PROCEEDING BOOK

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INTERNATIONAL SYMPOSIUM ON MATHEMATICS EDUCATION AND INNOVATION

Issues and Challenges in 21st Century Mathematics Education
"Working toward Meaningful Teaching and Learning"

SEAMEO Regional Centre for QITEP IN MATHEMATICS

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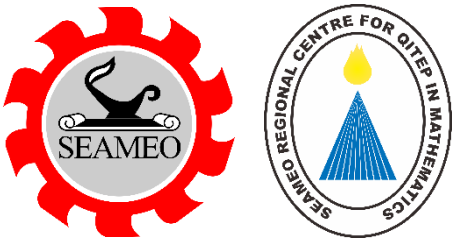
YOGYAKARTA INDONESIA

SOUTHEAST ASIAN MINISTERS OF EDUCATION ORGANIZATION (SEAMEO)
REGIONAL CENTRE FOR QUALITY IMPROVEMENT OF TEACHERS AND EDUCATION PERSONNEL (QITEP) IN MATHEMATICS



PROCEEDING OF THE 4th INTERNATIONAL SYMPOSIUM ON MATHEMATICS EDUCATION INNOVATION

"Issues and Challenges in 21st Century Mathematics Education: Working toward Meaningful Teaching and Learning"

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The papers included have been reviewed and presented in the 4th International Symposium on Mathematics Education Innovation, on the 1-3 November 2016 hosted by Southeast Asian Ministers of Education Organization (SEAMEO) Quality Improvement for Teachers and Education Personnel (QITEP) in Mathematics.

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Foreword

This is with deep gratitude that I write this Foreword to the Proceedings of the 4th International Symposium on Mathematics Education Innovation (ISMEI).

SEAMEO Regional Centre for QITEP in Mathematics keeps maintaining its tradition to foster the exchange of innovative ideas and strategies for mathematics teaching and learning in modern classrooms and to encourage collaboration and partnership amongst mathematics educators. In this year's symposium, we have been pleased to provide mathematics educators with an intriguing theme on 'Issues and Challenges in 21st Century Mathematics Education'.

During the symposium, all paper presenters presented their works on several topics namely innovation in assessment and evaluation, curriculum issues, distance education, innovation in teaching and learning, learning environments, online learning, and teacher education. Their contributions helped the symposium as outstanding as it was. In addition to the contributed papers, we also invited five keynote speakers to give participants new insights about mathematics education. They were Assoc. Professor Allan White from the University of Western Sydney, Assist. Professor Maitree Inprasitha from the University of Khon Kaen, Professor Tom Lowrie of the University of Canberra, Professor Mohan Cinnapan from the University of South Australia, and Dr. Thien Lei Mee from our senior sister Center, SEAMEO RECSAM.

I believe that this proceeding will be a fresh impetus to stimulate further study and research in mathematics education.

Finally, we thank all authors and participants for their willingness to share their latest research and ideas. Without their effort, the symposium would not be possible. Keep up the good work and see you in 2018.

Prof. Subanar, Ph.D.
Centre Director

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ANALYSIS OF STUDENT'S MATHEMATICS COMMUNICATION SKILL THROUGH PISA-ITEM ON UNCERTAINTY AND DATA CONTENT

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Abstract

The mathematics communication skills of teacher student become an important things in the last few years. Students not only must have competencies to solve a problem but also have to share with the others. Share how to solve a problem can improve student's mathematics communication skill so their mathematics knowledge also can be enhance. Program for International Student Assessment (PISA) is an instrument to assess the students' mathematics literacy especially related to student's mathematics communication skills. Many efforts which have been spent by a country that joins this program to increase its PISA scores. This article studies the percentage of student's mathematics communication skill through PISA-item on uncertainty and data content.

Keywords: *PISA-item, Uncertaninty and Data, mathematics communication skills*

Introduction

Mathematics communication skill is one of the learning goals that line in Permendiknas No. 22, 2006 which declared about mathematics subject intended that studentshave skills of communicating ideas with symbols, tables, diagrams, or other media to clarify the situation or problem. In line with these, Curriculum 2013 states that student's mathematics communication skill should be enhance in order to prepare global competencies for students. Mathematics communication skill also one of the skills that observed by PISA.

