

# PISA-Like Mathematics Problems Using Road Cycling Context in Asian Games

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**Abstract.** This study aims to create mathematical problems of uncertainty and data content in PISA using context road cycling which are valid and practical. This research was the design research of the development study. The subject in this study was student at tenth-grade Indo Global Mandiri senior high school Palembang. Data were collected using interviews and observation. The data was used in this study in data from students' mathematical literacy skills. this research resulted in 8 items PISA type of uncertainty and data content using bicycles and aquatic context in Asian Games are valid and practical. The criteria of valid can be seen from it's content, constructs, and languages based on validator review. The criteria of practical has fulfilled because the problem can be understood by students and does not pose a multi-faceted interpretation. In addition, the results of this study indicate that the context used road cycling can give a boost to the students in solving mathematical problems.

## INTRODUCTION

Statistics is part of mathematical material where there are ways of collecting data, processing and drawing inferences that are fundamental to the data set and data analysis performed (Sudjana, 1975). Statistics are very important to learn because, in various disciplines, statistics are so many uses, both natural sciences, business, and industry, that almost every decision made in that field uses statistical reasons (Bakker 2004).

In fact, there are many students who are facing difficulties in solving mathematical problems that result in low achievement, mathematics this occurs because students have not been accustomed to solving problems with the characteristics of a real context, and only do question exemplified by the teacher without knowing its usefulness in life daily (Wati, 2016). This is in line with the results of PISA for the content of uncertainty and data on which the results of PISA 2003, Indonesia was ranked 38 out of 40 countries with the acquisition of a score of 385 (OECD, 2004). While the results of PISA 2012, Indonesia was ranked 63 out of 65 countries for the acquisition of Indonesian student score so far below the OECD average score is 384 while the OECD average score for the content of uncertainty and data at 493. In addition, the Indonesian students only able to resolve the matter of uncertainty and data up to level 5 which is as much as 0.3% of students were far below the OECD average of 9.2% where students are able to solve problems even 3.2% level 5 students were able to complete up to level 6 (OECD, 2014 ). It is confirmed that Indonesian students' mathematical literacy is still very low in resolving problems of the type of PISA.

The low ability of Indonesian students in PISA because the Indonesian students are used yet with the problems The low ability of Indonesian students in PISA because the Indonesian students are used yet with the problems of contextual as in the matter of PISA, especially about the high level of both in the process of learning and evaluation (Novita, Zulkardi, and Hartono, 2012; Ahyan, Zulkardi, Darmawijoyo, 2014). In addition, it is difficult to find issues contextual designed to hone student problem-solving ability and having the characteristics and framework about PISA

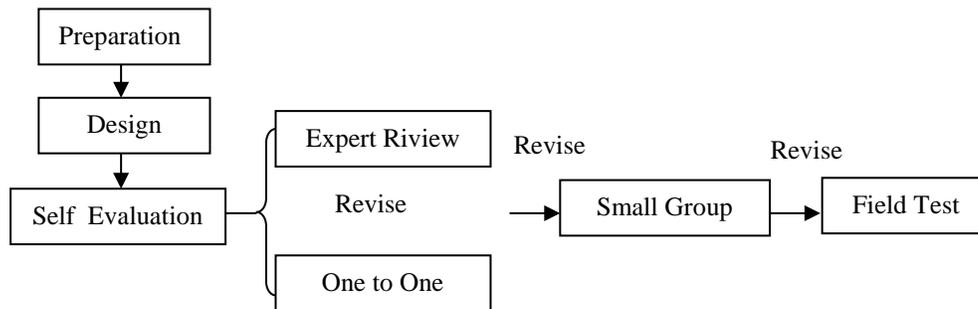
in mathematics textbooks that student is used Indonesia, even in mathematics textbooks already qualified BSNP (Ward & Rumiati, 2011; Fatmawati & Ekawati, 2016). This the basis for curriculum development in 2013 who want to adjust the learning in Indonesia with questions being tested on PISA so the questions used must be adapted to the characteristics about PISA (Kemendikbud, 2014). Therefore, it takes matters of non-routine with the characteristics matter PISA to familiarize students learn the procedures needed to solve the PISA.

At the content uncertainty and the data here researchers are more centered on the content of this data, where the data content is a material of statistical. Education statistics in Indonesia are generally centered on the teacher(teacher center)without any attempt to develop students' mathematical ideas through interaction or discussion (Widjaja, Julie, and Suryandari, 2010). In addition, Groth (2006) also revealed that the learning is done by giving the formula directly without first learning about basic concepts and procedures are meaningful (meaningful) for students. Shi, He, and Tao (2009) added one cause students less interested in statistics because statistics are taught theoretically and less connected to the real world. Thus, students do not know the application of each the material. This hs impact on the decreasing motivation and students' achievement in studying statistics. Therefore it is needed the problems of non-routine with PISA type characteristics to make the students accustomed to solving problems PISA type.

Statistics are very important in the field of sport. According to Jim Albert from Bowling State University and Ruud H. Sembiring of the University of Groningen, between sports and statistics has a close relationship. Not only measure performance, in fact, the statistics can also be used create a simulation game(fantasy games)(Kompasiana, 2013). Asian Games is an interstate competition among Asian countries organized by the Olympic Council of Asia every 4 years (OCA, 2016). This competition was first held first in 1951 in New Delhi, India and is followed by the state - a country in Asia, including Indonesia. Asian Games 18thwill be held in 2018 in Palembang and Jakarta, Indonesia.

## METHOD

This research was the design research of the development study (Akker, 2006) which aimed to produce a valid and practical x class and to see potential effects of the problems that developed towards the student's literacy ability math senior high. This research was also designed question of type PISA taught at the senior high school X grade and developing questions are made it became a valid and practical matter. This research was conducted in two stages: the first stage Preliminary evaluation and Formative evaluation (Zulkardi, 2006).



