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Analysis of Student's Higher-Order Thinking Skill in Newton's law

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ABSTRACT
This study aims to describe the level of higher-order thinking skills of students. This research is a descriptive study with research subjects, namely 60 students of class XI IPA 1 and XI IPA 2 at SMA N 1 Pagaralam. Data were collected using the HOTS question instrument in the form of a multiple-choice test of Newton's law material. Further data were analyzed using the Rasch modeling analysis. The results of the analysis obtained 44 students according to Rasch capital and 16 students including outliers or misfits. The instrument reliability test results used were 0.95, including the very reliable category. Overall, the results showed that the average ability of students at the level of application, analysis, evaluation, and creation was 35.91 (low), 50.46 (enough), 64.29 (enough), and 21.37 (low). The results obtained indicate that the high order thinking skills of students at SMA N 1 Pagaralam need to be trained through appropriate learning innovations.

Keywords: *Analysis, Higher-order thinking skills, Physics, Newton's law.*

1. INTRODUCTION

The 2013 curriculum wants high quality human resources capabilities. The purpose of the 2013 curriculum not only emphasizes knowledge and skills but emphasizes more on scientific approaches [1]. The 2013 curriculum is expected to produce more productive, creative, innovative, and effective human resources so as to address the challenges of the 21st century.

The 21st century became one of the solutions to answer the challenges of revolution 4.0 in the present era. One of the must-have abilities of the 21st century is high-level thinking ability or commonly called HOTS. Higher Order Thinking Skills is based on the hierarchy of cognitive skills processing [2]. High level thinking ability is one aspect that must be possessed by student [3]. HOTS mean the thinking of students' ability to apply knowledge and skills that have been developed and used to solve a problem [4]. HOTS is very closely related to critical thinking. Critical thinking skills are very developed mainly in science subjects including physics so that learners can analyze and create a variety of more complex concept [5].

The study [6] concluded that there are obstacles faced by students namely in communication, critical way of thinking and problem solving faced by students due to three factors namely the structure of the current education system, the complexity of students' skills and the competence of teachers in teaching. Besides, the results showed that if teachers consciously and continuously practice using high-level thinking learning strategies for example, teaching according to real conditions, encouraging open class discussion and encouraging inquisition learning then it can make students able to think critically [7]. Higher-order thinking skills have a higher level of thinking than memorizing facts or retelling something that is heard[8].

According to a survey conducted by the organization for Economic Cooperation and Development (OECD) using the Programmed for International Student Assessment (PISA) test in 2015, Education in Indonesia ranked 69th out of 76 countries that took PISA tests and Indonesia scored 403 in 2015, this shows the importance of teachers directing students to think highly in order to be able to compete with other countries [9]. The factors that result in high-level thinking skills are still low, namely being poorly trained in solving questions that are demanding analysis,

evaluation and creativity [10]. To solve the problem in physics need to have much deeper thinking process and needs to have analysis process before deciding an issue [11]. The questions that have these characteristics are the questions to measure HOTS [12].

Previous research on high-level thinking skills in physical matter has been conducted by [13], [14], [11]. The difference in research that has been done with previous research lies in how to analyze. The purpose of the study was to find out the high level of thinking ability of students in newton's legal material. This research is a follow-up study with the same theme of high-level thinking skills, but there is a new way of analyzing it is using the Rasch *modeling* and mini step software that will detect if there is a pattern of answers of students who do not match and see the reliability of the question items [15]. Based on this explanation, this research needs to be done because high-level thinking skills in physical matter are very important.

2. METHOD

The method used in this study is a descriptive method. The population in this study is students of class XI IPA at SMA Negeri 1 Pagaralam with a research sample of 2 classes namely class XI IPA 1 and XI IPA 2. Sample retrieval technique using *cluster random sampling*. Data collection techniques in the form of multiple-choice objective tests using HOTS questions. The test results data will be included in the mini step *software* which is one of the series in Rasch modeling. The output in the software is in the *form of Item Measure*, *Person Measure*, *Variable Maps* and Reliability tables that have been converted previously to logit numbers. This logit number must qualify *Outfit Mean Square* (MNSQ), Outfit *Z Standard* (ZSTD), *Point Measure Correlation (Pt Mean Corr)* and Reliability value according to Rasch modeling.