PISA mathematics results show that start on 2000, 2003, 2006, 2009, and 2012, Indonesia occupied the position 39thof 41 participating countries, 38thof 40 participating countries, 50thof 57 participating countries, 61stof the 65 participating countries, and 64thof the 65 participating countries. PISA results show that Indonesia is still at the lower level. It means that mathematics skill of Indonesian students in solving problems that require the ability to review, giving reasons and communicating effectively, and solve and interpret problems in various situasions is still lacking (Kamaliyah, Zulkardi, and Darmawijoyo, 2013).

Based on PISA result show that mathematics skill of Indonesian student is still in low level. It caused by student's mathematics communication skill is not effectively and interpret solution of the problems of PISA-item. This study will be categorise PISA-item in uncertainty and data content besed on mathematics communication skill.

Theoritical Framework

Mathematics communication skill

According to the National Council of Teachers of Mathematics (NCTM) Principles and Standards for School Mathematics (2000), communication is an essential part of mathematics. The communication process helps build meaning. When students are challenged to think and reason and then communicate their ideas orally or in writing, true conceptual understanding develops. Listening to others' explanations provides students opportunity to clarify their understanding and consolidate mathematical ideas.(Kimberly Hirschfeld-Cotton, 2008)

The seven fundamental mathematical capabilities used in this framework are as follows: (1)*Communication,* (2) *Mathematishing,* (3) *Representation,* (4) *Reasoning and Argument* (5) *Devising Strategis for solving problems,* (6) *Using symbolic, Formal and Techical Language and Operation,* and (7) *Using Mathematics Tools* (PISA OECD, 2015).

Mathematical literacy involves communication. The individual perceives the existence of some challenge and is stimulated to recognize and understand a problem situation. Reading, decoding and interpreting statements, questions, tasks or objects enables the individual to form a mental model of the situation, which is an important step in understanding, clarifying and formulating a problem. During the solution process, intermediate results may need to be summarized and presented. Later on, once a solution has been found, the problem solver may need to present the solution, and perhaps an explanation or justification, to others. (PISA OECD, 2016: 70).

Sumarmo (2000) summarizedthe goal of learning mathematics language and symbols was to communicate mathematically so that students were able: (1) to reflect and explain their ideas mathematically; (2)to formulate definition of mathematics concepts and compile generalizationthrough invention method; (3)to express a figure, diagram, or a real situation into mathematical language,symbol, idea, or model;(4) to explain or clarify mathematical ideas, situation, or relation in daily languageorally or written; (5) to read, to clarify, and to examine mathematical presentation meaningfully; (6) to appreciate the beauty and the power of mathematical notations and used themaccurately and precicely. (Qohar dan Sumarno, 2013).

PISA (*Program for International Student Assesment*)

PISA is organized by the OECD in conjunction with a group of other participating countries, including Indonesia. The first survey took place in 2000, and then every 3 years since that time. PISA measures knowledge and skills of 15-year-olds, an age at which students in most countries are nearing the end of compulsory schooling. The focus is on areas that are important for life after school, including mathematics. PISA is a statistically rigorous programme to assess student performance and to collect data on the student, family and institutional factors that can help to explain differences in performance in countries around the world. (Stacey, 2011)

The OECD identifies the key features of PISA as: 1) policy orientation, with the major aim of informing educational policy and practice; 2) the PISA concept of "literacy" (see below) with a foundation of assessment of literacy for reading, mathematics and science; 3) its relevance to lifelong learning, so that assessment of knowledge is supplemented by reports on motivation to learn, attitudes towards learning and learning strategies; 4) its regularity, enabling countries to monitor improvements in educational outcomes in the light of other countries' performances on assessments held every 3 years; 5) measurement of student performance alongside characteristics of students and schools, in order to explore some of the main features associated with educational success; 6) breadth, with over 60 countries and economies participating by 2009, representing around 90% of the world economy. (Stacey, 2011)

PISA 2012 will focus on mathematics as the main domain as in 2003. In each assessment, trend data is collected through an abbreviated test on the other two domains, using 'link items' from the earlier assessment to give results that can indicate trends. Students also answer a 30 minute background questionnaire, providing information about themselves, their attitudes to learning and their homes. School principals answer a questionnaire about their schools. These questionnaires provide baseline information about the conditions of schooling in different countries, and enable the examination of issues such as equity of schooling and effective practices. PISA is also developing other assessments. For example, it measures Information and Communication Technology skills and assesses the reading of electronic texts. In 2012, there will be an optional component on financial literacy. Since the science assessment of 2006, computer-based assessments have also been used to support a wider range of dynamic and interactive tasks. The mathematics assessment for 2012 will have an optional computer-administered component, which will provide new opportunities for presentations of items and may also test some aspects of doing mathematics assisted by a computer.(Stacey, 2011).

