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Development of Physics Laboratory Assistance to Improve Higher Order Thinking Skills in Simple Harmonic Motion for High School Students

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ABSTRACT
This study aims to (1) produce Physics Laboratory Assistance (PLA) that is suitable for use, (2) determine the percentage of Higher Order Thinking Skills (HOTS) using PLA, (3) describe students' HOTS using Rasch modelling analysis, (4) determine the effectiveness of students' HOTS on simple harmonic motion materials in learning. This type of research was research and development (R&D) adapted according to the Borg & Gall model. Data collection used interviews, questionnaires, and test methods. The subjects in this research were students of class X IPA1 MA Ushuluddin Singkawang, X IPA1 and X IPA2 SMAN 1 Selakau. The instrument was declared to be valid in terms of content and empirically by following the analysis of Rasch modelling with the help of the Winstep 3.37 program. The results of the content validation showed that PLA was feasible to use with an average score of 3.61 in the excellent category. The percentage of HOTS of students was analyzed using the Microsoft Excel application in the extensive trial of the experimental class and the control class with an average pretest score of 38.90 and posttest of 39.90. The description of the student's HOTS was analyzed using Rasch modelling, it was obtained that the ability to evaluate is the ability that is most mastered by the student, then create and analyze. The effectiveness of HOTS in students was known to use PLA in learning using effect size obtained in a limited trial of 0.14 and a broad trial of 0.15 with a low category.

INTRODUCTION

Physics, including the Natural Sciences (IPA) family, can be seen as scientific processes, products, and attitudes. Physics as a process includes the skills possessed by scientists to acquire and develop knowledge where they are not only understanding but also willing to analyze, evaluate, and create something. Physics as a product includes a set of knowledge consisting of facts, concepts, principles, laws and theories. Physics as a scientific attitude includes the preparation of physical knowledge that begins with creative activities such as observation, measurement, and investigation or experiment, all of which require mental processes and attitudes derived from thought. Therefore, physics is important to learn, but students often have difficulty understanding physics concepts, especially in physics problems that require inference (Rahayu, 2014). Inference skills are closely related to HOTS skills, which include the ability to analyze, evaluate and create. This ability is not mastered by students in physics subjects, so many students have learning outcomes that tend to be low.

The low achievement of physics learning outcomes can be seen from the results of the national exam in West Kalimantan in 2015 with an average score of 54.69, chemistry 58.55, and biology 55.37 with a maximum score of 100 (Ministry of Education and Culture, 2015). In addition, the results of Ramos et al. (2013) research show that there is a relationship between students' HOTS and academic achievement in the field of physics by examining the physics problem-solving ability of students who are part of HOTS. Based on the data and results of the study, it also shows that many students have difficulties in learning and understanding physics concepts and students' ability to solve physics problems is still not optimal due to the weak HOTS of students.

The weakness of students' physics HOTS can be proven through the findings of Arifiyanti (2016) who researched the physics HOTS of high school students in West Kalimantan in five schools and produced data on student HOTS, namely SMAN 7 Pontianak (50.7%), SMAN 1 Sungai Raya (55.8%), SMAN 1 Mempawah (52.3%), SMAN 3 Singkawang (51.1%), and SMAN 1 Pemangkat (51.4%). Based on the results of the preliminary survey, the HOTS of students in West Kalimantan is relatively low with an average percentage score of 52.26% which shows that the ability of HOTS physics is still relatively low.

In addition, based on the results of the PISA (Program for International Student and Assessment) study on the education system and the ability of students at school. The results of the PISA survey found that Indonesia scored 386 for mathematics, 397 for reading and 403 for science, the data shows that Indonesia's score was 62nd out of a total of 70 countries that participated in the PISA study in 2015 (OECD, 2015). A similar survey from TIMSS (Trends International and Science Study) and PIRLS (Progress in International Reading Literacy Study) in 2011 also placed Indonesia at 39th out of 43 countries (TIMSS & PIRLS, 2011). The two surveys above are surveys of students' ability to use test questions whose realm of thinking leads to HOTS ability.

A preliminary survey that has been conducted by researchers related to the increase in HOTS Hugeret and Kortam (2014) researched the increase in HOTS through a science and inquiry approach which found that an average of 82% of students' HOTS ability increased. Ya-Ting and Carolyn (2015) researched the increase in HOTS of students using the digital game approach which found that 68% of students who had HOTS below average ability could be improved by being given media in the form of digital games. Kuldas et al. (2014) researched the importance of students in Malaysia to improve HOTS, finding that students' backgrounds greatly affect their ability to complete cognitive tasks.

