Developing the Sixth Level of PISA-Like Mathematics Problems for Secondary School Students

Kamaliyah, Zulkardi, Darmawijoyo

Abstract

Indonesia's involvement in the Programme for International Student Assessment (PISA) is one attempt to see how far the development of educational programs in our country compared to other countries in the world. PISA results show that Indonesia is still at the lower level. This means that the ability of Indonesian students in solving problems that require the ability to review, giving reasons and communicating effectively, and solve and interpret problems in various situations is still lacking. This may be due to government policy in the presence of the National Examination (UN) in which the spread of the UN's questions are still at the lower levels of cognitive aspects that are not in line with government regulations on curriculum which suggests that the fulfillment of cognitive aspects as one of the important aspects of education. To that end, researcher conducted a study that aims to produce valid and practical the sixth level of PISA-like mathematics problems for middle school students. This study is the development research formative evaluation type. The research subjects are ninth grade students SMP Negeri 1 Palembang. Data collection techniques used are walk through, documentation, interviews, and tests. From the analysis it can be concluded that this research has resulted a product the sixth level of PISA-like mathematics problems. At the stage of expert review, an expert and two colleagues evaluated the problems from different aspects. Trying out at one-to-one and small group was performed on students with different mathematical abilities. Then at the field test stage, 26 students in one class answered the questions that were developed.

Keywords: development research, PISA questions, development the sixth level of PISA-like mathematics problems

Abstrak

Keterlibatan Indonesia dalam *Program International for Student Assessment* (PISA) adalah salah satu upaya untuk melihat sejauh mana perkembangan program pendidikan di negara kita dibandingkan dengan negara-negara lain di dunia. Hasil PISA menunjukkan bahwa Indonesia masih berada pada level bawah. Ini berarti bahwa kemampuan siswa Indonesia dalam menyelesaikan soal-soal yang menuntut kemampuan untuk menelaah, memberi alasan dan mengomunikasikannya secara efektif, serta memecahkan dan menginterpretasikan permasalahan dalam berbagai situasi masih sangat kurang. Hal ini mungkin disebabkan kebijakan pemerintah dengan adanya Ujian Nasional (UN) di mana penyebaran soal UN masih berada pada level bawah dari aspek kognitif yang tidak sejalan dengan peraturan pemerintah mengenai KTSP yang mengisyaratkan agar

Kamaliyah, Zulkardi, Darmawijoyo

terpenuhinya aspek kognitif sebagai salah satu aspek penting dalam pendidikan. Untuk itu, peneliti melakukan penelitian yang bertujuan untuk menghasilkan soal matematika model PISA level 6 untuk siswa sekolah menengah pertama yang valid dan praktis. Penelitian ini adalah penelitian pengembangan (*development research*) tipe *formative evaluation*. Subjek penelitian adalah siswa kelas IX SMP Negeri 1 Palembang. Teknik pengumpulan data yang digunakan adalah *walk through*, dokumentasi, wawancara, dan tes. Dari hasil analisis dapat disimpulkan bahwa penelitian ini telah menghasilkan suatu produk soal matematika model PISA level 6. Pada tahap *expert review*, tiga orang pakar dan teman sejawat mengevaluasi dari aspek yang berbeda. Uji coba soal pada tahap *one-to-one* dan small group dilakukan pada siswa dengan kemampuan matematika yang berbeda. Pada tahap *field test*, 26 orang siswa dalam satu kelas menjawab soal-soal yang dikembangkan.

Kata Kunci: penelitian pengembangan, soal PISA, pengembangan soal matematika model PISA level 6

Introduction

Development of science and technology is faster and faster, especially on information and communication scope so that human resources that are reliable and able to compete globally are necessary. Indonesian students should be able to compete with other students from various countries in the face of the current era of globalization. Various tests conducted internationally can be used as a benchmark to determine the extent to which Indonesian students competing in the globalization era. The results of these tests are often used as a basis for program development and improvement of education quality. Indonesia's involvement in the Programme for International Student Assessment (PISA) is one attempt to see how far the development of educational programs in our country compared to other countries in the world.

PISA results show that Indonesia is still at the lower level. Of the 65 participating countries in PISA 2009, Indonesia occupied the position 61st for PISA mathematics. This means that the ability of Indonesian students in solving problems that require the ability to review, giving reasons and communicating effectively, and solve and interpret problems in various situations is still lacking. Based on the results of PISA mathematics in 2009 (Stacey, 2010), only 0.1% of Indonesian students are able to solve problems for the two top level in PISA.

This may be due to government policy in the presence of the National Examination (UN). Based on research results Sampoerna Foundation (Yunengsih, Widiatmika &

Candrasari, 2008) about the deployment of UN remains at the level of cognitive aspects memorize, perform the procedure, and demonstrate understanding. As for the other two aspects namely conjecture/generalize/prove and solve non-routine problems not at all touched by the UN in the subject matter of mathematics. Yet these two aspects occupy the highest levels of cognitive aspects. This is inconsistent with government regulations on curriculum which suggests that the fulfillment of the cognitive aspects as one of the important aspects of education.

