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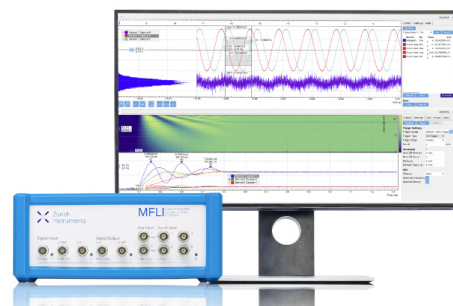
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Preface: International Conference on Science and Applied Science (ICSAS) 2018

International Conference on Science and Applied Science (ICSAS) 2018 was held at the Solo Paragon Hotel, Surakarta, Indonesia on 12 May 2018. The ICSAS 2018 conference is aimed to bring together scholars, leading researchers and experts from diverse backgrounds and applications areas in Science. Special emphasis is placed on promoting interaction between the science theoretical, experimental, and education sciences, engineering so that a high level exchange in new and emerging areas within Mathematics, Chemistry, Physics and Biology, all areas of sciences and applied mathematics and sciences is achieved.

In ICSAS 2018, there are eight parallel sessions and four keynote speakers. It is an honour to present this volume of AIP Conference Proceedings and we deeply thank the authors for their enthusiastic and high-grade contribution. From the review results, there are 166 papers which will be published in AIP Conference Proceedings We would like to express our sincere gratitude to all in the Programming Committee who have reviewed the papers and developed a very interesting Conference Program, as well as thanking the invited and plenary speakers. Finally, we would like to thank the conference chairman, the members of the steering committee, the organizing committee, the organizing secretariat and the financial support from the Sebelas Maret University that allowed ICSAS 2018 to be a success.

The Editors

Prof. Dra. Suparmi, M.A., Ph.D
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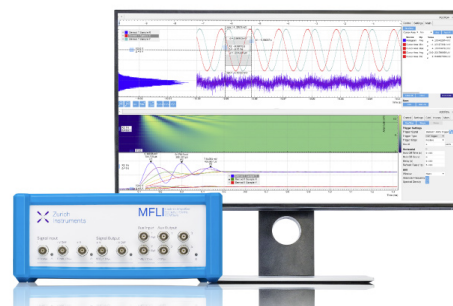
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Committee:

Organizer

Graduate Program, Physics Department, Universitas Sebelas Maret, Indonesia
Jl. Ir. Sutami 36A Ketingan Jebres Surakarta 57126, Indonesia
Phone/fax : (0271) 632450 psw 308
Email : icsas@mail.uns.ac.id

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IT-based HOTS assessment on physics learning as the 21st century demand at senior high schools: Expectation and reality

Edi Istiyono

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IT-Based HOTS Assessment on Physics Learning as the 21st Century Demand at Senior High Schools: Expectation and Reality

Edi Istiyono^{1, a)}

¹Graduate School of Yogyakarta State University
Jl. Colombo No 1 Yogyakarta 55281 , INDONESIA

^{a)}edi_istiyono@uny.ac.id

Abstract. This research describes the implementation of Higher Order Thinking Skill (HOTS) assessment on physics learning at Senior High School which covers the understanding of physics teachers related to HOTS, the implementation of HOTS assessment, and the media employed to administrate HOTS assessment. The research subjects were physics teachers from 30 senior high schools in Special Region of Yogyakarta. The subjects were selected randomly by considering the level of school. The data were collected by using questionnaires, observation form, dan interview guidelines. The data collected were analyzed using quantitative descriptive analysis. The four categorical data (polytomous) were analyzed using the percentration of each category and supported by the interview report. The result of the research indicated that, in general, the HOTS understanding of physics teachers were low. It was considered to be low and very low, with the score respectively 9.77% and 76.44%. There were 13.79% teachers included in high level, but no one considered to have very high level of understanding (See Figure 1). Figure 2 shows that the implementation of HOTS assessment was in very low and low level with the score respectively 29.06% and 62.07%. There were 8.87% included in high level and no one in very high level. Therefore, the implementation of HOTS assessment were considered to be low. The assessment media used were paper and pencil test (PPT), Computer Based Test (CBT), and Computer Adaptive Test (CAT). Figure 3 shows that most of teachers were using PPT, rarely use CBT and nearly never use CAT.