Several studies reveal the difficulties of students in understanding simple harmonic motion, including research conducted by Yeyen et al. (2016) shows that many students still have difficulty in mathematical representation, reading and describing position graphs over time and determining the factors that affect the spring and pendulum periods. Students also have difficulty in determining the change in direction of the insulated object (Pernafes, 2010). From some of these studies, it can be concluded that in simple harmonic motion material, there are still many students who experience difficulties, for this reason, there is a need for other methods in physics learning, one of which is practicum activities.

Practicum activities cannot be separated from physics learning, this is because practicum can strengthen the concepts and knowledge obtained from classroom learning. However, in reality, practicum activities are still rarely applied in physics learning in the classroom. This can be proven from the results of interviews with physics teachers at SMAN 1 Selakau who said that in teaching and learning activities, teachers still rarely apply learning in the form of practicum and more often use the lecture method. Therefore, researchers want to develop a tool called Physics Laboratory Assistance (PLA).

From several preliminary surveys, research on PLA has still not been conducted. Researchers only obtained research on the impact of physics laboratories in the Western Ethiopian area and found that physics laboratories can help students teach physics learning in high school (Godwin et al., 2015). In addition, research by Thomas et al. (2018) on students' perception of changes in the learning environment of the physics laboratory found that the size effect was 0.70 and 1.20 which showed that there were significant positive changes in students about the dimensions of the learning environment in the physics laboratory.

The PLA developed is a package of practicum guides and tools that can be used to carry out practicum activities in the physics learning process. In the PLA there are objectives, how to use, tools and materials to conduct practicum as well as evaluation questions for HOTS capabilities, which consist of the ability to analyze, evaluate and create. The physical material in PLA is made in simple harmonic motion on simple pendulum swings and springs. PLA is also equipped with HOTS pretest and posttest questions that are used to analyze the development of HOTS.

Therefore, based on the background of the above problem, learning to use practicum tools to improve students' HOTS abilities still needs to be done because it is still rarely used, so research aimed to (1) produce Physics Laboratory Assistance (PLA) that is suitable for use, (2) determine the percentage of Higher Order Thinking Skills (HOTS) using PLA, (3) describe students' HOTS using Rasch modelling analysis, (4) determine the effectiveness of students' HOTS on simple harmonic motion materials in learning.

RESEARCH METHOD

This research is research and development known as R&D (Research & Development). The development model used is a development model adapted according to Borg & Gall (Sugiyono, 2015) which consists of 10 stages, namely collecting information, making a research design that includes research objectives, estimating and time costs required and compiling research work procedures, developing initial products, conducting preliminary field trials (limited trials), revising the main product, conducting major field trials (extensive trials), revising the main field trials, conducting operational field tests, revising the final product and disseminating products.

In this study, the researcher only carried out six stages, namely only until the trial was widespread. In a limited trial, the researcher tested the initial product at the school studied at MA Ushuluddin Singkawang. This is intended that the researcher only looks at the feasibility of the product based on the assessment of physics lecturers and teachers. Research data was collected using expert validation sheets, teacher interview sheets, tests, and questionnaires. Meanwhile, the researcher tested the product at SMAN 1 Selakau in two classes, namely the experimental class and the control class.

The researcher used two types of data collected, namely: (1) qualitative data, namely data in the form of interviews with physics teachers, validation and responses from lecturers and physics teachers; (2) quantitative data, namely data consisting of HOTS evaluation tests, validation and student response questionnaires. The data analysis technique for PLA validation on simple harmonic motion materials is carried out with the following steps: (1) summing the scores of validators for each component in PLA; (2) calculate the average total score of each component scored by validators using equation (1).

$$X = \frac{\sum X}{n} \quad (1)$$

Information:
X = Average score
$\sum X$ = Total Score
n = Number of items in the rated component

(3) Converting scores using categorization can be seen in Table 1.

