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PROCEEDING

" Research and education for developing scientific attitude in sciences and mathematics "

4th ICRIEMS

Yogyakarta State University

4th ICRIEMS

4th International Conference on Research, Implementation, and Education of Mathematics and Science 2017

15 - 16 May 2017

PROCEEDING

" Research and education for developing scientific attitude in sciences and mathematics "

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Yogyakarta, 14 – 16 May 2017

Research And Education For
Developing Scientific Attitude
In Sciences And Mathematics

Faculty of Mathematics and Science
Yogyakarta State University

Proceedings of the 4th ICRIEMS (Regular Edition)

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Preface

This is the regular edition (non-Scopus-indexed) of the proceedings of the 4th International Conference on Research, Implementation, and Education of Mathematics and Sciences (ICRIEMS) held by the Faculty of Mathematics and Science, Yogyakarta State University, Indonesia on 14 – 16 May 2017. All of the papers in this proceeding are obtained from a selection process by a team of reviewers and had already been presented in the conference. Some selected papers from the conference were compiled under separate proceedings and published by the American Institute of Physics (AIP). This proceedings comprises 9 fields, that is mathematics, mathematics education, physics, physics education, chemistry, chemistry education, biology, biology education, and science education.

The theme of this 4th ICRIEMS is '*Research And Education For Developing Scientific Attitude In Sciences And Mathematics*'. The main articles in this conference are given by six keynote speakers, which are Dr. Jean W.H. Yong (University of Western Australia & Curtin University), Assoc. Prof. Khajornsak Buaraphan, Ph.D. (Mahidol University, Thailand), Prof. Maitree Inprasitha, Ph.D. (Khon Kaen University, Thailand), Prof. Dr. Zuhdan Kun Prasetyo, M.Ed. (Yogyakarta State University, Indonesia), Dr. Liem Peng Hong (NAIS Co. Inc., Japan), and Assoc. Prof. Dr. Nor Azowa Ibrahim (Universiti Putra Malaysia). Besides the keynote and invited speakers, there are also parallel articles that present the latest research results in the field of mathematics and sciences, and the education. These parallel session speakers come from researchers from Indonesia and abroad.

Hopefully, this proceeding may contribute in disseminating research results and studies in the field of mathematics and sciences and the education such that they are accessible by many people and useful for the development of our civilization.

Yogyakarta, June 2017

Editorial Team

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Forewords by Head of Committee of the 4th ICRIEMS 2017

Assalamu'alaikum warahmatullahi wabarakatuh

May peace and God's blessings be upon you all

First of all, on behalf of the organising committee of the 4th ICRIEMS let me welcome you to Yogyakarta State University, Indonesia. This International Conference on Research, Implementation, and Education of Mathematics and Science which is organized by the Faculty of Mathematics and Science is dedicated to the 53rd anniversary of Yogyakarta State University. The theme of this conference is "Research and Education for Developing Scientific Attitude in Science and Mathematics".

This conference facilitates academics, researchers and educators to publish and disseminate their research findings in the fields of pure, application and education of Science and Mathematics. We hope that this conference enable us to establish and maintain cooperation, communication, and networking among academics, researchers and educators in the levels of both national and international.

The succes of this conference depends not only on the committe but also on the the other parties. Therefore, in this occasion I would like to express my highest appreciation and gratitude to the following keynote speakers and invited speakers.

Keynote speakers:

1. Dr. Jean WH Yong - University of Western Australia & Curtin University (Biology);
2. Assoc. Prof. Khajornsak Buaraphan, Ph.D. - Mahidol University, Thailand (Science);
3. Assistant Prof. Maitree Inprasitha, Ph.D. - Khon Kaen University, Thailand (Mathematics Education);
4. Prof. Dr. Zuhdan Kun Prasetyo, M.Ed. - Yogyakarta State University, Indonesia (Physics Education);
5. Dr. Liem Peng Hong - Nippon Advanced Information Service (NAIS Co.,Inc), Japan (Physics);
6. Associate Profesor Dr. Nor Azowa Ibrahim - Universiti Putra Malaysia, Serdang (Chemistry)