INTRODUCTION

Every school, apart from planning and implementing learning process, also performs assessment to learning results to confirm the effectiveness and efficiency of the process. The curriculum reform sought by the Government is among others attained by updating learning process guidelines. An educator must at least possess pedagogical, personal, social, and professional competencies. In terms of pedagogical competency, an educator needs to have the ability to perform assessment and evaluate learning process and learning outcomes, with the core competency of being able to determine significant aspects of learning process and outcomes for assessment and evaluation [17]. Therefore, assessment plays an important role in determining learners' learning achievements. A proper assessment system will encourage educators to improve their teaching method and motivate learners to improve their way of learning. This is why a proper assessment system is called for in improving education quality.

Global reform occurs in the assessment of learning achievements, particularly in the field of science education, which promotes the shift from traditional teaching to algorithmic skills, lower order thinking to HOTS capabilities [1]. Assessments needs to be planned to measure knowledge and concepts, science process skills, and high-level reasoning. This is in pursuant to the Regulation of the Minister of Education of the Republic of Indonesia Number 41 of 2007 concerning Process Standards. With that being said, certain skills, e.g. HOTS, are required to achieve the objective. Assessment can be implemented to assist learners improving their HOTS. This is supported by the argument that HOTS questions may encourage leaners to think thoroughly on learning materials [6]. Therefore, it is essential to have the assessment instruments that are capable to properly, accurately, and meticulously measure learners' skills.

The basis of HOTS assessment essentially utilizes tasks that encourage the use of knowledge and skills under different conditions. HOTS assessment must be applied to a new paradigm. [7]. It is among others

performed to any sets of items depending on the context. A proper and accurate assessment requires standardized learning test instruments. The preparation for such standard instruments can be performed in several stages. There are nine stages required to develop test instruments, namely: (1) compiling test specification; (2) listing test items; (3) reviewing test items; (4) testing test instruments; (5) analyzing test items; (6) improving test items; (7) formulating test items; (8) performing test; (9) interpreting test outcomes [8]. Preparing a good Physics test instrument must comply with certain standards, so that the test is able to properly and accurately learners' HOTS. A teacher's understanding and professionalism is crucial to the formulation of a good test.

Thinking skills are important in teaching and learning process, particularly in higher education. Thinking is a cognitive skill aimed at gaining knowledge. Thinking skills are cognitive processes divided into several tangible steps that are used to guide thinking process. Students with HOTS can improve their learning performance and reduce their weaknesses [11]. It is a thinking process where students are encouraged to develop and prepare in order to face the real world, in addition to receiving simple learning of facts and contents.

HOTS can help students in following the learning process. HOTS is a critical and creative thinking process which students can eventually use to complete their activities [9]. Critical thinking and creativity are two of human's most basic skills that help encourage a person to constantly face issues critically and creatively find pertinent resolutions. HOTS is defined by three categories, i.e. by transfer, by critical thinking, and by problem solving [13].

According to revised Bloom's taxonomy, cognitive process is divided into Lower Order Thinking Skills (LOTS) and Higher Order Thinking Skills (HOTS). LOTS include the skills to 'remember', 'understand', and 'apply', while HOTS include the skills to 'analyze', 'evaluate', and 'create' [18]. A thorough learning must cover both LOTS and HOTS.

We are currently living in the 21st century where the following are required: 1) learning and innovative skills that include critical thinking and problem solving capability, creativity and innovation, and communication and collaboration skills; 2) media and technology, information and communication (TIC) skills; 3) life-career balancing skills that include adaptability, flexibility, initiative, self-development, sociocultural capabilities, productivity, reliability, leadership, and accountability [19]. The education system aims at raising question and encouraging critical thinking, both of which are integrated in the practiced curriculum [15]. The facts found in the field show that Indonesia has low HOTS level [10]. Indonesian learning method struggles to optimally achieve HOTS when learners must understand question items that require the use of critical thinking. This brings a consequence that in sorting the right from the wrong questions, learners are struggling to achieve high-level thinking. Students' skills in determining problem solutions are depending on their creativity.

The emerging requirements for assessment and evaluation in the 21st century obviously leads to the development of computer-based testing. Computer-based tests offer a number of new opportunities for measuring skills. It becomes a novel and innovative method which measures new domains accurately and efficiently [12]. The innovation will subsequently facilitate the planning, implementation, and assessment of learning.