Table 1. Categorization of Eligibility Scores by Validators

Interval		Category
$X \geq \underline{X} + 1.\ SB_X$	$X \geq 3{,}0$	Very Good
$\underline{X} + 1.\ SB_X > X \geq \underline{X}$	$2{,}5 \leq X \leq 3{,}0$	Good
$\underline{X} > X \geq \underline{X} - 1.\ SB_X$	$2{,}0 \leq X \leq 2{,}5$	Enough
$X < \underline{X} - 1.\ SB_X$	$X \leq 2{,}0$	Bad

(Djemari Mardapi, 2018;123)

Information:
$\underline{X}$ = Average score obtained
SB_X = Overall score standard deviation
X = Score collection

The percentage of HOTS of students was analyzed using Microsoft Excel using equation (2).

$$\textit{Aspects of HOTS} = \frac{X}{Y} \times 100\% \tag{2}$$

Information:
X = The number of HOTS question score weights for all students
Y = The number of maximum grade weights of HOTS question items for all students

The description of HOTS in this study uses Rasch modelling analysis of Winsteps software version 3.73 with data in the form of polytomy data (Sumintono & Widhiarso, 2015; 89). Meanwhile, to find out the effectiveness of HOTS, students use the equation effect size formula (3).

$$ES = \frac{\underline{Y_E} - \underline{Y_C}}{\underline{S_C}} \tag{3}$$

(Sutrisno et al., 2007)

Information:
ES = Effect size
$\underline{Y_E}$ = Average score of the experimental group
$\underline{Y_C}$ = Average value of the comparison group
$\underline{S_C}$ = Standard deviation of the comparison group

RESULTS AND DISCUSSION

The feasibility test of PLA products in this study was validated by two physics education lecturers and one physics teacher. Validation in the study uses a Likert-scale questionnaire in the form of quantitative data which is then converted into qualitative data that follows scoring references and criteria can be seen in Fig. 1.

Fig. 1 shows that the validation of the average score of Lecturer I on the HOTS evaluation test sheet is 3.27, the HOTS evaluation test score sheet is 3.57, PLA is 3.57 and the student response questionnaire is 3.80 with the "very good" criteria. The validation of the average score of Lecturer II on the HOTS evaluation test sheet was 3.57, the HOTS evaluation test score sheet was 3.61, PLA 3.42 and the student response questionnaire was 3.84 with the criteria of "very good". Meanwhile, the average validation score of physics teachers on the HOTS evaluation test sheet was 3.71, the HOTS evaluation test score sheet was 3.61, PLA was 3.57 and the student response questionnaire was 3.82 with the criteria of "very good".

The results of the percentage increase in students' HOTS in the limited and extensive trials can be seen in Fig. 2. Based on data on the limited trial at MA Ushuluddin Singkawang, a pretest score of 38.85 and a posttest of 39.90 and a broad trial at SMAN 1 in the experimental class obtained a pretest of 42.80 and a posttest of 45.60.