Invited speakers:

1. Prof. Muthuraaman (Madras University, India)
2. Prof. Pipat Chooto (PSU Thailand)
3. Dr. Azlan Kamari (UPSI Malaysia)

4. Beni Setiawan, M.Pd. (UNESA)

5. Prof. Dr. Abdullah Dolah Dalee (Yala Rajabhat University, Thailand)

6. Prof. Dr. Eddy Hermawan (LAPAN Indonesia)

7. Dr. Hongki Julie (USD Yogyakarta)

Furthermore, allow me to inform you that the number of papers to be presented in this conference is about 304 papers out of 400 applicants from six countries, i.e. Australia, Indonesia, India, Japan, Malaysia, and Thailand. There are more or less 130 selected papers will be published by AIP Publisher which is Scopus Indexed. The rest of the papers will be published on selected DOAJ Journals and Regular ICRIEMS Proceeding. Therefore, we address very big appreciation and many thanks to all presenters and participants who have been actively involved in this seminar. Without your participation, we – the committee – are nothing.

Finally, I would like to say thank you very much to all members of the committee who have been working very hard since November last year in order to ensure the success of this conference. However, nothing is perfect, of course except the God, so if you find any shortcomings and inconveniences in this conference, we really apologize, indeed. We hope that this conference will be very succesful. Have a nice conference and enjoy Yogyakarta

Thank you very much.

Wassalamu'alaikum warahmatullahi wabarakatuh.

Yogyakarta, May 2017

Drs. Joko Sudomo, MA

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Forewords by Dean of Faculty of Mathematics and Sciences Yogyakarta State University

Assalamu'alaikum warahmatullahi wabarakatuh

May peace and God's blessings be upon you all.

On behalf of the Organizing Committee, first of all allow me to extend my warmest greeting and welcome to the 4th International Conference on Research, Implementation, and Education of Mathematics and Sciences 2017, held in Yogyakarta State University, one of the qualified education universities in Indonesia.

To celebrate the 53rd Anniversary of Yogyakarta State University, our faculty, has an opportunity to conduct the 4th ICRIEMS 2017 with the theme of Research and Education for Developing Scientific Attitude in Sciences and Mathematics. This conference proudly presents six keynote speeches by six fabulous speakers: Dr. Jean WH Yong, Assoc. Prof. Khajornsak Buaraphan, Ph. D., Assistant Prof. Maitree Inprasitha, Ph.D., Prof. Dr. Zuhdan Kun Prasetyo, M.Ed., Dr. Liem Peng Hong, and Associate Profesor Dr. Nor Azowa Ibrahim.

This conference is aimed to pull together researchers, educators, policy makers, and practitioners to share their critical thinking and research outcomes. Therefore, we are able to understand and examine the development of fundamental principle, knowledge, and technology. By perceiving the matters and condition in research and education field of mathematics and sciences, we could take a part in conducting qualified education to reach out the real independence of our nation.

This conference will be far from success and we could not accomplish what we do without the support from various parties. So let me extend my deepest gratitude and highest appreciation to all committee members. I would also like to thank each of participants for attending our conference and bringing your expertise to our gathering. Should you find any inconveniences and shortcomings, please accept my sincere apologies.

To conclude, let me wish you a fruitful discussion and a very pleasant stay in Yogyakarta.

Wa'alaikumsalam warahmatullahi wabarakatuh

Yogyakarta, May 2017

Dr. Hartono

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Forewords by Rector of Yogyakarta State University

Assalamu'alaikum warahmatullah wabarakatuh.

May peace and God's blessings be upon all of us.

