



**ICMSE 2015**

INTERNATIONAL CONFERENCE ON MATHEMATICS,  
SCIENCE, AND EDUCATION



Proceeding of

**INTERNATIONAL CONFERENCE ON MATHEMATICS,  
SCIENCE, AND EDUCATION 2015**

*Applied Research of Mathematics and Natural Sciences  
to Improve Its Usefulness for Knowledge and Society*

**Aston Hotel, Semarang  
5 – 6 September 2015**

Organized by  
Faculty of Mathematics and Natural Sciences,  
Semarang State University - Indonesia



**PROCEEDING  
INTERNATIONAL CONFERENCE ON MATHEMATICS,  
SCIENCE, AND EDUCATION**

**"Applied Research of Mathematics and Natural Sciences to  
Improve Its Usefulness for Knowledge and Society"**

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Prof. Dr. Hans-Dieter Barke  
Prof. Ir. Ibnu Maryanto, M.Si., Ph.D.  
Prof. MD Rahim Sahar  
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Aji Purwinarko, M.Cs

**FACULTY OF MATHEMATICS AND NATURAL SCIENCES  
SEMARANG STATE UNIVERSITY  
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## PREFACE

Thanks to God Almighty this International Conference Proceeding could be completed. All articles in this proceeding are presented in International Conference On Mathematics, Science, and Education – Applied Research of Mathematics and Natural Sciences to Improve Its Usefulness for Knowledge and Society on September 5-6, 2015 at Aston Hotel Semarang. This Conference is organized by Faculty of Mathematics and Natural Science. This proceeding has been reviewed of Mathematics and Science experts before it is published.

This conference is designed to improve the discussion and research scope in mathematics, science, and education area in the international level. Sub topics in this proceeding cover mathematics, applied mathematics, and mathematics education in accelerating character building. Enhancing biology and biology education research for a better life. Green chemistry in research and education. Physics and physics education for trending research. Hopefully this publication of proceeding will be profitable for all of us.

Semarang, 3 December 2015

Regards  
Committee of ICMSE 2015

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## **MESSAGE FROM THE DEAN OF FMIPA UNNES**

Dear Participants of ICMSE 2015,

It is a pleasure to welcome all of you in the first International Conference on Mathematics and Science Educations (ICMSE 2015) held by Faculty of Mathematics and Natural Sciences, Semarang State University.

Faculty of Mathematics and Natural Science Semarang State University or more popularly known as FMIPA Unnes has 6 departments and 11 study programs of Mathematics and Natural Sciences education backgrounds and non education backgrounds. FMIPA Unnes has the mission of being an excellent and meaningful faculty by improving human resources through scientific activity.

One of efforts to result excellent and meaningful human resources through scientific activity is by performing discussion and knowledge sharing. To widen discussion of science and research development in mathematics and science educations scopes in national and international level, ICMSE 2015 was initiated as the medium of that discussion. I believe that ICMSE 2015 as the first international conference held by FMIPA Unnes can facilitate the knowledge sharing in mathematics and science educations area in order to establish a global cooperation among experts and researchers.

With the hope that this conference will be the medium to optimize the role of Mathematics, Science and Education in global cooperation, I am proud to welcome all of you and I wish you a pleasant sharing and discussion in this conference and enjoyable stay in Semarang, Indonesia.

**Prof. Dr. Wiyanto, M.Si.**

Dean of Faculty of Mathematics and Natural Sciences  
Semarang State University

## **MESSAGE FROM CONFERENCE CHAIRMAN**

My pleasure, welcome to you today on the occasion of this International Conference on Mathematics, Science, and Education (ICMSE 2015). I would like to extend my warmest welcome to all of the distinguished participants, especially those who have travelled long distances to be present here. This conference has already established itself as a key event to offer various thoughts and knowledge in enhancing our understanding in fundamental sciences and education.

This conference focus on “Applied Research of Mathematics and Natural Sciences to Improve Its Usefulness for Knowledge and Society”, offers all of us the opportunity to explore exciting information. The aim of the conference is to provide an interdisciplinary forum for scientist engaged in the full spectrum of research and development activities. The meeting intends to bring together researchers, scientists, and scholars to exchange and share their experiences, new ideas, and research result in related fields and discuss the practical challenges encountered and the solutions adopted. I invite all of you to approach this year's events to take advantage of the many ways in which you too might explore the unfamiliar - and discover a great deal in the process.