According to [16], the logit numbers obtained from the output of the mini step software, there is an interval scale that explains the state of the number. the scale is:

1. Mean Square outfit valued (MNSQ) accepted: 0.5 < MNSQ < 1.5
2. Z-Standard outfit value (ZSTD) accepted: -2.0 < ZSTD < +2.0
3. Measure Correlation value (Pt Mean Corr): 0.4 < Pt Measure Corr < 0.85

Based on these values students will qualify according to or not with modeling. In addition to *using software* in this study will calculate the percentage of high level of thinking ability as follows.

Table 1. High level of thinking ability [17]

Percentage	Category
0-50%	Low
51%-75%	Enough
76%-87%	Middle
88%-100%	High

3. FINDING AND DISCUSSION

The data analysis was done by describing the value of high-level thinking ability based on four categories, but before searching for the average percentage of researchers first validated and reliability questions to see the quality of the question. Validation and reliability performed using Rasch modeling with the help of mini step. Furthermore, researchers analyzed how many students included *outliers or mifits and respondents* corresponding to Rasch modeling [18]. The advantages of Rasch modeling compared to other methods are being able to predict lost answers, make measurements using logit scale, can predict biased and unbiased data and can predict the distribution of answers and students [4].

Based on a Table of 2 questions used as many as 25 details of physics on the concept of newton law. The *item measure table* can be used for validation in Rasch modeling. This table can provide information in the form of logit number data that shows the quality of the question used. The numbers in the table are analyzed through number intervals on the *Infit and Outfit criteria.* From the results obtained can be concluded the question has been valid in Rasch modeling rules because it already meets the *criteria of Infit and Outfit.* The aspects seen are *the Mean-Square outfit (0.5<MNSQ<1.5), Z-Standard outfit (-2.0<ZSTD<+2.0) and Point Measure Correlation (0.4<Pt Measure Corr<0.85).*

In the table can also be seen the level of difficulty of the question namely in question number 24 is a question that is a high difficulty level because of the 60 students who can answer only 1 learner while the problem whose difficulty level is low or can be said to be easy to find in question number 20 because that can answer as many as 48 students from 60 students. Furthermore, analysis of the individual abilities of students. Analysis is used to identify students who have higher levels of ability possessed by students as well as to see outliers or misfits.

Analysis of the difficulty level of the problem can be seen in Table 2 below.

Table 2. Item Measure

Entry Number	Total Score	Infit		Pt Measure Corr
		MNSQ	ZSTD	
24	1	1.05	0.37	-0.09
17	3	1.00	0.16	-0.09
8	4	1.24	0.67	-0.36
1	5	0.94	-0.06	0.23
6	11	1.14	0.76	0.08
23	16	1.45	2.94	-0.14
25	16	1.08	0.62	0.22
12	17	1.18	1.32	0.19
22	18	0.93	-.51	0.42
2	19	1.16	1.38	0.17
3	22	1.15	1.40	0.22
11	26	1.20	1.82	0.26
16	35	0.73	-2.19	0.69
13	37	1.04	0.31	0.47
10	40	1.00	0.03	0.48
14	41	0.64	-2.38	0.75
5	45	0.80	-1.05	0.63
9	46	1.01	0.11	0.51
18	46	0.80	-1.01	0.64
4	47	0.73	-1.34	0.67
15	47	0.59	-2.26	0.70
19	47	0.62	-2.02	0.73
21	47	0.68	-1.69	0.70
73	48	0.61	-2.01	0.74
20	48	0.61	-2.06	0.75
MEAN	2.93	0.94	-0.3	
P.SD	16.7	0.24	1.4	

The level of ability of students can be seen in table 3. Based on a Table of 3 the highest abilities are possessed by 60 students with a logit value of 2.56 and the lowest ability possessed by students 24, 27, 57 and 59 with a logit value of -2.89. if there is the same logit value, indicating the same raw score and the same ability. However, to be able to determine which students have the highest abilities can be seen through the scalogram table. Scalogram's can systematically sort item difficulty levels. Through the scalogram will also see which students have high abilities even though they have the same logit value. Scalogram can also detect if there is a pattern that does not match Rasch modeling that is from the answer pattern, students can answer difficult question category questions while easy questions cannot be answered [4]. Furthermore, the same pattern of answers among students is read by Rasch modeling system. The order of students who have criteria does not match the Rasch modeling as follows.