Education is in Indonesia has long been an object of criticism. Mathematics and Science Education, in particular, has been considered pretty low in terms of international ranks. In reports released by Program for International Student Assessment (PISA), for example, the students' mathematics achievement were very low, that was rank 66 0f 72 countries in 2015. Although it improved when compared to the rank released in 2012 – rank 71 of 72 countries, it is still far behind the other countries, even from Thailand (56), Malaysia (45), Vietnam (22), and Singapore (1). Science is not much better when referring to PISA report. Indonesian students Science achievement was only slightly better than that of Mathematics. In addition, many students consider Mathematics and Science among the most difficult and scary school subjects. Many students feel depressed because they have Math in the schedule, or would rather escape, when it is possible.

Such a condition is not ideal and should be a significant consideration for Mathematics and science teachers, lecturers and researchers to devote more works to improve the quality of not only students' mathematics achievement, but also leaning processes. It is through The 4th International Conference on Research, Implementation and Education of Mathematics and Science (4th ICRIEMS), that we expect to find solution to the problems. The 4th ICRIEM brings together teachers, lecturers, researchers, and practitioners in Mathematics and Science Education to sit together, discuss, and share their experiences, research findings, and ideas to make better practices and innovations in Mathematics and Science Education, and thus improve students learning and achievement.

Yogyakarta State University (Universitas Negeri Yogyakarta), with its new leaderships, has high commitment and is highly determined to promote research and publications among the university members to help improve the quality of Mathematics and Science learning in particular, and the quality of education in general. Furthermore, with the commitment to lead to the World Class University, Universitas Negeri Yogyakarta strive to increase its impact on the education worldwide, by promoting research and publications to journals with international reputation. In addition, Universitas Negeri Yogyakarta with its new leaderships has launched a commitment to a transformative leadership by promoting transparency, participation, and collegiality. With this commitment, it is expected that Universitas Negeri Yogyakarta can contribute better in improving the educational system in particular, and the society in general.

Finally, appreciation and gratitude are for those who have been working hard to make this conference possible. I also hope that this conference be one of the conferences that really contribute to the upbringing of the scientific life.

Wassalamu'alaikum warrahmatullah wabarakatuh.

Yogyakarta, 15 May 2017

Prof. Dr. Sutrisna Wibawa, M. Pd.

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MATHEMATICS EDUCATION

The analysis of senior high school students' physics HOTS in Bantul District measured using PhysReMChoTHOTS

Edi Istiyono

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The Analysis of Senior High School Students' Physics HOTS in Bantul District Measured Using PhysReMChoTHOTS

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Yogyakarta State University, Yogyakarta, Indonesia

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Abstract- The purpose of this research is to describe the results of higher order thinking skills in physics (PhysHOTS) measurement including: (1) percentage of PhysHOTS level and (2) percentage of the domination of response in the category of students in each analyzing, evaluating, and creating skill. There were 404 10th grade students in Bantul District as the respondents of this research. The instrument used for measurement was PhysReMChoTHOTS. It was divided into two sets consisting of 44 items and including 8 anchor items stated valid by a Physicist, Physics Education Expert, and Physics Education Measurement Expert. The instrument was fit to PCM. The reliability coefficient of this test is 0.71, while the difficulty index of the items ranges from -0.61 to 0.51. The results of the measurement show that: (1) The percentage of each category of PhysHOTS for the 10th grade students in Bantul District for the very low, low, medium, high, and very high category is 4.75 %, 40.30 %, 33.45 %, 19.50 %, and 2.00 %, respectively; and (2) The order in analyzing skills, starts from the weakest, is attributing, differentiating and organizing. The order in evaluating skills, starts from the weakest, is critiquing and checking. Meanwhile, the order in creating skills, starts from the weakest, is producing, planning, and generating.

INTRODUCTION

Physics subject is conducted according to Standard Process. Standard Process is a criterion regarding the implementation of learning in the educational unit to Achieve Graduates Competency Standards [1]. Assessment is a very important process in the learning process of physics. Assessment informs what are expected by the students in the learning process. There are many educators who had failed to give questions regarding the knowledge content of thingking skills of the students [2], the educators are only able to give questions regarding the aspect of students' memory which is a part of *Lower Order Thinking Skills*. Therefore, there should be made for questions which seriously measure the higher order thinking skills. [3] The active learning that promotes the higher order thinking skills (HOTS), plays an important role in the education system, especially in science education. [4] There has been conducted for a review that the higher order thinking skills is very important for effective learning and the main objective of science education.