Evy Yosita Silva (2011) have developed mathematical questions PISA-model on the content uncertainty for ninth grade secondary school students that are grouped based on clusters competencies in PISA. However, this study did not categorize the questions that have been developed into the PISA levels. In addition, Annisah (2011) also developed mathematical questions PISA-model on content quantity level 2 through 6 for measuring mathematical reasoning ability for middle school students. The results of this study include the inability of students in identifying problems and looking at the matter of the relevant mathematical way to solve the given problem.

Aiming to produce the sixth level of PISA-like mathematics problems that are valid and practical, the research question of this study is how to develop valid and practical mathematics questions PISA-mode level 6 for secondary school students. The results of this research are expected to be useful for students, so they accustomed to use their knowledge in everyday life by answering mathematical questions PISA-model, for mathematics teacher, to use the questions as an alternative in the improvement of learning evaluation that can be used to train students in applying mathematics skills and knowledge in everyday life.

Theoritical Framework

1. **Programme for International Student Assessment (PISA)**

PISA is a collaborative effort on the part of the member countries of the OECD to measure how well students at age 15, and therefore approaching the end of compulsory schooling, are prepared to meet the challenges of today's societies. PISA assessment takes a broad approach to assessing knowledge and skills that reflect the current changes in curricula, moving beyond the school based approach towards the use of knowledge in everyday tasks and challenges. PISA combines the assessment of domain-specific areas such as reading, mathematical, and scientific literacy with

important cross-curricular areas, also a priority among OECD countries (OECD, 2003). PISA assessment has been conducted for four periods, namely 2000, 2003, 2006, and 2009. In the 2000, PISA study focused on reading ability, while two other aspects as a companion. In 2003, mathematical literacy became the main focus, then science literacy in 2006 and in 2009, the main focus shifting from science literacy towards reading literacy.

The mathematical literacy definition for PISA is (OECD, 2009a):

> *Mathematical literacy is an individual's capacity to identify and understand the role that mathematics plays in the world, to make well-founded judgements and to use and engage with mathematics in ways that meet the needs of that individual's life as a constructive, concerned and reflective citizen.*

Thus knowledge and understanding of mathematical concepts is important, but the ability to turn on mathematical literacy to solve problems encountered in daily life is more important. Therefore, the questions given in PISA are presented mostly in the context of real-world situations that can be felt the benefits of mathematics to solve problems of daily life. The purpose of PISA is to measure the level of students' skills in using mathematical knowledge and skills to handle everyday problems.

2. Mathematical Content – The four "overaching ideas" – in PISA

Mathematical concepts, structures, and ideas have been invented as tools to organize he phenomena of the natural, social and mental world. Since the goal of PISA is to assess students' capacity to solve real problems, the strategy has been to define the range of content that will be assessed using a phenomenological approach to describing the mathematical concepts, structures or ideas. This means describing content in relation to the phenomena and to kinds of problems for which it was created. This approach ensures a focus in the assessment that is consistent with the domain definition, yet covers a range of content that includes what is typically found in other mathematics assessments and in national mathematics curricula.

The following list of overaching ideas is used in PISA to meet the requirements of historical development, coverage of the domain, and reflection of the major threads of school curriculum: *quantity*, *space and shape*, *change and relationship*, and *uncertainty*. With these four, mathematical content is organized into a sufficient number of areas to ensure a spread of items across the curriculum, but at the same

time a number small enough to avoid a too fine division that would work against a focus on problems and concepts that make sense and can be encountered within and across a multitude of different situations.

3. Situations or Context in PISA

An important aspect of mathematical literacy is engangement with mathematics: using and doing mathematics in a variety of situations. It has been recognized that in dealing with issues that lend themselves to a mathematical treatment, the choice of mathematical methods and representations is often dependent on the situation in which the problems are presented. The situation is the part of the student's world in which the tasks are placed. It is located at a certain distance from the students. For OECD/PISA, the closest situation is the student's personal life; next is school life, work life, and leisure, followed by local community and society as encountered in daily life. Furthest away are scientific situations. Four situation- types are used for problems to be solved: personal, educational/occupational, public, and scientific. The context of an item is its specific setting within a situation. It includes all the detailed elements used to formulate the problem.

4. The PISA Scale and Difficulty

To summarise data from responses to the PISA test instrument, a six-level described performance scale is created. The scale created statistically, using an item response modeling approach to scaling ordered outcome data. The overall scale is used to describe the nature of performance by classifying the students performances of different countries in terms of the five described performance levels, and thus provide a frame of reference for international comparisons.