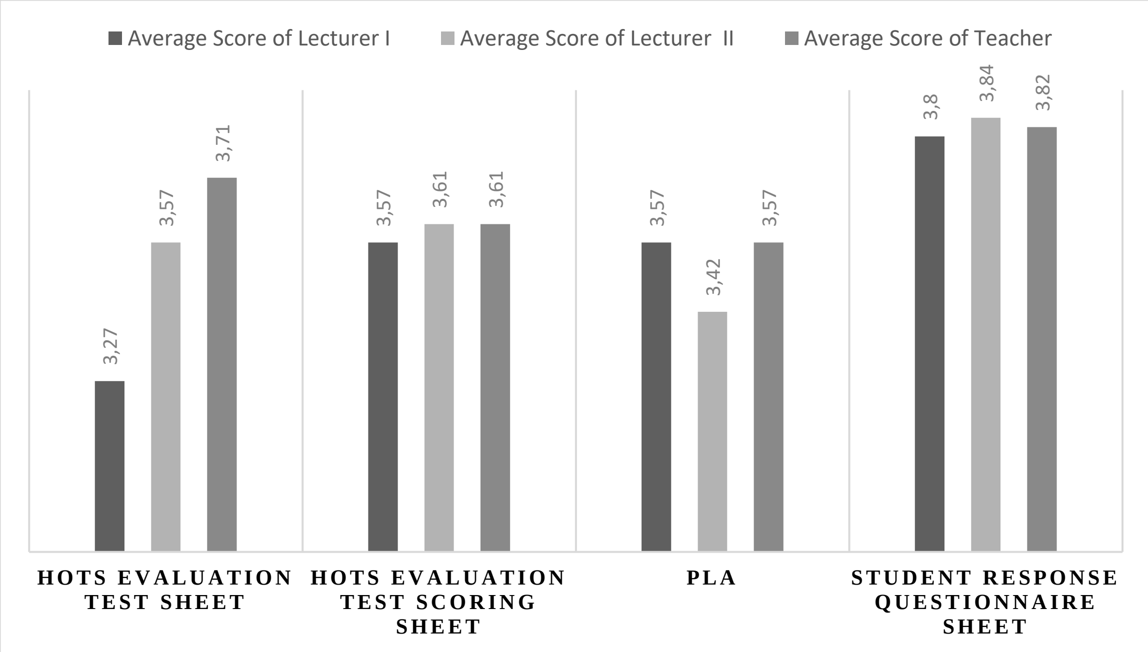

Fig. 1 *PLA product Feasibility Results by Validator*

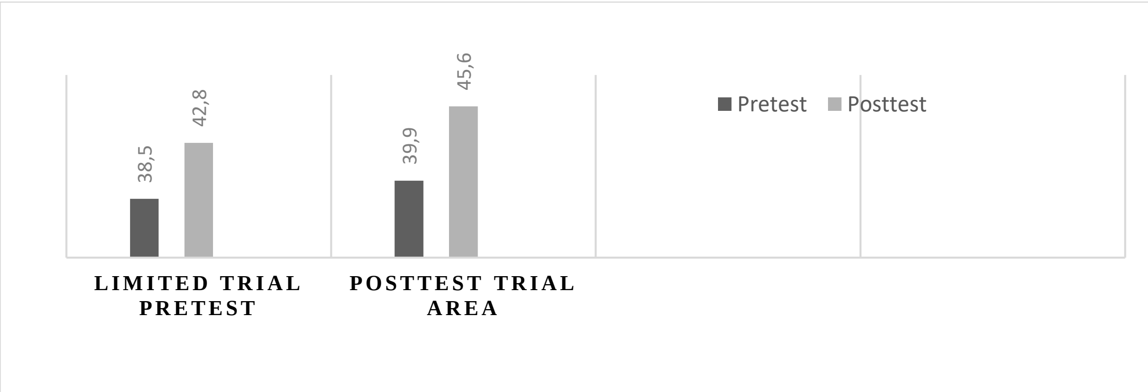

Fig. 2 *Percentage Increase in HOTS in Limited and Extensive Trials*

The description of the HOTS of students using PLA was obtained from the results of the analysis of post-test question items. The analysis of the question items used Rasch modelling analysis assisted by the Winsteps 3.73 application. The results of the data analysis will be described including the distribution of the difficulty level of the question items, the distribution of the ability level of students, and the distribution of the level of individual suitability to their abilities.

Distribution of Difficulty Item Measure

Based on the item analysis using Rasch modelling analysis assisted by the Winsteps 3.73 application, the distribution of the difficulty level of the question items shown by the item measure table was obtained. The table of item measures that shows the difficulty level of the question item can be seen in Fig. 3.

In the table, there is an entry number column that sorts questions based on their level of difficulty, namely based on item measure (4th logit item). The rightmost column (item) describes the name of the question item entered earlier. The question items in the table are sorted by logit value from the largest (2nd question) to the smallest logit (6th question). In the item measure, there is also information on the standard deviation value (1.71). If the value is combined with the mean value of the logit, the difficulty level of the item can be combined. For example, 0.0 logit +1 SD is a group of difficult questions, greater than +1 SD is a very difficult problem, 0.0 logit -1 SD is an easy problem; and smaller than -1 elementary school is a very easy question. This means that there are four groups of questions based on the level of difficulty. In the table, item E2 has a logit value of 1.27 which is a very difficult problem. Items E7, E5 and E9 with logit values of 0.50, 0.15, and 0.01 are classified as difficult problems. Items E8, E4, E1, E3 and E6 with logit values of -0.07, -0.035, -0.39, -0.51 and -0.62 are relatively easy questions. So, from the table, it can be concluded that there are 1 question classified as very difficult, 3 questions classified as difficult and 5 questions classified as easy.