Higher Order Thinking Skills (HOTS) is based on the hierarchy of cognitive skills processing. HOTS include the skills to analyze, evaluate and create, following the C4, C5 and C6 levels of the revised Bloom's Taxonomy [8, 14, 15]. In many developed countries, the utilization of HOTS in assessment starts to be implemented in the education system by the local government, for example, in Malaysia [9]. However, in Indonesia, HOTS is still rarely used, especially in the form of HOTS assessment. The results of survey based on the data on TIMSS (*Trends in International Mathematics and Science Study*) in 2011, stated that Indonesia was left far behind compared to other ASEAN countries such as Singapore, Thailand, and Malaysia, based on the learning outcomes especially for HOTS. That is why the learning using HOTS, especially for HOTS assessment, in Indonesia needs to be developed further.

The usual form of instrument test used in the assessment is the test instrument [5]. Previously, the test is analyzed using the classical test theory, however [7] the classical test theory has some weaknesses, they are; 1) the results of classical test measurement depend on the characteristics of the test used and 2) the item parameters in the

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classical test depend on the ability of the students in a group. The implementation of test and assessment procedures used are usually in the form of scoring which is conducted step-by-step and score per item obtained by the students which is then summed. The weaknesses of the classical theory encourage the implementation of item analysis using modern test theory known as Item Response Theory (IRT). There are several IRT models, among others; Nominal Response Model (NRM), Partial Credit Model (PCM), Generalized Partial Credit Model (GPCM), Rating Scale Model (RSM), and Graded Response Model (GRM) [10]. However, the commonly used alternative scoring approach is the Partial Credit Model (PCM) [6]. There has been developed the PhysReMChoTHOTS test instrument for the 10th grade subject polytomous scoring according to PCM. The PCM model for polytomous items have different difficulty index characteristics between categories, to be able to move from one category to another, the value to move from one category to another category is known as *delta*, so that the magnitude of the *delta* for a certain catagory stage is different between items. *PCM* is developed to analyze the test items that require multiple completion steps, in which an item that follows the partial credit pattern so that the individual with higher skill is expected to have a higher score than the individual who has the lower skill.

Based on the explanation above, there was a measurement carried out using PhysReMChoTHOTS instrument, then was a description on the higher order thinking skills conducted which includes: (1) the percentage of HOTS level of the 10^{th} grade students in Bantul District and (2) the percentage of domination of low category response of the students in each analyzing, evaluating, and creating skill.

METHOD

The steps in the measurement include: 1) The assembly of the test to be ready for measurement, 2) The determination of the respondents for measurement activities, 3) The implementation of measurement, 4) The analysis of the measurement results, and 5) The interpretation of measurement results. The steps are shown in Fig. 1.