First, the various sessions that have been organized for the next day promise exciting revelation for all who attend them. Each speakers who are experts in their respective fields, will address a major topic or issue related to Fundamental Sciences,. You might learn more about a topic with which you were already familiar; or you might also find yourself discovering a whole new world of ideas and information you didn't know existed. Either way, you'll have many opportunities to explore fascinating new terrain with these reputable speakers.

Second, the key note speakers will provide, for all of us, an important window into the world of the future. We are privileged to have them as our key note speakers Prof. Barke, Munster University Germany, Prof. Martin Stein, Munster University Germany, Prof. Simone Krees, Munster University Germany, Prof. Matthias Ludwig, University Frankfurt Germany, Prof. Van Horsen, Delf Univesity Netherland, Prof. Rahim Sahar, UTM Malaysia and Dr. Margareta Rahayuningsih, M.Si experience has taken them through the whole cycle of Life and General science.

Finally, as you attend these various events, keep in mind that other people can also serve as doorways to new worlds. Hearing of someone else's background and experiences can often make for fascinating discoveries that can educate and profoundly affect us. So take advantage of this rare gathering of hundreds of people working in various fields to meet one another, talk with one another, and learn from one another.

In conclusion, I hope that you will find your time with us exciting. We have a great agenda for you with esteemed speakers and presenters from our profession. I do hope you will enjoy the next couple of days. I would like to once again extend my gratitude to all the participants, generous sponsor and I look forward to a most successful and fruitful conference.

**Professor Dr. Supriyadi, M.Si**  
Chairman of ICMSE 2015



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## ANALYSIS OF HIGHER ORDER THINKING SKILLS CONTENT OF PHYSICS EXAMINATIONS IN MADRASAH ALIYAH

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### ABSTRACT

This research aims to identifying Higher Order Thinking Skills content in physics item test given to *Madrasah Aliyah* students in Yogyakarta. To identify Higher Order Thinking Skill content using dimensions of thinking by Bloom's Taxonomy. These research subjects are daily exams, mid semester exam and final exam on physics. The exams collected are the physics ones at eleven *Madrasah Aliyah* in Yogyakarta. The data are analyzed with analysis check list of cognitive domain in Revised Bloom taxonomy especially on the Higher Order Thinking Skills. The research result shows that the examinations the students do are merely the memorizing and the formula applications. The data obtained shows that the evaluation exams are given with the level of remembering at 12.7%, understanding at 10.9%, implementing at 69.6% and analyzing at 5.14%. The type of exams for evaluating and creating is rarely and even never used in the examinations to assess the students in *Madrasah Aliyah*.

Keywords: Physics Examinations, Higher Order Thinking Skills

### INTRODUCTION

One aim of education for the 21<sup>st</sup> Century Skills is to cultivate the problem solving, critical thinking and higher order thinking skills. Higher order thinking skill basically means a thinking that is taking place in the higher levels of the hierarchy of cognitive processing. The most widely accepted hierarchical arrangement of this sort in education is the Bloom Taxonomy, viewing a continuum of thinking skills starting with knowledge-level thinking to evaluation-level of thinking (Ramos, 2013).

According to Resnick (1987), Higher Order Thinking Skill (HOTS) is non-algorithmic, complex, often produces multiple solutions, involves judgment and interpretation, involves the application of several criteria, often involves uncertainty, involves self-regulation in the thinking process, involves the process of finding meaning, and attempts. Sternberg (1995) classifies the high order thinking skills in three categories: meta-component, performance component, and knowledge acquisition component. Meta-

component of high order thinking process includes planning, monitoring, decision making, and evaluating. Performance component includes skills used in the actual implementation of the task. Knowledge acquisition component is used in learning the new information. According to Lavonen and Meisalo (1998), being creative and critical thinking, and problem solving are included in the higher-order thinking skills.

According to the National Center for Education Statistics (1996), teaching for HOT along with professional development in HOT were found to be two of the top five variables positively associated with improved student achievement. Students of teachers who teach for both Lower Order Thinking Skill (LOTS) and HOT outperform students whose teachers only teach for LOT. many US state exams primarily focus on (LOTS) (procedural skills; symbol manipulation) at the expense of HOT (problem solving; reasoning) (Thomson, 2012). Lower Order Thinking Skill is often characterized as the recall of information or the application of concept or knowledge to familiar situations and context. Dimension of thinking from

Bloom Taxonomy identifying LOTS consist of three component, namely: remember, understanding and apply. While HOTS level is a complex thinking from analyze, evaluate and create.

The taxonomy classifies cognitive performances into six major headings arranged from simple to complex by revision of the Bloom's taxonomi (Anderson & Krathwohl,2001): 1) Remember, 2) Understand, 3) Apily, 4) Analyze, 5) Evaluate, 6) Create

Remember involves recognizing or recalling facts and concepts. Understand involves basic comprehension, understood in light of newer theories of learning that emphasize students constructing their own meaning. Processes in this category include interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.