TABLE 13.1 data eksperimen ZOU560WS.TXT Jul 9 10:04 2018
INPUT: 34 Person 9 Item REPORTED: 34 Person 9 Item 4 CATS WINSTEPS 3.73

Person: REAL SEP.: .00 REL.: .00 ... Item: REAL SEP.: 1.97 REL.: .79

Item STATISTICS: MEASURE ORDER

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item
2	39	34	1.27	.43	1.11	.4	1.34	.7	.12	.14	88.2	87.2	E2
7	46	34	.50	.27	1.27	.8	1.07	.3	.39	.23	76.5	66.8	E7
5	52	34	.15	.22	.73	-.9	.70	-.9	.36	.27	50.0	53.4	E5
9	55	34	.01	.21	.89	-.3	.81	-.5	.54	.29	55.9	47.4	E9
8	57	34	-.07	.20	1.08	.4	.96	.0	.33	.30	11.8	37.4	E8
4	65	34	-.35	.18	.38	-3.8	.36	-3.6	.42	.33	70.6	29.0	E4
1	66	34	-.39	.18	1.42	1.9	1.40	1.6	.31	.33	14.7	29.1	E1
3	70	34	-.51	.17	.75	-1.3	.83	-.8	.10	.34	41.2	28.2	E3
6	74	34	-.62	.17	1.60	2.9	1.62	2.8	.19	.35	8.8	28.3	E6
MEAN	58.2	34.0	.00	.22	1.03	.0	1.01	.0			46.4	45.2	
S.D.	10.9	.0	.56	.08	.36	1.8	.37	1.7			27.9	19.6	

TABLE 13.3 data eksperimen ZOU560WS.TXT Jul 9 10:04 2018
INPUT: 34 Person 9 Item REPORTED: 34 Person 9 Item 4 CATS WINSTEPS 3.73

Item CATEGORY/OPTION/DISTRACTOR FREQUENCIES: MEASURE ORDER

Fig. 3 *Screenshot Output of Item Measure*

Distribution of Student Ability Level (Person Measure)

The distribution of the level of ability of students, analyzed with Rasch modelling assisted by the Winsteps 3.73 application is shown in the person measure table. The person-measure table that shows the distribution of students' ability levels can be seen in Fig. 4.

Person STATISTICS: MEASURE ORDER

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Person
28	21	9	-.19	.33	1.40	1.2	1.37	.9	.27	.45	22.2	33.0	28PD
15	20	9	-.30	.33	1.01	.2	1.06	.3	.25	.44	22.2	33.0	15LD
23	20	9	-.30	.33	1.02	.2	1.19	.6	.15	.44	33.3	33.0	23PD
25	20	9	-.30	.33	.66	-1.0	.61	-.9	.69	.44	44.4	33.0	25PD
24	19	9	-.41	.33	.80	-.5	.74	-.5	.46	.42	44.4	33.5	24PD
19	18	9	-.52	.34	1.22	.7	1.06	.3	.39	.40	44.4	33.8	19LD
31	18	9	-.52	.34	.82	-.4	.92	.0	.20	.40	33.3	33.8	31PD
13	17	9	-.64	.35	.54	-1.3	.59	-.7	.46	.38	66.7	39.0	13PD
1	16	9	-.77	.37	1.14	.5	.99	.2	.38	.35	44.4	39.6	01PD
5	16	9	-.77	.37	1.14	.5	.99	.2	.38	.35	44.4	39.6	05PD
17	16	9	-.77	.37	1.14	.5	.99	.2	.38	.35	44.4	39.6	17LD
18	16	9	-.77	.37	1.14	.5	.99	.2	.38	.35	44.4	39.6	18PD
29	16	9	-.77	.37	1.14	.5	.99	.2	.38	.35	44.4	39.6	29PD
30	16	9	-.77	.37	.74	-.5	.79	-.2	.33	.35	55.6	39.6	30LD
10	15	9	-.92	.39	1.47	1.0	1.84	1.3	-.06	.33	11.1	44.3	10LD
16	15	9	-.92	.39	1.02	.2	1.32	.7	.09	.33	44.4	44.3	16LD
22	15	9	-.92	.39	.86	-.1	.66	-.4	.52	.33	44.4	44.3	22PD
34	15	9	-.92	.39	.81	-.2	.77	-.2	.39	.33	55.6	44.3	34PD
2	14	9	-1.08	.42	1.14	.4	.84	.0	.43	.30	44.4	49.4	02PD
3	14	9	-1.08	.42	1.14	.4	.84	.0	.43	.30	44.4	49.4	03PD
7	14	9	-1.08	.42	1.14	.4	.84	.0	.43	.30	44.4	49.4	07LD
8	14	9	-1.08	.42	1.41	.8	4.06	2.8	-.43	.30	44.4	49.4	08PD
9	14	9	-1.08	.42	1.37	.8	1.19	.5	.24	.30	44.4	49.4	09LD
20	14	9	-1.08	.42	1.14	.4	.84	.0	.43	.30	44.4	49.4	20LD
21	14	9	-1.08	.42	1.14	.4	.84	.0	.43	.30	44.4	49.4	21PD
32	14	9	-1.08	.42	1.10	.4	.78	-.1	.47	.30	66.7	49.4	32PD
4	13	9	-1.28	.47	1.60	1.0	1.89	1.2	.12	.27	44.4	55.4	04PD
6	13	9	-1.28	.47	.76	-.2	.59	-.3	.42	.27	55.6	55.4	06PD
11	13	9	-1.28	.47	.76	-.2	.59	-.3	.42	.27	55.6	55.4	11PD
12	13	9	-1.28	.47	.76	-.2	.59	-.3	.42	.27	55.6	55.4	12PD
14	13	9	-1.28	.47	.76	-.2	.59	-.3	.42	.27	55.6	55.4	14PD
26	13	9	-1.28	.47	.76	-.2	.59	-.3	.42	.27	55.6	55.4	26PD
27	13	9	-1.28	.47	.76	-.2	.59	-.3	.42	.27	55.6	55.4	27PD
33	12	9	-1.53	.54	.99	.3	.77	.0	.38	.23	77.8	66.7	33PD
MEAN	15.4	9.0	-.90	.40	1.02	.2	1.01	.1			46.4	45.2	
S.D.	2.4	.0	.34	.05	.25	.5	.62	.7			12.5	8.7	