At proficiency level 6, students can conceptualise, generalize, and utilize information based on their investigations and modeling of complex problem situations. They can link different information sources and representations and flexibly translate among them. Students at this level are capable of advanced mathematical thinking and reasoning. These students can apply this insight and understandings along with a mastery of symbolic and formal mathematical operations and relationships to develop new approaches and strategies for attacking novel situations. Students at this level can formulate and precisely communicate their actions and reflections regarding their findings, interpretations, arguments, and the approprieteness of these to the original situations.

        Kamaliyah, Zulkardi, Darmawijoyo

5. Mathematical Literacy and Mathematics Learning Goals

Based on the definition of mathematical literacy that is mentioned in the previous section, mathematical literacy is concerned with student's ability to formulate, implement, and interpret mathematics in various contexts, including the ability to reason mathematically and use the concepts, procedures, and facts to illustrate, explain or predict phenomena. Mathematical literacy helps one to understand the role or usefulness of mathematics in everyday life as well uses it to make the right decisions as citizens.

In line with this, Permendiknas No. 22, 2006 about content standards of mathematics subject for basic education scope states that mathematics courses intended that learners have the following capabilities (Wardhani, 2008).

1. Understanding mathematical concepts, explain the link between concepts or algorithms flexibly, accurately, efficiently, and appropriately, in solving problems.

2. Using the reasoning on the pattern and nature, performing mathematical manipulation in making generalizations, compiling evidence, or explaining ideas and mathematical statements.

3. Solving problems that include the ability to understand the problem, designing a mathematical model, completing model and interpreting the obtained solution.

4. Communicating ideas with symbols, tables, diagrams, or other media to clarify the situation or problem.

5. Having respect for the usefulness of mathematics in life, have a curiosity, attention, and interest in studying mathematics, and a tenacious attitude and confidence in problem solving.

If mathematical literacy is compared with the mathematics learning goals then there is suitability and understanding. The learning golas to be used in Permendiknas is mathematical literacy. Note that, the goals for mathematics subject according to content standards are essentially an ability also known as mathematical literacy.

Method

The research was conducted in odd semesters of the school year 2011/2012 in ninth grade SMP Negeri 1 Palembang. The method in this study is development research formative evaluation type (Tessmer, 1993) which includes expert review and one-to-

Developing The sixth level of PISA-like mathematics problems for Secondary School Students

one, small group, and field test. At expert review, the designed products were observed, assessed and evaluated by experts. Experts were examining content, construct, and the language of each prototype. The suggestions of the experts were used to revise the questions that have been developed. In one-to-one, the researcher tested the questions to students as a tester. Students' answers and comments used to revise the questions that have been made.

The results of revision of the experts and the difficulties experienced by students while testing the first prototype were used as a basis for revising the prototype and then the result is called the second prototype tested in small groups. At this stage, six students grade nine were asked to solve the problems that have been designed and were also asked their comments on that question through interviews. Suggestions and comments and the test results on a second prototype used as a basis for revising the design of the second prototype. The results of revisions were tried out to the subjects in this research as a field test. The sequence of formative evaluation is as follows.
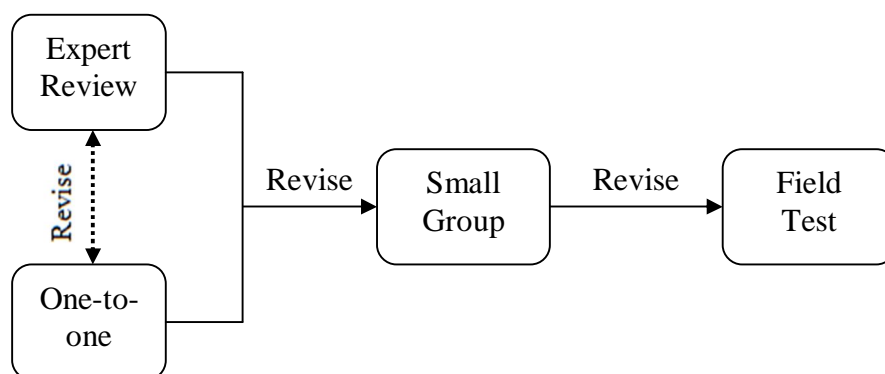

Figure 1. General sequence of formative evaluation types (Tessmer, 1993)

Data collection techniques used in this study is walk through to find out the qualitative validity of the content, construct, language; documentation to determine the practicality of a matter; interviews to determine students 'suggestions and comments, and tests to determine students' answers to the questions that were developed.

Result and Analysis

In the early stages, some preparation is done which includes analysis of students to determine the level of mathematical ability of students in choosing a subject of

Kamaliyah, Zulkardi, Darmawijoyo

research, analysis the curriculum by indentifying mathematics learning material for secondary school student, analyzing PISA questions by reviewing several sources of PISA to identify the characteristics of PISA questions level 6, then designing the sixth level of PISA-like mathematics problems. Furthermore, based on the development steps described earlier, the stages are as follows.