Some students will use HOTS, such as for providing explanations and reasons, without implying those as a hope. Some teachers will teach and assess HOT skills regardless of whether or not they are directly contained in the curriculum. Nevertheless, HOT without significant representation in the assessment implementation and results are available in the Curriculum, albeit with little to no relevance between the outcome and the assessment. In science education, teachers are responsible to perform teaching and assessment [15]. Based on preliminary survey resulted from the interviews with high school physics teachers in the Special Region of Yogyakarta (SRY/DIY), it was found that most of the schools, both during middle and final semester exams, use regular multiple choices method. Such a method used in the senior high school (SHS) only measures PhysLOTS while disregarding PhysHOTS [20].

METHOD

The research subjects were physics teachers (vary in grades) from 30 senior high schools in the Special Region of Yogyakarta academic year of 2016-2017. The subjects were selected randomly by considering the level of school. The data were collected using questionnaires, observation form, and interview guidelines. The data collected were analyzed using quantitative descriptive analysis. The four categorical data (polytomous) were analyzed using the percentage of each category and supported by the interview report.

RESULT AND DISCUSSION

Teacher's understanding on HOTS in Physics course

Figure 1. summarizes physics teachers' understanding on HOTS on Physics course. Based on Figure 1, there were 9.77% of teachers at very low level, 76.44% of teachers at low level, 13.79% of teachers at high level, and no teachers were at very high level. That means the physics teachers' understanding on HOTS requires improvement, as their understanding on HOTS was dominantly low.

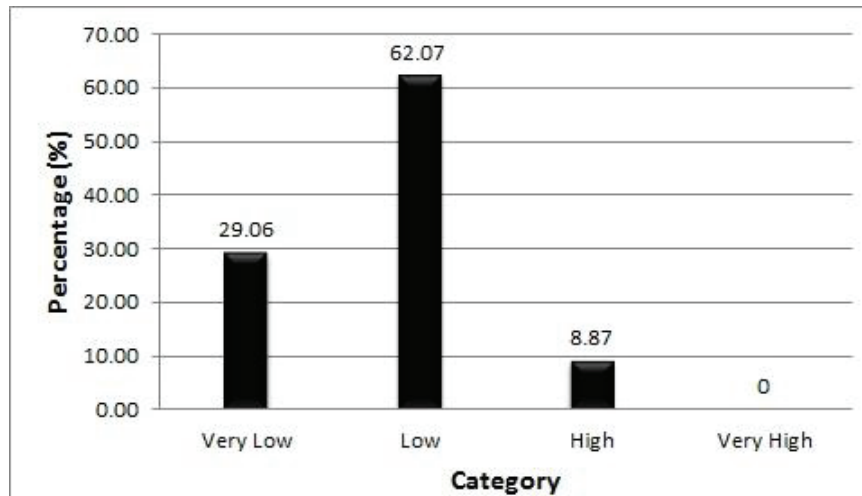


FIGURE 1. Physics Teacher's understanding of HOTS

HOTS is an educational reform concept based on taxonomy learning, e.g. Bloom's taxonomy. The idea is that some types of learning require more cognitive processing than others, while having more general advantages. High-level cognitive processes should be emphasized in the learning process, not just for learners but also teachers. The research conducted by Liliarsi on improving the quality of teachers in HOTS in the chemistry learning model can develop critical thinking skills by providing reasons, deducting, and examining the results of deduction using a rigorous procedure, concluding, applying concepts, communicating, and asking questions [2].

The physics teachers' understanding on HOTS were also reflected on their capability in preparing HOTS-based learning instruments. A research conducted by Pratama & Istiyono on the assessment of learning planning i.e. HOTS-based teaching plan (*Rencana Pelaksanaan Pembelajaran/RPP*) stated that HOTS-based physics teaching plan was at moderate level [5]. Tajudin and Chinnappan stated that a teacher's learning education and professionalism was a target for building students' HOTS. Mathematics teachers required guidance in planning the learning that articulates clear understanding on the definition of HOTS-based learning and its application in class [14].