Table 3. Person Measure

Entry Number	Total Score	Total Count	Measure
60	20	25	2.18
43	18	25	1.44
45	18	25	1.44
49	18	25	1.44
37	17	25	1.11
47	17	25	1.11
5	16	25	0.80
7	16	25	0.80
20	16	25	0.80
34	16	25	0.80
54	16	25	0.80
1	15	25	0.51
2	15	25	0.51
3	15	25	0.51
9	15	25	0.51
29	9	25	-1.08
32	9	25	-1.08
41	8	25	-1.34
21	7	25	-1.61
31	7	25	-1.61
44	7	25	-1.88
14	6	25	-1.88
38	6	25	-1.88
39	6	25	-2.18
55	5	25	-2.18
56	5	25	-2.89
24	3	25	-2.89
27	3	25	-2.89
57	3	25	-2.89
59	3	25	-2.89
P.SD	4.3	0.0	1.19

Based on Table 4 above found there are 16 students classified as *outliers or misfits* while 44 students are classified as students who are already following Rasch modeling. Students 32P2, 01L2, 03P2, 16P2, 14P1, 10P2,11P2, 27P1, 29P2 and 31L2 are students classified as outliers because the answer pattern is not appropriate, difficult questions can be worked on while easy questions cannot be answered. Furthermore, students 09P1 and 29P1 were found to have the same answer pattern which means indicated to cooperate between students in answering questions as well as students 27P1 and 29P2. The advantage of Scalogram on Rasch modeling is that it can see the causes of outliers such as students can answer difficult question category questions while easy questions cannot be answered. Furthermore, there is a pattern of answers between students read by Rasch modeling system which means there are indications that students work together in answering questions. Furthermore, the reliability test of HOTS test items using Cronbach alpha value is the interaction between person and question item.

Table 4. Scalogram

Person	Item
	72411291511111322122618120 591 8 40361 2235 74
60	11111111111111101110111010
43	11111111111111111100100000
45	11111111111111111110000000
49	11111111110110110101011000
37	11111111111010111010100000
47	11111111111111100001110000
5	11111111111111100101000000
7	11111111111111100101000000
20	11111111111111011100000000

34	11111111111111011100100000
54	11111111111111100010100000
1	11111111111111000001001000
2	11111111111111100100000000
3	11111111111111100100000000
9	11111111111111110000000000
29	00001000000110001001111101
32	01111101110000010000000000
41	10010001100101100010000000
21	01010101101100000000000000
31	10000100000001011110000000
44	10101010011000000000010000
14	10101010000000001000100000
38	00000110000001010101000000
39	00000000000100000011100100
55	00000011000000000001000110
56	00000011000000000001000110
24	00000000101000000000000000
27	01000010000000010000000000
57	00000000000001100010000000
59	00000000001000010000010000

In summary measured person and summary measured item can be seen the reliability value of the learner is 0.79 and the item is 0.95 which indicates that the problem has good reliability so that it is able to measure what it wants to measure. Based on research that has been conducted using 25 question instruments about the multiple choice of legal material newton has tested reliability and declared reliable then the instrument is declared worthy to be used to measure the high level of thinking ability of students of newton legal material. Furthermore, based on the results of the study showed that the percentage of high-level thinking ability of newton legal material students with an average score of 43.01 is in the low category. Furthermore, this study was classified based on indicators of high-level thinking ability that at the C3 level obtained an average value of 35.91 that fell into the low category, at the C4 level obtained an average value of 50.46 that fell into the category enough, at the C5 level obtained an average value of 64.29 which entered the category enough and level C6 obtained an average value of 21.37 which fell into the low category.