1. Expert Review

At this stage the qualitative validity were consulted and examined based on the content, construct, and language to the professors and colleagues who have experience in mathematics education as a validator, the validator is: Prof. Dr. Sutarto Hadi, M. Si, M. Sc, professors and lecturers of mathematics education courses Lambung Mangkurat University, Banjarmasin to review the mathematical concepts and contexts used in the questions that are already developed in accordance with the characteristics of PISA questions level 6. Nurjannah, S. Pd, a Secondary School mathematics teacher who reviewed the correspondence between problems developed with the level of secondaryh school students in grade nine also with Indonesian curriculum, interest students to solve, and interest mathematics teachers to use these problems in teaching and learning. Rully Charitas Prahmana Indra, writer and a student of Sriwijaya University Graduate Program as an editor of the writing and the use of sentences in the questions that were developed to improve the clarity.

2. One-to-one

At one-to-one, in which the questions developed were tested to three students with different mathematical abilities, namely high, medium, and low. The procedure was same for each student, although it was performed at different times. The researcher met with each student individually and involved them in an informal conversation. Evaluation of one-to-one focusing on clarity, ease of use, and effectiveness of the questions that were developed, as well as the interest of students to such questions. Here are the comments of students on the stage of one-to-one.

Tabel 1. Students' comments in one-to-one evaluation

Students' name	Comments
Farah Ayodya Swari (high mathematical ability students)	Not accustomed to work on problems like this. Usually work on the problems using the formula Do not like doing it because it is difficult to read the long questions
Fakhriah Febriana Fitria (medium mathematical	Accustomed to work on the problems like this Actually, a little confused how to solve it but I enjoy it.

ability students)	Must be more carefully in order to answer the questions.
Deandra S.	Like to do the problem like this because it is good for our brain.
(low mathematical ability students)	The words and sentences on the matter, most obviously Difficult to provide explanations for the answers given.

After the expert review phase and one-to-one, the questions were revised in order to obtain prorotype II tested in small group.

3. Small group

At this stage, the researcher was only as an observer in which the questions were tested to six ninth grade students SMPN 1 Palembang. Students are required to solve all the questions provided and then provide suggestions/comments on the matter that has been done.

Tabel 2. Students' comments in small group evaluation

Students' name	Comments
Iklimah dan Dasi Edimas (high mathematical ability students)	• The problem is very difficult and the words make me dizzy and confused. • The problems given are quite difficult, not only have to calculate, but also must use logic correctly to find the answer.
Fadel Muhammad and Fatya Rimandita Hero (medium mathematical ability students)	• Actually, this problem is not too difficult. • Although I had found the results, but as if hard to articulate explanation. • The questions are rather difficult because the questions are difficult to understand.
Pingkan Taradhita and Muhammad Adil Wira S. (medium mathematical ability students)	• The questions are easy and the answers are also easy to obtain. • The questions are quite difficult but I can answer them. • Difficult to explain how to find the answer.

4. Field test

Field tests conducted on November 28th, 2011 in class IX 2 SMPN 1 Palembang with the number of students were 26 people consisting of 12 male students and 14 female students. Twelve questions were given to students and worked for 2 hours of lessons (90 minutes).

The sixth level of PISA-like mathematics problems were categorized qualitatively valid and practical. Validity is reflected from the results of the validator, the validator states where almost all items based on the content (in accordance with the characteristics PISA, mathematical ability level indicator 6 PISA), construct (develop mathematical literacy skills, rich with the concept, accordance with secondary school

Kamaliyah, Zulkardi, Darmawijoyo

students grade nine, inviting further development of the concept), and language (in accordance with the EYD, the questions not beating around bush, the quesions do not contain a double interpretation, the limits of the questions and answers is clear).

The revision based on comments/suggestions of students on one-to-one and small group evaluation showed that the questions developed are practical in which all students can use the device well. The questions developed in accordance with the student's train of thought, the contexts given are familiar to the students, easy to read, and not cause a diverse interpretation.