Apply means to execute or implemant a procedure to solve a problem. Application level problems still usually have one best answer. Analyze means to break information into its parts, determining how the parts are related to each other and to the overall whole. Processes include differentiating, organizing, and attributing. Multiple correct responses are still likely in analysis level tasks. Evaluate means judging the value of material and methods for given purposes, based on criteria. Processes include checking and critiquing. Create means putting disparate elements together to form a new whole,or reorganizing existing elements to form a new structure. Processes include generating, planning, and producing.

To solve the problem in phisics needs to have much deeper thinking process and needs to have analysis process before deciding an issue. The analysis process is a part of HOTS. The ability to think is very important in describing and explaining the physical phenomena of empowerment of Higher Order Thinking Skill in phisics learning that can help the students to analyze the meaning of the basic principles and to make decisions in everyday life.

National Assessment of Educational Progress [NAEP] indicate that the US educational system is not preparing students to solve complex problems, or in general, to think at higher levels (Thomson,2012).

Assessment is an essential part of learning because the assessment is the evidence that a teacher can use to describe the skills of the students throughout the learning process (Holmes, 2002). An assessment may describe the condition of the students. The teacher needs to know the development of the students' learning in order to ensure that they experience the learning process correctly. If the teacher's collected data identifies that the students have a blockage in learning, he may soon be able to take appropriate measures so that they can be free from the blockage in learning. An assessment may facilitate the development of Higher Order Thinking Skills of the students. They are forced to think of solving the problems to find the answers of the examinations that they do. With the developement of test item phisisc for examinations that assess higher order thinking skill is key to facilitating the development of HOT by all students.

Danovan Peterson (1992) states that the assessment the teachers do all this time is merely mathematical and logarithmic without trying to develop the higher order thinking skills on the students. Therefore, it is important to know how the assessment done so far. The purpose of this research is to determine whether the phisics examinations used to assess the students in *madrasah aliyah* already contain the higher order thinking skills.

## METHODS

The population in this research is all *Madrasah Aliyah* in Yogyakarta City, Bantul Regency and Sleman Regency either the public or private schools. The sample selection technique is random sampling. The samples in this research are eleven *Madrasah Aliyah*.

Data collection technique in this study is a non-test technique. The non-test technique is conducted to obtain the data of the examinations that have been used by teachers to assess the students. The methods used in this research are the documentation and interviews. The data analysis technique used is the analysis of qualitative data. The qualitative analysis is conducted through a review of the examinations used to determine the suitability of the examinations in the test with the indicator of higher order thinking skill that have been arranged previously.

**RESULT AND EXPLANATION**

The frequency of using the dimension of HOTS is found based on the data analysis that is classified by the bloom taxonomy as follows

Table 2

Classification of thinking aspect of the physics tests

Thinking Skill Assigned by Bloom Taxonomy for the Physics Examinations Test	Analysis Result (%)
Remembering	12.7 %
Understanding	10.9 %
Applying	69.9 %
Analyzing	5.14 %
Evaluating	0 %
Creating	0 %

Of the six thinking aspect classified by Bloom, there are only four thinking skills used: Remembering, Understanding, Applying and Analyzing. The analysis result for the remembering skill on the physics examinations used in *Madrasah Aliyah* is at 12.7%. The understanding skill is 10.9%, the applying skill is 69.9%, while the evaluating skill and creating skill are 0%. The examinations that have been used all this time contain no Higher Order Thinking Skills because there are no examinations that measure the skills of evaluating and creating. Most of the examinations

lie on the LOT. The physics examinations mostly only ask the students to apply the physics formula.

Many researches identifying the level of HOTS evidently show that the examinations used in the high schools are at the low order thinking skill (Lane, 2004; Webb, 2002). Other researches in mathematics conducted by Tony Thomson (2012) show that the math examinations used is at the low order thinking. Similarly, in this research the analysis result of the physics examinations used in *Madrasah Aliyah* shows the low order thinking.