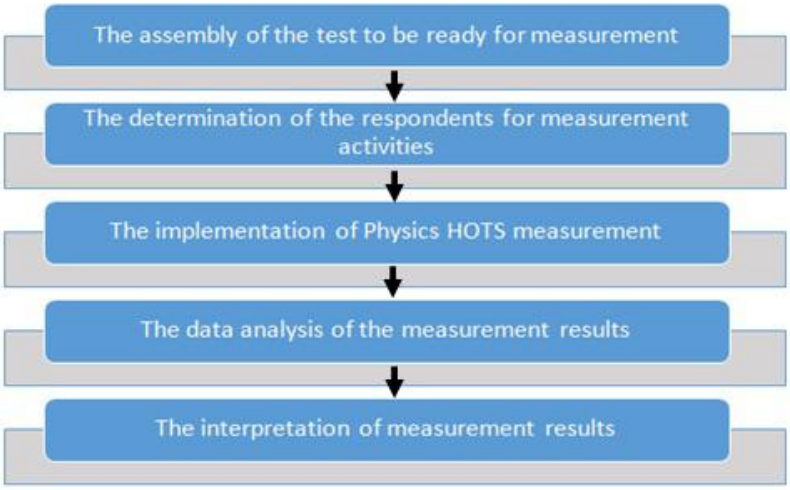

FIGURE 1. Measurement Procedures

Based on the analysis of the data in the try out, there was a revision conducted on the test items. After the revision on test items, there was a test assembly conducted. The assembled test was then ready for the measurement on the level and the weakness of higher order thinking skills in Physics.

The number of respondents involved is higher than at the try out. Therefore, the number of respondents on measurement activity was more than 250 of 10^{th} grade students in Bantul District. There are 404 students of Senior High School.

Once the test was ready for use, the next step was to perform the measurement on higher order thinking skills in Physics for the Senior High Schools Students in Bantul District. The purpose of this measurement is to obtain data regarding the level and the weakness in higher order thinking skills. The provisions for the students in doing the test, among others: (a) students who sit adjacent worked on different test sets (set A and set B) of the PhysReMChoTHOTS, and (2) the test was timed for 90 minutes.

The response of the testeeswere analyzed using a modern theory of Item Response Theory (IRT). The scoring on test items was conducted using *Partial Credit Model(PCM)* which is the development of a the 1-PL model and included into the Rasch model family. *PCM* is a development of the dichotomous item *Rasch* model which is applied on polytomous item. Based on the results of data analysis obtained the following test characteristics.

The determination whether every question item is valid or not is conducted based on *PCM*. [12]. The item criteria are stated valid (*fit*) by seeing the item validation criteria used in the research using the *infit mean square criteria* (MNSQ), with the criteria of 0.77-1.30 [16].

The difficulty level or difficulty index (*b*) for each item is one of the test characteristics. An item is said to be good if it has a difficulty index of more than -2.0 or less than 2.0 which can be expressed by ($-2.0 < b < 2.0$).

Instrument reliability is seen based on the *summary of item estimates*. The *reliability of estimate* value indicates the reliability of the test. The interpretation of instrument reliability value of test results with *Rasch* model is categorized as follows.

TABLE 1. The Interpretation of Reliability Value

Reliability Value	Interpretation of Reliability
>0.94	Excellent
0.91 – 0.94	Very Good
0.81 – 0.90	Good
0.67 – 0.80	Acceptable
<0.67	Poor

The interpretation of the measurement results was conducted on the basis of polytomous score with four categories of measurement results. Based on the domination of the four categories of students' answers and distribution of ability, it can be described that the *ability* of the students is dominant at the level of very low, low, medium, high, or very high. Furthermore, it can also be determined for the sub-aspects of the weaknesses of higher order thinking skills in physics.

RESULTS AND DISCUSSION

PhysReMChoTHOTS's Characteristics

The results of research data analysis obtained that the PhysReMChoTHOTS fits to PCM, and is stated reliable, with the coefficient of this test reliability of 0.71. The item difficulty index ranges from -0.61 to 0.51. Each aspect and sub-aspect of PhysReMChoTHOTS has different question difficulty index distribution. The final score of item difficulty index per aspect and sub-aspect of PhysReMChoTHOTS is shown in Table 2.

TABLE 2. The Mean of Item's Difficulty Index based on Aspects and Sub-Aspects

Aspect	Sub-aspect	b
Analyze	Differentiating	-0.30
	Organizing	-0.42
	Attributing	-0.21
Evaluate	Checking	0.26
	Critiquing	0.18
Create	Generating	0.33
	Planning	0.37
	Producing	0.43

Based on Table 2, it is known that the order of the difficulty index, from the most difficult, is creating, evaluating and analyzing. It is suited to the order of cognitive levels in the revised-version Bloom's taxonomy. The difficulty index of items was illustrated in the chart diagram in Figure 2.