The following is an explanation about the the sixth level of PISA-like mathematics problems as well as some students' answers on the field test:

MOTIF BATIK

Gambar berikut adalah motif batik Jawa

n = 1   n = 2   n = 3
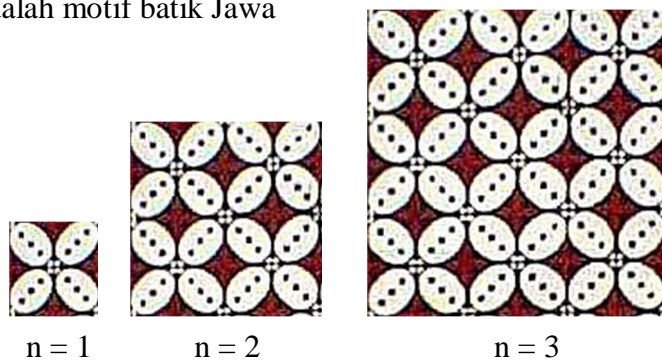
Sumber: http://kamusjawa.com/wp-content/uploads/2011/08/batik_kawung1.jpg

Untuk kain dengan luas 6 cm^2, dilukis 1 buah bunga putih yang terdiri dari 4 kelopak, kemudian untuk kain seluas 12 cm^2 dilukis 4 buah bunga putih, dan seterusnya. Jika *n* adalah jumlah baris dari bunga putih maka

Jumlah bunga putih $= n^2$ dan luas kain $= 6n$

Andaikan kain yang digunakan semakin luas dengan motif bunga putih yang sama dengan pola sebelumnya, yang manakah yang meningkat lebih cepat: jumlah bunga putih atau luas kain?

Buktikan dan jelaskan jawabanmu!

Developing The sixth level of PISA-like mathematics problems for Secondary School Students

Content : Quantity

Konteks : Occupation

Skoring:

Full credit:

Correct answers (the number of white flowers) equipped with a valid explanation, for
example:

- The number of flowers = $n \times n$ and the fabric's wide = $n \times 6$, both formulas have a factor of n, but the number of flowers has n that also increased while fabric's wide has 6 that remain constant. So that the number of flowers will increase more rapidly;

- The number of flowers will increase more rapidly because the number will be squared compared with multiplied by 6; or

- The number of flowers is a quadratic number. fabric's wide is linear. Thus, the number of flowers will rise faster.

Partial credit

Correct answers (the number of white flowers) equipped with an explanation based on examples, for example:

- Using table,

	n = 1	n = 2	n = 3	n = 4	n = 5	n = 6	n = 7
Fabric's wide	6	12	18	24	30	36	42
The number of white flowers	1	4	9	16	25	36	49

- The number of white flowers will raise faster if n> 6.

No credit: wrong answer and missing

The question is related to the subject of algebra associated with multiplication. This relationship is expressed in algebra symbol n. Because every representation of a symbol that has the purpose and nature of each, the process of translation becomes very important and determines in accordance with the situation and work to be done. Context of work on a matter related to *batik* made by craftsmen. Students' knowledge about mathematical concepts is expected to help formulating, conducting the classification problem, and solving the problem of employment in general.

Based on indicators level 6, students should be conceptualized, generalize, and use information based on extensive investigation and modeling of fabric's wide and the

number of flowers expressed in *n* then connect the source of information and different representations for fabric's wide and the number of interest with their respective size and flexibly translate the increase in comparable of fabric's wide and the number of flowers where if the number of fabric's wide increases, the number of flowers will also increase. In addition, students need to demonstrate mathematical thinking and good reasoning to determine which one is increasing faster and apply this insight along with a mastery of symbolic and formal mathematical operations and relationships (a quadratic number and a result of multiplying a number by a constant number) to develop an approach and a new strategy to determine the extent of fabric's wide or the number of flowers will rise even faster, then formulate and communicate with appropriate action and reflection on the discovery, interpretation, argument, and the suitability of the discovery, interpretation, and argument with the original situation.

Only 7.7% of students were able to answer this question with a valid explanation furnished. They were able conceptualized, generalize, and use information based on extensive investigation and modeling of fabric's wide and the number of flower expressed in *n* then connect it with the equation. They have also demonstrated the mathematical thinking and good reasoning to determine the amount of increase due to the increased of flower in the quadratic equation (Figure 2). In addition, Mahali answered this question correctly but with the explanation just using example (Figure 3) so that when n> 6 he realized that the number of flower is increasing faster than the broad fabric. There were also 7.7% of students answering using examples like this.

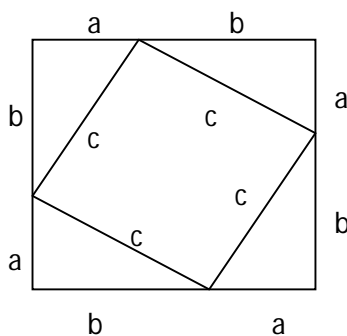Figure 2. Shafira's answer for the first question

Figure 3. Mahali's answer for the first question
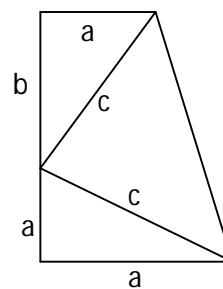
TEOREMA PYTHAGORAS