Fig. 4 *Screenshot of the Distribution of Students' Ability Level*

In the polytomy data, there is a total score column, which is the maximum number of scores obtained by students. With 9 question items and each item has a maximum score of 4, the maximum score for the test as a whole is 36, and the minimum score is 1. On the other hand, the total count column states how many questions are worked on by students. If the number is 9, it means that everything is done by the student; However, if it is less than 9, it indicates that the data is missing. This means that students do not answer all the questions. The measured column expresses the level of capability in logit units. In the table above, the highest ability is owned by 28PD (measure = -0.19 logit) to the lowest ability is owned by 33PD (measure = -1.53 logit). If the logit value is the same, it shows the same raw score (total score) as well as the same ability. However, to be able to determine which students have high ability, it can be known through a scalogram. Scalograms rank the difficulty level of the question items systematically. Through the scalogram, it will be seen which students have higher abilities even though they have the same logit value. The same thing is found if students who do not disagree about response patterns are following the ideal model.

Distribution of Individual Suitability Levels for Their Abilities (Person Fit Order)

Based on the analysis of question items using Rasch modelling analysis assisted by winsteps 3.73, the pattern of students' responses to the question items they answered was obtained. This response pattern can be seen in the person fit order table. The table of person fit orders that show the distribution of the individual's level of conformity to the HOTS can be seen in Fig. 5.

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Person STATISTICS: MISFIT ORDER