PISA has also conducted tests of general problem solving, and will do so again in 2012. The problem solving assessment taps students' "capacity to use cognitive processes to confront and resolve real, cross-disciplinary situations where the solution path is not immediately obvious and where the literacy domains or curricular areas that might be applicable are not within a single domain of mathematics, science or reading" (OECD 2013: 156).

The mathematics assessment also contains many items that might be considered problem solving, but they draw explicitly on mathematics content. The contents of PISA-item are: (1) *Change and Relationship,(2) Space and Shape;* (3) *Quantity; and* (4)*Uncertainty and data.* The *Uncertainty and data* content category includes recognising the place of variation in processes, having a sense of the quantification of that variation, acknowledging uncertainty and error in measurement, and knowing about chance. It also includes forming,interpreting and evaluating conclusions drawn in situations where uncertainty is central.

PISA-item on Uncertainty and Data Content

Problem 1

FAULTY PLAYERS

The *Electrix Company* makes two types of electronic equipment: video and audio players. At the end of the daily production, the players are tested and those with faults are removed and sent for repair.

The following table shows the average number of players of each type that are made per day, and the average percentage of faulty players per day.

Player type	Average number of players made per day	Average percentage of faulty players per day
Video players	2000	5%
Audio players	6000	3%

Question : FAULTY PLAYERS (*PM00EQ02 – 019)*
One of the testers makes the following claim:

"On average, there are more video players sent for repair per day compared to the number of audio players sent for repair per day." Decide whether or not the tester's claim is correct. Give a mathematical argument to support your answer.

.....

(Source: PISA 2012 Released Mathematics Items 2013: 41-42)

Picture 1. PISA-item about faulty players

Problem 2

Question 3: FAULTY PLAYERS PM00EQ03 – 0

The *Tronics Company* also makes video and audio players. At the end of the daily production runs, the *Tronics Company's* players are tested and those with faults are removed and sent for repair.

The tables below compare the average number of players of each type that are made per day, and the average percentage of faulty players per day, for the two companies.

Company	Average number of video players made per day	Average percentage of faulty players per day
Electrix Company	2000	5%
Tronics Company	7000	4%

Company	Average number of audio players made per day	Average percentage of faulty players per day
Electrix Company	6000	3%
Tronics Company	1000	2%

Which of the two companies, *Electrix Company* or *Tronics Company*, has the lower overall percentage of faulty players? Show your calculations using the data in the tables above.

(Source: PISA 2012 Released Mathematics Items 2013: 41-42)

Picture 2. PISA-item about faulty players 2

Problem 3

PENGUINS

The animal photographer Jean Baptiste went on a year-long expedition and took numerous photos of penguins and their chicks.

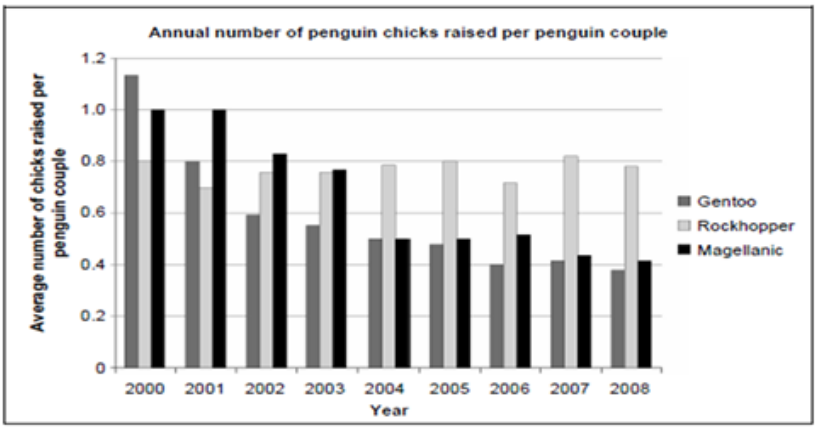
He was particularly interested in the growth in the size of different penguin colonies.