Teorema Pythagoras menyatakan bahwa: jumlah kuadrat kedua sisi siku-siku pada segitiga siku-siku sama dengan panjang kuadrat sisi miringnya, yaitu $a^2 + b^2 = c^2$ seperti gambar di samping.
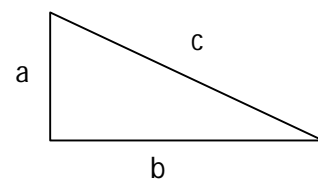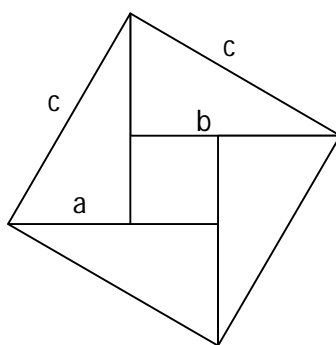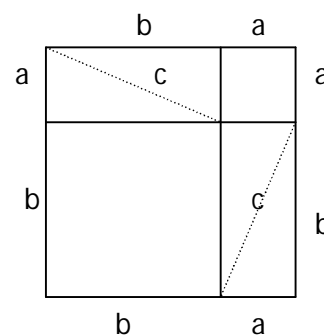
Perhatikan Gambar di bawah ini!

Gambar A

Gambar B

Gambar C

Gambar D

Soal 11

Tulislah "Ya" atau "Tidak" untuk setiap gambar yang juga dapat digunakan untuk membuktikan teorema Pythagoras.

Gambar yang dapat digunakan	Gambar ini dapat digunakan untuk membuktikan $a^2 + b^2 = c^2$
Gambar A	Ya / Tidak
Gambar B	Ya / Tidak
Gambar C	Ya / Tidak

Gambar D	Ya / Tidak

Kamu harus membuktikan jawabanmu dengan menunjukkan bahwa persamaan $a^2 + b^2 = c^2$ dapat ditemukan pada Gambar A, B, C, dan D di atas!

Content   : Space and shape

Context   : Science

Scoring   :

Full credit:

Correct answers (in order: Yes, Yes, Yes, No) with valid proof, namely:

Figure A is a square with side length a + b in which there were four congruent right-angled triangle the square with side c then the area of Figure A is

$$(a + b)^2 = 4 \times (½ \times a \times b) + c^2 \Leftrightarrow a^2 + 2ab + b^2 = 2ab + c^2 \Leftrightarrow a^2 + b^2 = c^2$$

Figure B is a right-angled trapezoid with a length of the parallel sides are *a* and *b* in which consists of two congruent right-angled triangle and an isosceles right triangle with side length c, so the area Figure B is

$$½ (a + b) \times (a + b) = 2 \times (½ \times a \times b) + ½ c^2 \Leftrightarrow ½ a^2 + ½ab + ½ab + ½ b^2 = ab + ½c^2$$

$$\Leftrightarrow ½ a^2 + ½ b^2 = ½c^2 \Leftrightarrow a^2 + b^2 = c^2$$

Figure C is a square with side length c within it consists of four congruent right-angled triangles, and a square with side length (ab), so the area of Figure C is

$$c^2 = 4 \times (½ \times a \times b) + (a\text{-}b)^2 \Leftrightarrow c^2 = 2ab + a^2 - 2ab + b^2 \Leftrightarrow c^2 = a^2 + b^2$$

Figure D is a square with side length a + b in which consists of two square pieces each of length a and b sides and four congruent right-angled triangles, so the area of Figure D is

$$(a + b)^2 = a^2 + b^2 + 4 \times (½ \times a \times b) \Leftrightarrow a^2 + 2ab + b^2 = a^2 + b^2 + 2ab$$

Partial score:

Correct answers (in order: Yes, Yes, Yes, No) equipped with a less detailed explanation.

No credit: other responses and missing

The question is the kind of "quasi-realistic" that is more widely available in mathematics than in everyday life. Although not considered a typical, small part about this type tested in PISA. Students need the ability to realize that they have to prove

whether in Figure A, B, C, and D apply the Pythagorean Theorem. Therefore they need to mark the visual information and see pictures of them as a square or trapezoid consisting of triangles and use the broad approach to prove it. This question requires students to understand the visual information, using argumentation skills, using technical knowledge and insight into the geometry, and sustainable use logical thinking.

Based on indicators about level 6, students conceptualized, generalize, and use information based on the investigation and modeling of problem situations are presented, namely proof of the Pythagorean Theorem using a broad approach. They also have to connect the source of information and different representations of the images provided and flexibly translate them if could be used to prove the Pythagorean theorem. Then the students demonstrate mathematical thinking and reasoning are well associated with the broad square, triangle area, large rectangle, and trapezoid area, and apply this insight along with a mastery of symbolic and formal mathematical operations and relationships to develop a strategy of proof is applicable equation $a2 + b2 = c2$ to images that are available. Formulate and communicate their actions and reflections to the right of discovery, interpretation, argument, and the suitability of the discovery, interpretation, and argument with the original situation.