Saido et al. presented their following findings on teachers and curriculum makers: First, science teachers utilized the assessment of their students' cognitive skills to identify their weaknesses and enhance their abilities by adopting HOTS-encouraging learning. Second, curriculum makers might utilize the results of what the science teacher collected to assess how far the science curriculum has reached the target, and to design solutions to improve the students' HOTS [16]. HOTS can be upgraded through professional science teacher training program by developing the curriculum utilizing method in the provision of understanding of scientific concepts and their application in daily life.

Implementation of HOTS Assessment on Physics

Figure 2. describes the implementation of HOTS in physics assessment. 29.06% of the teachers were at very low level, 62.07% at low level, 8.87% at high level, and none at very high level in HOTS implementation in Physics learning. In brief, the implementation of HOTS-based assessments in physics remained at low level, whereas today, an assessment which is capable of measuring students' HOTS is required. The implementation of HOTS-based assessments must begin to be planned and developed by educators.

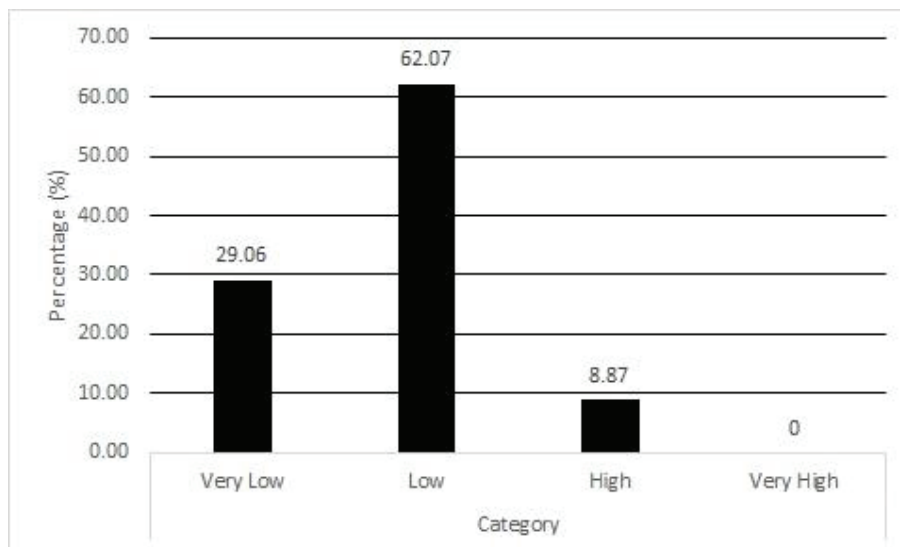


FIGURE 2. Implementation of HOTS Assessment in Physics

Jensen, et al. stated that most of the educators failed since they only gave questions that measure their students' thinking skills, whereas HOTS-measuring questions are also required [3]. The research of Malik et al. on the needs of teachers of SHS Negeri 1 Kotagajah Lampung Tengah for assessment instruments to improve the curriculum-based competencies, i.e. Higher Order Thinking Skills (HOTS) level assessment, stated that 100% of teachers had difficulties in preparing HOTS assessment instruments. Furthermore, a study by Siswoyo and Sunaryo stated that when viewed from HOTS requirements, the questions developed by teachers were still at the 'remember', 'understand', and 'application' levels, while HOTS requires the levels of 'think', 'analyze', 'evaluate', and 'create' [4].

Therefore, teachers must put extra effort to apply physics-based assessments in learning. Related to HOTS, Istiyono et al. has developed a test instrument for measuring the student's HOTS (PhysTHOTS) in the form of reasoned multiple-choice. PhysTHOTS requires 'analyze', 'evaluate', and 'create' skills on the subjects of motion, force, work, energy, momentum, and impulse; (2) the PhysTHOTS instrument has met the content validity with expert judgment and obtained empirical evidence of the fit and construct validity in the Partial Credit Model (PCM) based on the four-category polytomous data; (3) all items in PhysTHOTS were in good criteria because the difficulty level was within the range of -2.00 to 2.00. PhysTHOTS Reliability was confirmed, even considered at a high level (reliability coefficient over 0.90). Meanwhile, based on information function, PhysTHOTS was aptly used to measure PhysTHOTS of students with skill from -0.80 to 3.40 [20].