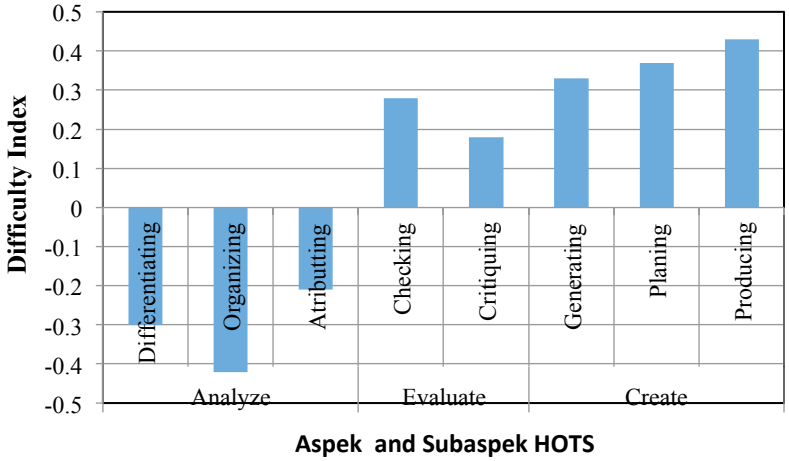

FIGURE 2. The Item's Difficulty Index Per Aspect and Sub-aspect

The results showed that the difficulty level of the items is good, ranging from – 0.61 up to 0.51, in accordance with the IRT theory [11]. A good difficulty index is if the value difficulty level of items is ranging between -2 and +2.

PhysHOTS Ability Level

PhysHOTS distribution of the students based on the percentage of the categories of students' is divided into five levels of ability, they are very low, low, medium, high and very high. The distribution of PhysHOTS ability level distribution is shown in Figure 3.

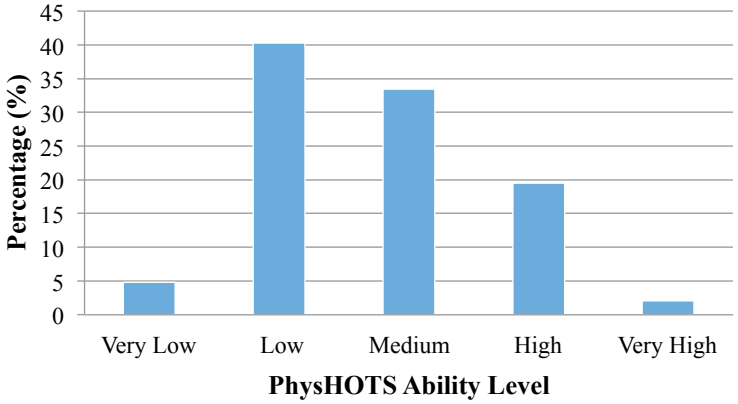

FIGURE 3. The students' PhysHOTS Ability Level

The percentage of each category of higher order thinking skills in physics of the 10th grade students in Bantul District for the category of very low, low, medium, high, and very high is 4.75%, 40.30%, 33.45%, 19.50% and 2.00% respectively. Based on the category, the level of students' ability is known if the highest PhysHOTS of the students is in the low category then in the medium category [13]. It can be said that the PhysHOTS of the High School students in Bantul District is categorized low to medium.

The order of ability in each of these aspects and sub-aspects

The percentage frequency data of the test takers in answering per item category in every aspect and sub-aspect of PhysHOTS is presented. The answer frequency of the test takers per category on the aspects and sub-aspects of cognitive level of PhysHOTS is shown in Table 3.