ENTRY NUMBER	TOTAL SCORE	TOTAL COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PT-MEASURE CORR.	PT-MEASURE EXP.	EXACT MATCH OBS%	EXACT MATCH EXP%	Person
8	14	9	-1.08	.42	1.41	.8	4.06	2.8	A-.43	.30	44.4	49.4	08PD
4	13	9	-1.28	.47	1.60	1.0	1.89	1.2	B .12	.27	44.4	55.4	04PD
10	15	9	-.92	.39	1.47	1.0	1.84	1.3	C-.06	.33	11.1	44.3	10LD
28	21	9	-.19	.33	1.40	1.2	1.37	.9	D .27	.45	22.2	33.0	28PD
9	14	9	-1.08	.42	1.37	.8	1.19	.5	E .24	.30	44.4	49.4	09LD
16	15	9	-.92	.39	1.02	.2	1.32	.7	F .09	.33	44.4	44.3	16LD
19	18	9	-.52	.34	1.22	.7	1.06	.3	G .39	.40	44.4	33.8	19LD
23	20	9	-.30	.33	1.02	.2	1.19	.6	H .15	.44	33.3	33.0	23PD
1	16	9	-.77	.37	1.14	.5	.99	.2	I .38	.35	44.4	39.6	01PD
2	14	9	-1.08	.42	1.14	.4	.84	.0	J .43	.30	44.4	49.4	02PD
3	14	9	-1.08	.42	1.14	.4	.84	.0	K .43	.30	44.4	49.4	03PD
5	16	9	-.77	.37	1.14	.5	.99	.2	L .38	.35	44.4	39.6	05PD
7	14	9	-1.08	.42	1.14	.4	.84	.0	M .43	.30	44.4	49.4	07LD
17	16	9	-.77	.37	1.14	.5	.99	.2	N .38	.35	44.4	39.6	17LD
18	16	9	-.77	.37	1.14	.5	.99	.2	O .38	.35	44.4	39.6	18PD
20	14	9	-1.08	.42	1.14	.4	.84	.0	P .43	.30	44.4	49.4	20LD
21	14	9	-1.08	.42	1.14	.4	.84	.0	Q .43	.30	44.4	49.4	21PD
29	16	9	-.77	.37	1.14	.5	.99	.2	q .38	.35	44.4	39.6	29PD
32	14	9	-1.08	.42	1.10	.4	.78	-.1	p .47	.30	66.7	49.4	32PD
15	20	9	-.30	.33	1.01	.2	1.06	.3	o .25	.44	22.2	33.0	15LD
33	12	9	-1.53	.54	.99	.3	.77	.0	n .38	.23	77.8	66.7	33PD
31	18	9	-.52	.34	.82	-.4	.92	.0	m .20	.40	33.3	33.8	31PD
22	15	9	-.92	.39	.86	-.1	.66	-.4	l .52	.33	44.4	44.3	22PD
34	15	9	-.92	.39	.81	-.2	.77	-.2	k .39	.33	55.6	44.3	34PD
24	19	9	-.41	.33	.80	-.5	.74	-.5	j .46	.42	44.4	33.5	24PD
30	16	9	-.77	.37	.74	-.5	.79	-.2	i .33	.35	55.6	39.6	30LD
6	13	9	-1.28	.47	.76	-.2	.59	-.3	h .42	.27	55.6	55.4	06PD
11	13	9	-1.28	.47	.76	-.2	.59	-.3	g .42	.27	55.6	55.4	11PD
12	13	9	-1.28	.47	.76	-.2	.59	-.3	f .42	.27	55.6	55.4	12PD
14	13	9	-1.28	.47	.76	-.2	.59	-.3	e .42	.27	55.6	55.4	14PD
26	13	9	-1.28	.47	.76	-.2	.59	-.3	d .42	.27	55.6	55.4	26PD
27	13	9	-1.28	.47	.76	-.2	.59	-.3	c .42	.27	55.6	55.4	27PD
25	20	9	-.30	.33	.66	-1.0	.61	-.9	b .69	.44	44.4	33.0	25PD
13	17	9	-.64	.35	.54	-1.3	.59	-.7	a .46	.38	66.7	39.0	13PD
MEAN	15.4	9.0	-.90	.40	1.02	.2	1.01	.1			46.4	45.2	
S.D.	2.4	.0	.34	.05	.25	.5	.62	.7			12.5	8.7	

Fig. 5 *Screenshot of the Distribution of Individual's Suitability Level for Their Abilities*

In the image above, sorting the level of incompatibility with the model, there are three students whose response patterns are considered unfit, namely 08PD, 04PD and 10LD students. The Outfit Mean Square score of 08PD, 04PD and 10PD students outside the accepted limit is 4.06, 1.89, 1.84, and Z-standard 08PD is 2.8, while the accepted limit is less than +2.0. This also indicates the inconsistency of students and the inconsistency of the answers given with their abilities. Information on this unusual response pattern can be found further by looking at the scalogram. Through this Guttman matrix, the direct cause of why the response pattern does not match the model will be known. The detection of any discrepancies with the model is easily predicted by the scalogram. It can be seen that students 08PD, 04PD and 10PD cannot do questions with easy difficulty, but cannot do difficult problems and it can be stated that these students 01PD, 05PD, 17LD, 18PD, 29PD, 02PD, 03PD, 07LD, 20LD, 21PD, 32PD, 06PD, 11PD, 12PD, 14PD, 26PD and 27PD can be suspected of cheating on each other because they have the same item score on the question.