Translation Note: In French, "penguin" is "manchot".

Question 4: PENGUINS PM921Q04

After he gets home from his trip, Jean Baptiste has a look on the Internet to see how many chicks a penguin couple raise on average.

He finds the following bar chart for the three penguin types Gentoo, Rockhopper and Magellanic.



Based on the chart above, are the following statements about these three penguin types true or false?

Circle "True" or "False" for each statement.

Statement	Is the statement true or false?
In 2000, the average number of chicks raised per penguin couple was larger than 0.6.	True / False
In 2006, on average, less than 80% of penguin couples raised a chick.	True / False
By about 2015 these three penguin types will be extinct.	True / False
The average number of Magellanic penguin chicks raised per penguin couple decreased between 2001 and 2004.	True / False

Translation Note: Gentoo - *Pygoscelis papua* / Rockhopper - *Eudyptes chrysocome* / Magellanic - *Spheniscus magellanicus*

Translation Note: Please translate "bar chart" with the term most commonly used in 15-year olds' mathematics classes. Avoid using more formal expressions such as "histogram" in ENG or "histogramme" in FRE that are less common and more difficult for 15-year olds.

(Source: PISA 2012 Released Mathematics Items: 57)

Picture 3. PISA-item about Penguins

Problem 4

HOLIDAY APARTMENT

Christina finds this holiday apartment for sale on the internet. She is thinking about buying the holiday apartment so that she can rent it out to holiday guests.

Number of rooms:	1 x living and dining room 1 x bedroom 1 x bathroom
Size:	60 square metres (m²)
Parking spot:	yes
Travel time to town centre:	10 minutes
Distance to the beach:	350 metres (m) in a direct line
Average usage by holiday guests in the last 10 years:	315 days per year

Price: 200 000 zeds

PM962C

Question 2: HOLIDAY APARTMENT

315 days per year is the average usage of the apartment by holiday guests over the last 10 years.

Decide whether the following statements can be deduced from this information. Circle "Yes" or "No" for each statement.

Statement	Can the statement be deduced from the given data?
It can be said with certainty that the holiday apartment was used on exactly 315 days by holiday guests in at least one of the last 10 years.	Yes / No
Theoretically it is possible that in the last 10 years the apartment was used on more than 315 days every year by holiday guests.	Yes / No
Theoretically it is possible that in one of the last 10 years the apartment was not used at all by holiday guests.	Yes / No

Note: Assume a year has 365 days.

(Source: PISA 2012 Released Mathematics Items: 57)

Picture 4. PISA-item about Holyday Apartment

Problem 5

CABLE TELEVISION

The table below shows data about household ownership of televisions (TVs) for five countries.

It also shows the percentage of those households that own TVs and also subscribe to cable TV.

Country	Number of households that **own TVs**	Percentage of households that **own TVs** compared to **all households**	Percentage of households that **subscribe to cable television** compared to households that **own TVs**
Japan	48.0 million	99.8%	51.4%
France	24.5 million	97.0%	15.4%
Belgium	4.4 million	99.0%	91.7%
Switzerland	2.8 million	85.8%	98.0%
Norway	2.0 million	97.2%	42.7%

Source: ITU, World Telecommunication Indicators 2004/2005
ITU, World Telecommunication/ICT Development Report 2006

Translation Note: Please do not change the countries in this unit.

Translation Note: Change to , instead of . for decimal points, if that is your standard usage, in EACH occurrence.

Translation Note: You may change the term "cable TV" to a relevant local terminology, for example, "subscription TV" or "pay per view TV".

Translation Note: There may be no word for "million" in some languages; translate one million appropriately (e.g. ten hundred thousand); if absolutely necessary, the numeral 1 000 000 could be used throughout.

Question 2: CABLE TELEVISION *PM978Q02 – 0011 12 99*

Kevin looks at the information in the table for France and Norway.

Kevin says: "Because the percentage of all households that own TVs is almost the same for both countries, Norway has more households that subscribe to cable TV."

Explain why this statement is incorrect. Give a reason for your answer.