Assessment Model by Media

Figure 3. presents the percentage of assessment media used by teachers, the never category for PPT media was at 3.33%, CBT media at 33.33%, and CAT media at 96.67%. The rarely category for PPT media was at 6.67%, CBT media at 50.00%, and CAT media at 3.33%. The frequently category for PPT media was at 23.33%, CBT media at 13.33%, and CAT media at 0.00%, whereas always category for PPT media was at 66.67%, CBT media at 3.33%, and CAT media at 0.00%. This means that PPT media were often used with a percentage of 66.67%, the percentage was greater than the use of CBT and CAT media in the always category. CBT media were rarely used with 50.00%, greater than that of CBT and CAT media in rarely category. CAT media have never been used with 96.67%, greater than that of PPT and CBT media in never category.

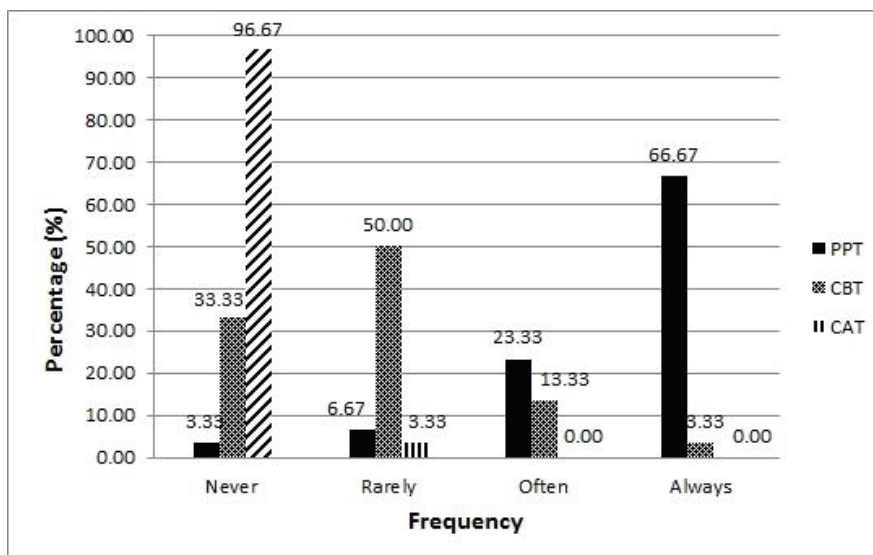


Figure 3. Percentage of assessment media

These results do not contradict Bodmann and Robinson's research that compared the difference in speed and performance between CBT and PPT. Approximately half of the class (28 students) took the first test with CBT and the rest of the first choice with PPT. The procedure shifted for the second test, the first group took PPT and the second group took CBT within two weeks. The result showed that the CBT was completed faster than PBT with no difference in score [21]. This indeed contradicts the results of the Magyar study indicating that paper-based test can be converted to adaptive form (CAT) that can be used effectively to estimate the skill level. Furthermore, in adaptive test technology, students with lower skills can provide slightly correct answers, so that the test may motivate them more. Whereas for students with high-level skills, it is more challenging for them to complete a test (CAT) [12]. The adaptive test (CAT) allows more accurate skill measurement, has more reliability, and is thoroughly relevant to samples, where more information at a significant amount can be extracted from them compared to conventional linear test. This is the reason why CAT media are preferable: due to their better precision, accuracy, and efficiency while in fact they are no longer used in today's learning process. Therefore, the efforts to shift the assessment from PPT into CBT, and finally CAT are called for.

CONCLUSIONS

Based on the analysis, three main conclusions were drawn. First, the understanding of physics teachers on HOTS were still low. Second, the implementation of HOTS assessment on Physics were still low. Last, most of physics teachers were using PPT, rarely using CBT and nearly never using CAT.

SUGESTIONS

Based on the analysis, it is suggested that:

1. Further research on Physics teachers' skills in preparing HOTS assessment instrument and CBT and CAT developments are required.
2. Relevant institutions are recommended to provide trainings on HOTS instrument for Physics subject, followed by CBT and CAT development trainings.

REFERENCES

- [1] Barak, M., & Dori, Y. J., "Enhancing undergraduate students' chemistry understanding through project-based learning in an IT environment", *Science Education* **89**, 117–139 (2005).
- [2] Liliyasi, "Peningkatan Mutu Guru dalam Keterampilan Berpikir Tingkat Tinggi melalui Model Pembelajaran Kapita Selekta Kimia Sekolah Lanjutan", *Jurnal Pendidikan Matematika dan Sains* **3**, 174-181(2003).
- [3] Jensen, J. L., McDaniel, M. A., Woodard, S. M., & Kummer, T. A, 2014, Teaching to the Test or Testing to Teach: Exams Requiring Higher Order Thinking Skills Encourage Greater Conceptual Understanding, *Educational Psychology Review* **26**, 307-329 (2014).