TABLE 3. Percentage of The Answers of Test takers Based on the Aspects and Sub-aspects

No	Aspect	Subaspect	Category 1 (%)	Category2 (%)	Category 3 (%)	Category 4 (%)
1	Analyze	Differentiating	45.6	31.3	21.6	1.50
		Organizing	45.6	28.4	5.8	20.2
		Attributing	84.5	12.0	3.5	0
2	Evaluate	Checking	35.8	35.5	23.7	5
		Critiquing	50.0	22.0	11.6	16.4
		Generating	51.2	22.3	23.2	3.3
3	Create	Planning	56.0	20.2	18.8	5.0
		Producing	63.2	16.4	13.3	7.1

The sub-aspect which has a high percentage in category 1 means that it is difficult. The most difficult sub-aspect is producing with the percentage of the answer of the test takers in category 1 for 63.2%. The sub-aspect which has the highest percentage in category 4 means that it is easy. Such sub-aspect is the organizing with a percentage of 20.2%. For more details, the distribution of frequency of the answers of test takers per category on the aspects and sub-aspects of instrument is shown in Figure 4.

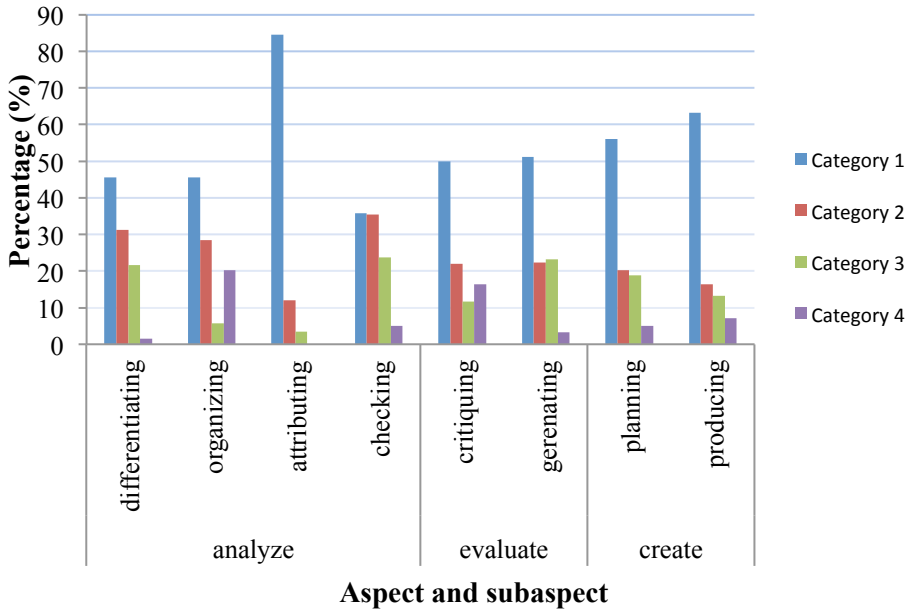

FIGURE 4. Distribution of Frequency of the Answers of test takers per category on the Aspects and Sub-aspects of the PhysReMChoTHOTS

Based on the distribution of difficulty index of items and the frequency of the percentage of answers of the students per item category, it will obtain the dominant category that appears in every aspect and sub-aspect of HOTS. The sub-aspect which is dominant in category 1, 2 and 3 is the easiest sub-aspect, means that the students are

able to answers the questions until the third category. While the most difficult sub-aspect is which has only one dominant category, means that there is no students able to answers the questions until category 2 and 3. For more details, the dominant category appears based on the answers of students is shown in Table 4.

TABLE 4. Dominant Category on the Aspects and Sub-aspects

No	Aspect	Subaspect	Dominant
1	Analyze	Differentiating	Category 1,2
		Organizing	Category 1,2,3
		Attributing	Category 1
2	Evaluate	Checking	Category 1,2
		Critiquing	Category 1,2,3
3	Create	Gerenating	Category1,2,3
		Planning	Category 1,2
		Producing	Category 1

Based on Table 4, then weakest order in analyzing ability is attributing, differentiating and organizing. The weakest order in evaluating ability is critiquing and checking, while the weakest order in creating ability is producing, planning, and generating.