None of the students are able to answer this question correctly. They determine the answer just by looking at the pictures provided if there is a right triangle as shown in Figure 4. They do not synchronize the pictures to prove the Pythagorean Theorem using a broad approach so that they do not develop a strategy of proof is valid.
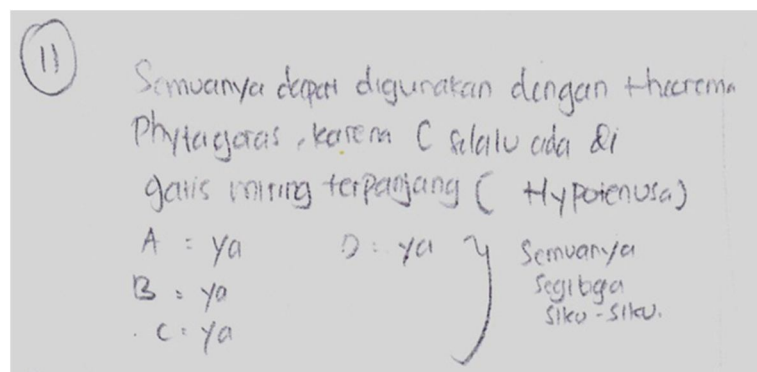

Figure 4. Shafira'2 answer for the second question

NILAI PISA

PISA (*Program for International for Student Assessment*) adalah studi literasi yang bertujuan untuk meneliti secara berkala tentang kemampuan siswa usia 15 tahun (kelas IX SMP dan Kelas X SMA) dalam membaca (*reading litercy*), matematika (*mathematics literacy*), dan sains (*science literacy*).

Seorang mahasiswa menunjukkan grafik berikut dan berkata:

"Grafik ini menunjukkan bahwa ada peningkatan yang sungguh sangat besar dalam rata-rata nilai PISA matematika Indonesia dari tahun 2003 ke tahun 2006."
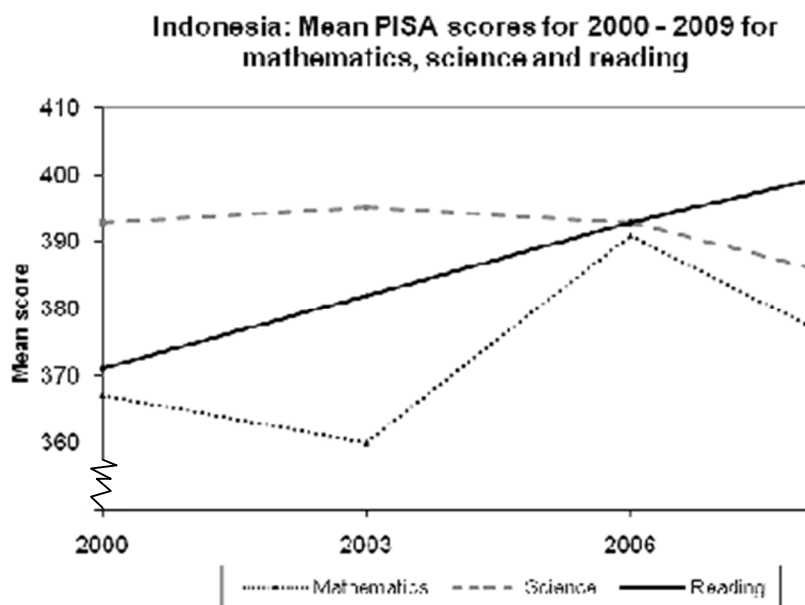
Sumber: http://jims-b.org/?page_id=152&download=12

Apakah menurut kamu, mahasiswa tersebut mengatakan pernyataan yang masuk akal? Berikan bukti dan penjelasan untuk mendukung jawabanmu!

Content : Uncertainty

Context : Public

Scoring :

Full credit:

Correct answers (no sense) with the explanation that focuses on the fact that only a small graph shown, for example:

- All graphs should be shown.

- It's not a reasonable interpretation because if the entire graph is shown then it will be seen that there is little increase in the value of PISA.

- Since the college student shows only a small portion of the graph, if there is the whole graph, i.e 0-410, then the value of PISA mathematics Indonesia is not very large increase.

- Although the graph shows a large increase, but if the number is concerned, it's not a huge increase

Correct answers (no sense) with the explanation that relates to the comparison and percentages.

- Since 30 points is not a huge increase when compared with a total of more than 300;

- Since when is calculated based on the percentage, the increase is only about 10%;

- Since only about 30 points higher than the previous year was not a huge increase when compared with the 360.

Partial credit: Correct answers (not sense) equipped with a less detailed explanation.

No credit: Wrong answer without explanation or missing.

