	Valid		Good	Medium	Rejected

Based on the table above, it is found that of the 8 critical thinking skills test questions that have been developed, it is known that 6 items are accepted and qualify well from the aspects of validity, difficulty level, and differentiation and 2 items are revised.

Evaluation Stage (Evaluate)

Summative evaluation is conducted based on the results of the implementation phase.

1. At the analysis stage, the evaluation was carried out when compiling the interview observation questionnaire for teachers at SMA Negeri 6 Medan, the evaluation was carried out based on the direction and guidance of the thesis supervisor. Evaluation is the skill of learners to be able to assess the credibility of statements, that is assess the logical strength of the intended inferential relationship of a statement or problem (Maslakhatunni'mah et al., 2019).

2. The design stage, the evaluation was conducted when determining the research objectives, research subjects, the form of test instruments, and the instruments needed in the trial. The evaluation was carried out based on the direction and guidance of the thesis supervisor.

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3. The development stage, the evaluation was carried out when preparing the first draft of the test instrument based on problem solving skills starting with the making of the test grid and scoring guidelines. Evaluation is carried out based on the direction and guidance of the thesis supervisor.

4. Implementation stage, the evaluation is carried out when improving the first draft of the test instrument based on problem solving ability based on the direction of the validator to produce the second draft of the test instrument based on problem solving ability. In addition, evaluation was also carried out after conducting small group and large group trials resulting in research products in the form of 8 critical thinking skills-based physics test items.

Analysis of Critical Thinking Skills of Learners

The development of critical thinking skills test instruments on momentum and impulse material refers to Facione's indicators which require students to provide answers based on sub-indicators of interpreting, analyzing, providing conclusions, providing explanations, evaluating, and self-regulating indicators. Based on the instrument that has been developed, the results of students' critical thinking skills in class XI MIA 1 SMA Negeri 6 Medan are presented in the following table

Table 7. Critical Thinking Skills of Learners

Question Items	Critical Thinking Indicators	Percentage	Category
3 and 7	Interpretation	68,85%	Critical
2 and 8	Analysis	63,85%	Moderately critical
4	Evaluation	66,6%	Critical
1	Inference	74,4%	Critical
6	Explanation	65%	Moderately critical
5	Self regulation	68,3%	Critical
	Average	**67,83%**	**Critical**

Based on the table above, it can be seen the results of the analysis of critical thinking skills in students. The analysis results show that in each indicator of critical thinking skills obtained results with an average percentage of 67.83% with critical criteria.

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3.2 DISCUSSION

In this study, the development of test instruments was carried out so that this research product was a critical thinking skills-based test instrument on momentum and impulse material with a total of 8 items that met the feasibility of test instruments. The test instrument was developed based on critical thinking indicators according to Facione. Facione explains the indicators of critical thinking skills, namely interpretation, analysis, evaluation, inference, explanation, and self-regulation (Edi & Rosnawati, 2021). A test instrument is good if it meets the eligibility standards, which include validity, reliability, objectivity, practicality, and economy (Arikunto, 2021).

The development of critical thinking skills test instrument on momentum and impulse material refers to Facione's indicators which require students to provide answers based on sub-indicators of interpreting, analyzing, providing conclusions, providing explanations, evaluating, and self-regulating indicators. Based on the instrument that has been developed, the results of students' critical thinking skills in class XI MIA 1 SMA Negeri 6 Medan are obtained.

Based on table 4.17, it can be seen the results of the analysis of critical thinking skills in students. The analysis results show that in each indicator of critical thinking skills obtained results with an average percentage of 67.83% with critical criteria.

The analysis results show that in the interpretation indicator there are 2 items that get results with an average percentage of 68.85% with critical criteria. In the analysis indicator, there are 2 items that get results with an average percentage of 63.85% with fairly critical criteria. In the evaluation indicator, there were 1 item that obtained results with 66.6% with critical criteria. In the conclusion indicator there is 1 item that gets results with 74.4% with critical criteria. In the explanation indicator there is 1 item that gets results with 65% with fairly critical criteria. In the self-regulation indicator there is 1 item that gets results with 68.3% with critical criteria.

The average result of critical thinking skills of class XI students of SMA Negeri 6 Medan was 67.83% with critical criteria. This can occur because based on the results of observations that have been made students have different learning styles which reveal that students are not familiar with problems that lead to critical thinking. Critical thinking skills in students are still sufficient because in the learning process they still learn by remembering and understanding and in learning they often memorize. Agnafia (2019) also stated that students do not have good

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or insufficient critical thinking skills because they are not familiar with the indicators of critical thinking skills and have not received lessons that apply critical thinking skills.

On the other hand, the test instrument that has been developed to test critical thinking skills on momentum and impulse material has properties that will help improve students' critical thinking skills. One of the advantages of the test instrument is the stimulus of questions that are contextual in nature, which allows students to better understand them in everyday life.

The goal is to train students in critical thinking so that they can be ready to face the challenges of the 21st century and solve problems that arise in the real world. The drawback of this instrument is that the momentum and impulse material has a long interval between the material studied and the research time. This makes it difficult for students to solve problems, Tanjung & Dwiana (2019) explained that it is less effective if there is a long time between the material students learn and the material on the instrument.

4. CONCLUSION

Based on the results of the research and the data that has been obtained, the conclusions of this study with respect to the research objectives that have been formulated are as follows: the process of developing HOTS test instruments based on students' critical thinking skills on momentum and impulse material is carried out using the ADDIE development model. ADDIE is one of the development models consisting of five stages, namely, analysis, design, development, implementation, and evaluation. The feasibility test carried out on the critical thinking skills-based HOTS test instrument on momentum and impulse material is by testing content validity, item validity, reliability, difficulty level, and differentiability. With content validity that obtained an average validation result of 0.99 with valid criteria and feasible to use but in some questions improvements had to be made on the advice of the validator. In the small group trial, the ten items were said to be reliable with, but of the ten items there were 2 invalid questions, the level of difficulty was easy, and the differentiating power was not good so that the two questions were discarded. Furthermore, in the large group trial, the eight items were said to be reliable and valid, but of the ten items there were 2 questions with easy difficulty levels, and poor differentiating power so that the two questions needed to be revised. After going through various tests, 8 critical thinking skills-based test items were produced that met the qualifications of a good instrument so that it could be said that the eight items were suitable for use to train and measure students' critical thinking skills. The results of students' critical

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thinking skills as measured by essay test instruments in this study obtained results with an average of 67.83% with critical criteria.

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