CONCLUSIONS

Based on the analysis, the conclusion of this research can be drawn as follows: The percentage of each level of higher order thinking skills in Physics (PhysHOTS) of the 10^{th} grade students in Bantul District for the level of very low, low, medium, high, and very high is 4.75%, 40.30%, 33.45 %, 19.50% and 2.00%, respectively. The weakest order in analyzing ability is attributing, differentiating and organizing. The weakest order in evaluating ability is critiquing and checking, while the weakest order in creating ability is producing, planning, and generating. Based on the analysis, it is recommended that Physics Teachers in Senior High School can choice learning model increasing students' higher order thinking skills in Physics (PhysHOTS).

REFERENCES

1. Mendikbud. *Permendikbud RI no. 22 tahun 2016 tentang Standar Proses*. Jakarta, 2016
2. Jensen, J. L, et al. Teaching to the Test or Testing to Teach: Exams Requiring Higher Order Thinking Skills Encourage Greater Conceptual Understanding. *Educational Psychology Review,* 1-24 (2014).
3. Madhuri G.V., Kantamreddi, S.S.N., &Goteti L.N.S. Promoting higher order thinking skills using inquiry-based learning.*European Journal of Engineering Education* **37** (2), 117-123 (2013).
4. Saido, G.M., et al. Higher Order Thinking Skills Among Secondary School Students in Science Learning. *The Malaysian Online Journal of Educational Science,* **3**(3) 13-20 (2015).
5. Brookhart, M.S., & Nitko A.J. *Assesment and Garding in Classroom*. (New Jersey: Pearson Education, Inc. 2008).
6. Widhiarso, W. *Aplikasi Teori Respon Item untuk Pemodelan Respons Menipu pada Skala Kepribadian*. Laporan Hasil Penelitian UGM, 2010.
7. Mardapi, D. *Pengukuran Penilaian dan Evaluasi Pendidikan* (Yogyakarta: Nuha Medika, 2012).
8. Anderson, L.W., and Krathwohl, D.R. *A Taxonomy of Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives* (New York: Longman, 2001).
9. Hassan, S.R., Rosli, R., &Zakaria, E., The Use of i-Think Map and Questioning to Promote Higher-Order Thinking Skills in Mathematics.*Creative Education,* **7**, 1069-1078 (2016).
10. Ostini, R., &Nering, M. L. *Polytomous Item Response Theory Models*. (New Delhi: Sage Publications, 2006).
11. Hambleton, R.K. &Swaminathan, H. *Item Respoonse Theory*. (Boston, MA: Kluwer Inc., 1985).
12. Sumintono, B., &Widhiarso, W. *Rasch Model MetodePengukuranModern Dalam Ilmu-Ilmu Social.* (Cimahi: Trim Komunikata publishing House, 2009).

13. Ramos, J.L.S., Dolipas, B.B., &Villamor, B.B. Higher Order Thinking Skills and Academic Performance in Physics of College Students: A Regression Analysis. *International Journal of Innovative Interdisciplinary Research,* 48-60 (2013).
14. Brookhart, S. M. *How to Assess Higher Order Thinking Skills in Your Classroom* (Alexandria: ASCD, 2010).
15. Schraw,G, and Robinson, D.H., *Assessment of Higher Order Thinking Skills*. (New York: Information Age Publishing, Inc., 2011).
16. Adams, R. J. &Khoo, S. T., *Quest: The interactive test analysis system version 2.1*. (Victoria:The Australian Council for Educational Reearch, 1996).

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Certificate

Ref: 1393/UN34.13/TU/2017

This is to certify that

Dr. Edi Istiyono, M.Si.

has participated in

The 4th International Conference on Research, Implementation and Education of Mathematics and Science 2017

Organized by Faculty of Mathematics and Natural Science, Yogyakarta State University

on May, 15th - 16th, 2017

as an

Author

with the paper entitled :

The Analysis of The Senior High School Students' Physics HOTS in Bantul District Measured Using PhysReMChoTHOTS

Dean,

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Yogyakarta, May 16, 2017
The Head of Commitee

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