The graph shown in this problem is obtained from the actual graph with little oversight. The graph seems to indicate, as the students: "really a very large increase in the average value of PISA mathematics Indonesia". Students were asked whether the statement is in accordance with existing data. It's important to look through the data and graphs, as is often shown in the media in order to function well in the knowledge society. This is an important ability in mathematics literacy. Mathematical content that exist in this problem is to analyze the graph and interpret data and understand the problems associated with data interpretation errors. In this graph, the y-axis cut shows that indeed very large increase in the average value of PISA mathematics Indonesia, but the real difference between the average value of PISA mathematics Indonesia in 2003 and 2006 is not really very large (Figure 5). This question requires students to understand and mark the graphical representation in a critical manner, making assessments and finding the appropriate arguments based on mathematical thinking and reasoning (interpretation of the data), using the reasoning in the context of comparative statistics and unusual situations, and communicate their reasoning process effectively.

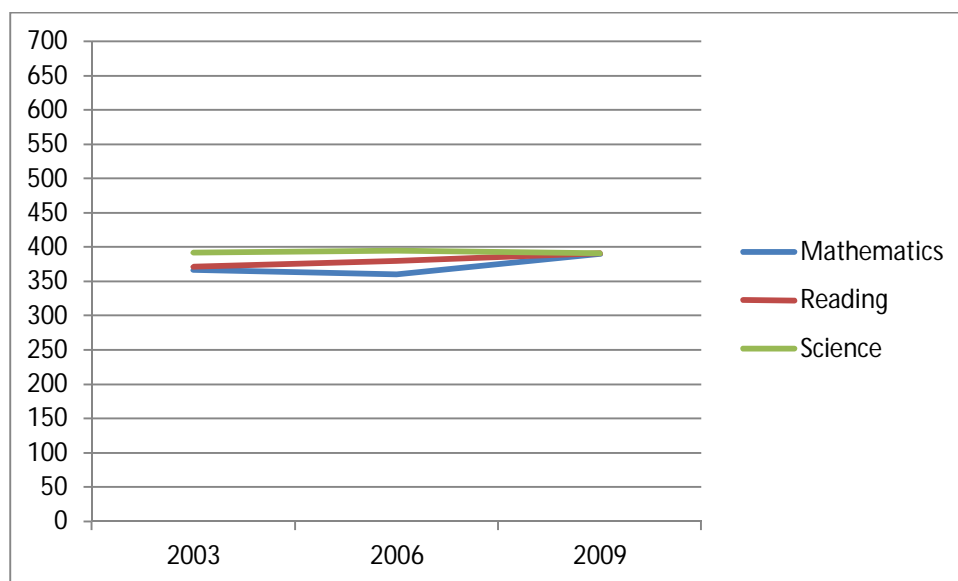Kamaliyah, Zulkardi, Darmawijoyo

Figure 5. The graph for the third question

This question includes PISA level 6 in which students conceptualized, generalize, and use information based on the investigation and modeling of the words of a student and connect sources of information and graphic representations of the average value of PISA Indonesia from 2000 to 2006 and flexibly translate. Then they demonstrate mathematical thinking and good reasoning to determine whether the statement of the college student in accordance with the chart shown, and apply this insight along with a mastery of symbolic and formal mathematical operations and relationships in a reading chart to develop approaches and strategies to determine whether the words of the incoming students sense. They also formulate and communicate with appropriate action and reflection on the discovery, interpretation, argument, and the suitability of the discovery, interpretation, and the argument that can support their answers.

Like the previous problem, there is no student who answered correctly. They did not notice that only a small graph shown that an increase in the value of PISA 2003 to the year 2006 looks very big. This indicates that they are not yet applying formal mathematical operations and relationships in reading graphs to develop approaches and strategies in determining whether the student is saying makes sense.

Based on the above explanation, no students are able to answer correctly the second and the third questions. Researchers assume that because that question was included level 6 of PISA and students have not been accustomed to work on issues like that, so they have not been able to understand the problem well. It is also in line with the

results of interviews with 3 ninth graders about the problems. They understand the problem after re-described and given instructions that can help them understand it. They can answer it and they also have the knowledge necessary to answer such questions.

Conclusion

This research has resulted the sixth level of PISA-like mathematics problems for secondary school students. At the stage of expert review, the questions that were developed were evaluated by three experts and colleagues from different aspects (mathematical content, compliance with the curriculum and students' mathematical ability, as well as the use of sentences and words on the matter). At one-to-one stage, the questions developed tested to three students with different mathematical abilities (high, medium, and low) that focuse on clarity, ease of use, and effectiveness, as well as the interest of students to solve them. At small group, the questions had been tried out to six students who also have different mathematical ability to justify revisions made based on expert review and one-to-one and revise again the questions are developed. In the field test stage, 26 students in one class answered the questions that were developed to determine whether such questions can be used on the actual situation.

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