Table 5. Description of students' high level of thinking skills

Category	C3	C4	C5	C6
Average value	35.91	50.46	64.29	21.37
Minimum value	0.00	14.29	0.00	0.00
Maximum value	85.71	85.71	85.71	75.00
Standard deviation	17.03	20.79	27.89	20.15

In the C3 level indicator, the average score obtained was 35.91 out of 60 students and entered into the category average. The minimum value at level C3 is 0, the maximum value is 85.71 and the default deviation value is 17.03. At the C3 thinking level, 49 out of 60 students had very low category high thinking skills and 9 out of 60 moderate category students and 2 out of 60 moderate category students.

In the C4 level indicator, the average score obtained was 50.46 out of 60 students and entered into the category simply accordingly. The minimum value at level C4 is 14.29, the maximum value is 85.71 and the standard deviation value is 20.79. At the C4 level, 28 out of 60 students had very low category high thinking skills, 27 out of 60 moderate category students and 5 out of 60 moderate category students.

In the C5 level indicator, the average score obtained was 64.29 out of 60 students and entered into the category simply accordingly. The minimum value at level C5 is 0.00, the maximum value is 85.71 and the standard deviation value is 27.89. At the C5 level, 13 out of 60 students had very low category high thinking skills, 20 out of 60 moderate category students and 27 out of 60 moderate category students.

In the C6 level indicator, the average score obtained was 21.37 out of 60 students and entered into the category simply accordingly. The minimum value at level C6 is 0.00, the maximum value is 75.00 and the default deviation value is 20.15. At the C6 level, 59 of the 60 students in the category were very low and 1 in 60 students in the category was sufficient. The results of the study conducted are the same as the previous research, According to the study [13] the results of data analysis can be concluded that HOTS-based physics learning planning that has been compiled by physics teachers at SMA Negeri 1 Margaasih for the cognitive realm creates only 18% while remembering by 70%. [14] the results showed the ability to analyze only 17% of the high level of thinking ability of students in central Bengkulu regency belongs to the moderate category. While according to the study [11] the results of the study in Madrasah Aliyah Yogyakarta showed that the high level of thinking skills of students belongs to a low category.

Overall, the average score obtained from 60 students who were at SMA Negeri 1 Pagaralam 43.01 entered the low category. The low ability to think high levels of students is suspected to be a factor that affects it, i.e. students are less prepared to learn. This is evident from the lack of initiative of students in learning, when learning is still a lot of playful [9]. In addition, students are less persistent in resolving the error. This supports research [19] regarding the analysis of the high level of thinking ability of students. The next factor that results in low level of thinking ability of students is the learning process experienced by the learners themselves. This is related to how teachers teach and how learners learn. Most teachers still do not understand effective and appropriate defense strategies to achieve learning goals or improve students' thinking skills. As a result, there is a tendency in teachers to do learning simply by transferring the material they know from the book to the learner.

Based on some of the results of the study the ability to think high levels of students on the material physics factor that affects the ability of students in solving questions. In solving the problem students do the thought process so that they are able to find an answer. The thought process of each learner varies, because each learner has different characters so that the intelligence of the learner also varies. The ability of students to solve problems is very much related to the thought process. The thought process of students in solving problems is characterized by the activities of thinking carried out [20]. The activity of thinking students when solving a problem is seen in the results of the work done., the work steps written in solving the problem and the demands of the answers given. At the time of completing the problem each learner has different thought processes according to their abilities so that there are different mindset characteristics in each category even in each learner.

Therefore, the results of the analysis of the high-level thinking ability of students of SMA Negeri 1 Pagaralam newton legal material, showing an average percentage of 43.01% who fell into the category of low or have not shown that students have a high level of thinking ability so need to be trained through proper learning innovation.

4. CONCLUSION

Based on the analysis and discussion above can be concluded there are 44 students according to Rasch modeling 16 students including *outliers* or *misfits.* The results of the instrument reliability test used at 0.95 belong to a very reliable category. Overall, the results showed that the average high level of thinking ability of students at the level of application, analysis, evaluation, and creation was 47.38 (low), 62.14 (enough), 65 (enough), and 20.82 (low). The results showed that the high-level thinking skills of students at SMAN 1 Pagaralam need to be trained through appropriate learning innovations.

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