- [4] Siswoyo & Sunaryo, "High Order Thinking Skills: Analisis Soal dan Implementasinya dalam Pembelajaran Fisika di Sekolah Menengah Atas", *Jurnal Penelitian & Pengembangan Pendidikan Fisika* **3**, 11-20 (2017).
- [5] Pratama, N.S & Istiyono. E., *Studi Pelaksanaan Pembelajaran Fisika Berbasis Higher Order Thinking (Hots) Pada Kelas X Di SMA Negeri Kota Yogyakarta* (Seminar Nasional Fisika dan Pendidikan Fisika, Surakarta, 2015) p. 104-112
- [6] Barnett, J.E & Francis, A.L., "Using higher order thinking questions to foster critical thinking: a classroom study", *Educational Psychology: An International Journal of Experimental Educational Psychology* **4**, 25-28 (2012).
- [7] Brookhart, S.M., *How to assess higher order thinking skills in your classroom* (ASCD, Alexandria, 12 (2010)
- [8] Djemari Mardapi., *Pengukuran penilaian & evaluasi pendidikan*, (Mitra Cendikia Offset Yogyakarta, 110 (2012)
- [9] Conklin, W., "Higher order thinking skills to develop 21st century learners", *Journal of Education and Practice* **8**, 108-121 (2012).
- [10] Susanti, E., Kusumah, Y.S., Sabandar, J., & Darhim., "Computer-assisted realistic mathematics education for enhancing students' higher order thinking skills (experimental study in junior high school in Palembang, Indonesia)", *Journal of Education and Practice* **5**, 51-58 (2004).
- [11] Heong, Y.M., Othman, W.B. & Yunos, J.M., "The level of Marzano higher order thinking skills among technical education students", *International Journal of Social Sciences and Humanity* **11**, 121-125 (2011).
- [12] Magyar, Andrea, *Comparing the Measurement Effectiveness of Computer-Based Linear and Adaptive Test*. University of Szeged, Szeged, 10 (2015).
- [13] Brookhart, S. M., *How to Assess Higher Order Thinking Skills in Your Classroom*. (ASCD, Alexandria, 14 (2010)
- [14] Tajudin, Nor'ain Mohd. & Chinnappan Mohan., "The Link between Higher Order Thinking Skills, Representation and Concepts in Enhancing TIMSS Tasks", *International Journal of Instruction* **9**, 199-214 (2016).
- [15] FitzPatrick Beverly & Schulz Henry., "Do Curriculum Outcomes and Assessment Activities in Science Encourage Higher Order Thinking?", *Canadian Journal of Science, Mathematics and Technology Education* **15**, 305-329 (2015).
- [16] Saido, Gulistan Mohammed., Siraj, Saedah., Bin Nordin, Abu Bakar., Al Amedy, Omed Saadallah., "Higher Order Thinking Skills Among Secondary School Students in Science Learning", *The Malaysian Online Journal of Educational Science* **3**, 13-20 (2015).
- [17] Nuh, Mohamad., *Act No. 152 about The Academic And Competency Qualification Standard of Educators* (The Indonesia Ministry of Education and Culture, Jakarta, 2014) p. 5-6.
- [18] Krathwohl, D. R. & Anderson, L. W., *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. Longman, New York, 30 (2001)
- [19] Baswedan, Anies., *Act No. 21 About The Content Standard for Primary and Secondary Education* (The Indonesia Ministry of Education and Culture, Jakarta, 2016) p.2
- [20] Istiyono, Edi., "Pengembangan Tes Kemampuan Berpikir Tingkat Tinggi Fisika (PysTHOTS) Peserta didik SMA", *Jurnal Pendidikan dan Evaluasi Pendidikan* **18**, 1-12 (2014).
- [21] Bodmann and Robinson, "Speed and Performance Differences among Computer-Based and Paper-Pencil Tests", *Journal of Educational Computing Research* **31**, 51-60 (2004).

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