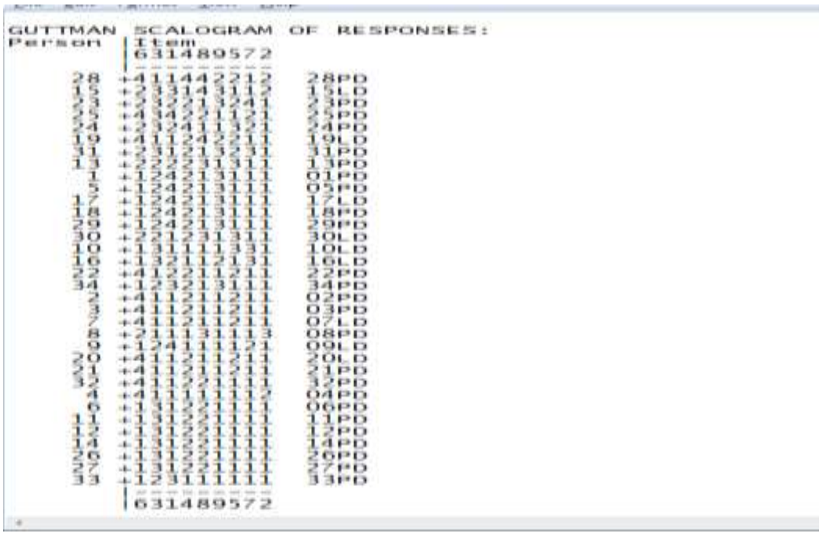

Fig. 6 *Scalogram*

The results of the analysis of research data showed that most of the students were weak in evaluation skills. This is evidenced by the most difficult question items and a lot of students who answer incorrectly shown by the question items with codes E2, E5, E7 and E2 are the most difficult of all the question items that are evaluating questions. The highest HOTS ability is shown in the ability to analyze where almost some students answer correctly only because some students answer less carefully in doing the questions. This is evidenced by the number of students who answered correctly with the codes E1, E3, and E6 where E1 and E6 of all question items are the ability to analyze, then followed by the ability to create.

The effectiveness of students in a limited and extensive trial using effect size with the help of Microsoft Excel can be seen in Table 2. Based on Table 2, it was found that the average HOTS pretest score in the limited trial conducted at MA Ushuluddin Singkawang was 38.85 and the posttest was 39.90 with an effect size value of 0.14 with a low category. Meanwhile, in the extensive trial conducted at SMAN 1 Selakau, a pretest of 42.80 and a posttest of 45.60 with an effect size of 0.15 with a low category. The cause of the low effectiveness of students' HOTS in the limited and extensive trial is that the questions tested are HOTS-based questions that are still difficult for students to understand and the time required in the learning process is also lacking.

Table 2. The Effectiveness of HOTS in Limited and Extensive Trials

	Pretest	***Posttest***	***Effect Size***	**Category**
Limited Trial	38.85	39.90	0.14	Low
Extensive Trials	42.80	45.60	0.15	Low

CONCLUSION

The conclusions of this study are (1) it has produced PLA on simple harmonic motion material based on the validation of physics lecturers and teachers with an average validation of the HOTS evaluation test sheet of 3.51, the scoring test sheet of the HOTS evaluation test of 3.59, PLA of 3.52 and the student response questionnaire of 3.82, so that the average validation is 3.61 with the category of "very good"; (2) PLA was able to increase the HOTS of students based on data in the limited trial with *a pretest* score of 38.85 and *a posttest* of 39.90 and in a broad trial obtained a *pretest* of 42.80 and *a posttest* of 45.60; (3) the description of the student's HOTS was analyzed using Rasch modeling and it was obtained that the average HOTS ability of students was below the difficulty level of the question item, where the ability to analyze was the most mastered ability by students with a log of -0.39 to +0.50, then the ability to create with a log value of -0.01 to +0.15 and the ability to evaluate with a log value of -0.07 to +1.27 which was the most difficult question item mastered by students; (4) there is an effectiveness in the use of PLA in HOTS students in simple harmonic motion material based on the average effect *size* in the limited test of 0.14 and the area test in two classes of 0.15 in the low category.

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