Table 3  
Sample of test items classified by Taksonomi Bloom

Bloom's Taksonomi Classifications	Test Items
Remembering	Explain the principle of Black
Remembering	Absolute Zero temperature is the temperature when
Remembering	Explain the transfer of heat !
Applying	Temperature of a body is 40 ° C. What is the temperature if it measured with a thermometer Reamur and fahrenheit?
Applying	Ice mass of 150 grams and a temperature of 0 °C included in 500 grams of water with temperature 20 ° C. If the heat melting ice 80 cal/g, the specific heat of water 1 cal/g, then the final temperature of the mixture is.....
Applying	How much heat is needed to melt the ice as 200 grams with a temperature of 0 ° C ? (latent heat of fusion of water 80 cal /g)

Physics test item at the level of LOTS is a usual solution likely to be routine and familiar to students and do not involve a new situation or require a student to solve a problem. Physics test item of classification that are identified on LOTS is on the domain remembering, understanding and applying.

As can be seen from table 3, it was not unusual for physics examination to classify the same or similar test items as both LOTS (remembering, understanding, and applying) and HOTS (analyzing, evaluating, and creating)

Remember and understand is part of LOTS. Remembering level is when teachers ask their students to answer questions correctly and fundamentally. At the level of this measure a person's ability to think in defines, describes, identifies, knows, embed, made the list, match, name, describe, recall and recognize.

Physics test item at the level of LOTS is a usual solution likely to be routine and familiar to students and do not involve a new situation or require a student to solve a problem. Physics test item of classification that are identified on LOTS is on the domain remembering, understanding and applying.

According to Bloom, test items that had already been practiced in class would be labeled remember and understanding. The following table includes examples of test items considered by the researcher

Explain the principle of Black Absolute Zero temperature is the temperature when Explain the transfer of heat
--

The main key to execute the question is if students remember the definition of the matter they choose have a best answer.

Apply skill is the ability to use a procedure to resolve the issue. The application skill consists of two cognitive processes: the executing skill and implementing skills. In executing skill is if students encounter problems that are already known to the students will be aware which

procedure will be used. This skill is more inclined to the ability to solve problems with the algorithmic

Ice mass of 150 grams and a temperature of  $0^{\circ}\text{C}$  included in 500 grams of water with temperature  $20^{\circ}\text{C}$ . If the heat melting ice  $80\text{ cal/g}$ , the specific heat of water  $1\text{ cal/g}$ , then the final temperature of the mixture is.....

From that question is so obvious that the skills needed to solve the problems is to logarithmic. Step problem solving with this type is to know the symbols that have been recognized by students and use the equation. If each step is done correctly, the results to be obtained is also certainly true.

One of the characteristic of HOT in is its newness to the solver or its non routine nature. However many of the test items for examination in madrasah aliyah were procedural and routine is Lower Order Thinking Skill.

Application level is a level that requires students to solve problems in new situations by applying knowledge, facts, techniques and rules in a different way. Application level is when the teacher asks students to solve problems using formulas or specific strategy when the issue has not been shown before. This is different to memorize or reiterating a fact and apply it to something new. For example, when students have to calculate how temperature somewhere by using a thermometer. To resolve this problem, the learners have to think how to use the scale and shall apply the scale reading skills so that they can resolve the issue. Some keywords and phrases that are used when learning at the level of application that includes is apply, built, choose, construct, develop, interview, make use of, organize, experiment with, plan, select, solve, modifies, predicts, produces, changes, identify, and model

Analysis described as the level of thinking that asks students to examine and decipher each piece of information by identifying the reasons or causes, to make conclusions and find facts to support broader conclusions. Some keywords used to the level of analysis that is analyze, categorize, classify, compare, contrast, discover, dissect, divide, examine, inspect, simplify, survey, take part in, test for, distinguish, distinction, relationships, function, motive, inference, assumption, and conclusion.

*Mathematics in the Classroom*. Washington, DC: National Research Council.

For analyze skill students required to able:

1. Analyze information, divide and structuring information into smaller parts to identify patterns or relationships.
2. Being able to recognize and distinguish between the causes and consequences of a complicated scenario.
3. Identifying or formulate questions

According (Brookhart, 2010) to assess the quality of students' thinking as they break down information into its parts and reason with that information, questions or tasks must ask students to find or describe those parts and figure out how they are related. Analysis level questions present students with material (or ask them to locate material), then ask questions or present problems whose answers require differentiating or organizing the parts in some reasonable manner. Explaining the reasoning used to relate the parts to one another is often part of the analysis task.

Bloom defined that evaluating is judging the value of material and methods for given purposes, based on criteria. Processes include checking and critiquing. evaluating as assessing the reasonableness and quality of ideas; creating standards for making judgments; confirming the accuracy of claims. For the evaluating skill student must have analyze skill to to claim the solution.

According (Brochart, 2010) to assess evaluation, you need items or tasks that can assess how students judge the value of materials and methods for their intended purposes. Students can appraise the material against criteria.

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