.....

(Source: PISA 2012 Released Mathematics Items: 73-75)

Picture 5. PISA-item about Cable Television

Result and Discussion

Categorising mathematics communication skill in uncertainty and data content will be identified by indicators of mathematics communication skill which have arranged. Indicators of mathematics communication skill have made based on the definitions above. Indicator of mathematics communication skill can be modified by Sumarno's and OECD's definitions. These are: 1) formulate definition of mathematics concepts and compile generalization through invention method; (2) to express a figure, diagram, or a real situation into mathematical language, symbol, idea, or model; (3) to explain or clarify mathematical ideas, situation, or relation in daily language orally or written and may need to present the solution, and perhaps an explanation or justification to the others; (4) to read, to clarify, and to examine mathematical presentation meaningfully; (5) to appreciate the beauty and the power of mathematical notations and used them accurately, precicely and may need to be summarized and presented.

Then, indicators of mathematics communication skill will be identified on 5 PISA-items. Theme of these item are: (1) Faulty players; (2) Penguins; (3) Holiday Apartment; (4) Cable Television. The result of analysis mathematics communication skill on PISA-item seatled on table below.

Table 1. The result of analysis mathematics communication skill on PISA-item

No.	Indicators of mathematics communication skill on PISA-item	Problem 1		Problem 2		Problem 3		Problem 4		Problem 5	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
1.	PISA-item fasilitate student's to formulate definition of mathematics concepts and compile generalization through invention method			√						√	
2.	PISA-item fasilitate student's to express a figure, diagram, or a real situation into mathematical language, symbol, idea, or model			√		√				√	
3.	PISA-item fasilitate student's to explain or clarify mathematical ideas, situation, or relation in daily language orally or written and may need to present the solution, and perhaps an explanation or justification to the others	√		√						√	
4.	PISA-item fasilitate student's to read, to clarify, and to examine mathematical presentation meaningfully.			√		√		√			
5.	PISA-item fasilitate student's to appreciate the beauty and the power of mathematical notations and used them accurately, precicely and may need to be summarized and presented			√						√	

Based on Table 1, actually these PISA-item are involved mathematics communication skill to assess student's mathematics knowledge which are formulate definition of mathematics concepts and compile generalization through invention method; express a figure, diagram, or a real situation into mathematical language, symbol, idea, or model; explain or clarify mathematical ideas, situation, or relation in daily language orally or written and may need to present the solution, and perhaps an explanation or justification to the others; read, to clarify, and to examine mathematical presentation meaningfully; appreciate the beauty and the power of mathematical notations and used them accurately, precicely and may need to be summarized and presented.

PISA-item on problem 1,2, and 5 provide challanges students to make their symbol and decoding of mathematics to help their calculation easier. Students can express a figure, diagram, or a real situation into mathematical language, symbol, idea, or model based on problem that faced. Then students must make the relation in daily language orally or written and may need to present the solution, and perhaps an explanation or justification to the others. Explanation and present to the others also tested and make meaningfully presentations of the problem may also test some aspects of doing mathematics assisted by a computer.

PISA-item on problem 3 and 4 provide challanges to think about the interpretations based on data above. But the questions must be answered by Yes or No and there are not reason or summirezed the calculation why to answer Yes or No. It makes mathematics communication skill not be improve well but it provide student to develop their mathematical thinking.

PISA tested on 2012 for mathematics assessment have been an optional computer-administered component, which will provide new opportunities for presentations of items and may also test some aspects of doing mathematics assisted by a computer. That so, all of mathematics communication skill have been assessed on PISA-item and Indonesia should be facilitate opportunity for student to improve their mathematics communication skill not only state on paper test but also the presentation skill to share mathematics solution.

Conclussion

Based on categorising PISA-item that involved mathematics communication skill, it conclude that all PISA-item on uncertainty and data content prepared challenges for students to solve the problem not only to get the solution but also must be state how to made it solution easy to understand for the others. But, PISA test don't facilitate the students to discuss with other so the communication to work in team not be improve. In classroom, teacher must facilitate student's to face PISA-like item so that students learn more many kind of problems and based

on PISA framework. Beside it, teacher can develop to immatiate items on PISA when they test their students. Teacher can develop PISA-like items which improve students' mathematics communication skill.

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