**Figure 1.** Flow Design Preliminary Evaluation and Formative Evaluation (Zulkardi 2006)

Preliminary phase evaluation consists of the preparation of which at this stage is the first step in researches developing questions of PISA type. At this stage, the researchers conducted an analysis of the characteristics of PISA matter analyze basic competency questions that will be developed based on the framework of PISA. Then designing which at this stage researcher design question devise include question grilles and card about the accordance with the characteristics of PISA problem.

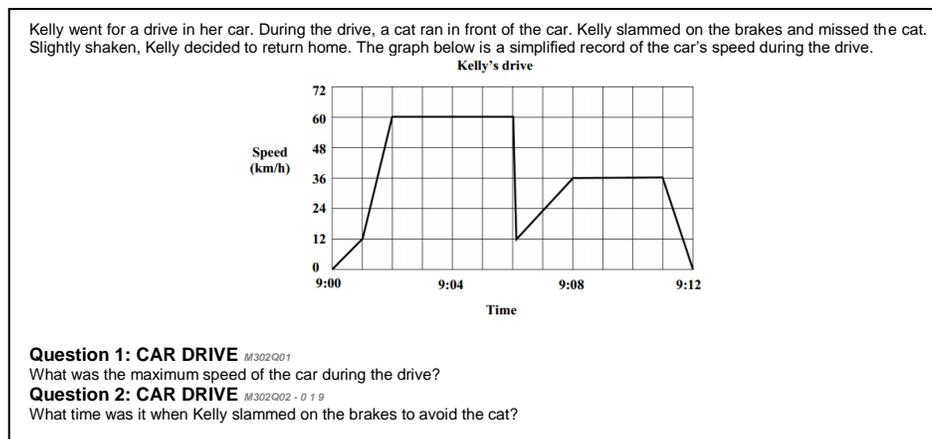
Formative evaluation consists of a self evaluation which at this stage the assessment of the PISA-type questions by the researchers themselves later improved and obtained about the prototype 1. Then continued to the expert review where at this stage about the first prototype 1 made by the researchers will be consulted to experts to do validation is evaluated of criteria content, construcs, and language. Simultaneously researchers conducted. one-to-one stage at this stage the researchers used three students who are not the subject of research as a tester and was asked to do, observe, comment and to give response freely to the matter of the prototype 1. After stage one to one, of researchers entering

the stage small group which at this stage the researchers tested the problem of protoripe 2 which this issue is a matter of prototype 1 had been revised to a group of students who are not the subject of research in order to get about prototype 3. Then the researchers entered its final phasethe test field which the last stage researchers tested the prototype about 3 to field realistic situation where testing is conducted on the subject of research. Here researchers will explain to the stage of formative evaluation namely small group.

## RESULT AND DISCUSSION

### *Preliminary Evaluation*

At this stage, researchers conducted an analysis of the characteristics of PISA question analyze basic competency questions that will be developed based on the PISA 2015 Assessment and Analytical framework and Mathematics ReleasedItems. Then the researchers analyze discussion point and indicators on the content uncertainty and the data to the curriculum in 2013 X class. From the results of this analysis, researchers set 4 problem contents uncertainty and data as a matter of basic development. From this PISA problems, Then researchers design a new problem including device including the content, context, level of problem, the problem statement and process competence. Based on four PISA problems, the research develop it into eight new problems of five unit at uncertainty and data content that using by cycling in Asian Games. One of the problems that will be developed are:



**Figure 1.** Problem PISA 2006 Car drive

The esearchers developed about PISA 2006 Car Drive by changing the context and information on the matter. On the matter of the new unit, the context is used is the bike path in a sport of Asian Games. The ability of the process is required is an of intervention with the prediction level of 3.

### *Formative Evaluation*

#### *Self Evaluation*

In this phase, researchers do their own a self-assessment about the results of development. Researchers check again the matter that has been developed and correct errors contained in the article about the bicycle units 1 and 2.

In this phase the researchers revised the problems consist of the statement in the problems. The result of this revision was called prototype 1.

#### *Phase Expert Review and One-to-One*

At this stage, the researchers conducted a validation prototype 1 logically, ie validation is seen from content validation, and constructs and language. Specialists who became the prototype validator 1 consists of 4 validators, namely:

- a. Hongki Julie, professor of mathematics education of Sanata Darma University
- b. Zulkardi, professor of mathematics education Sriwijaya University Palembang
- c. Somakim, professor of mathematics education Sriwijaya University Palembang
- d. Elika Kurniadi, professor of mathematics education Sriwijaya University Palembang
- e. Ranni Permatasari, magister student of mathematics education Sriwijaya University Palembang

f. Siti Marfuah, high school math teacher in LTI-IGM Senior High School Palembang validation process with Hongki Julie done via email and with three of Sriwijaya University lecturer through Focus Group Discussion (FGD). While the validation is done by teacher walkthrough directly. Experts evaluate a prototype 1 according to criteria and provide suggestion and comment to be used for consideration in revising the prototype 1.

Based on the expert validation process obtained, found that the unit bike about 1 and 2 is valid with some improvement of the suggestions and comments of the experts. That needs to be corrected is a typing error. For bicycle, unit is about 2 improved languages must be clarified and improve the image. Below is one comment from one of the experts.

In line with, expert review phase researchers conducted a phase one to one on the November, 6th 2017 with 3 students tenth-grade senior high school Indo Global Mandiri Palembang. The problem of prototype 1 was tested to high ability students (SR), medium ability students (OVW) and low-ability students (JCT). the three students are asked to do on the question third prototype 1 for 2 hours lesson and give feedback on the subject.

Based on the results of one to one, three students have to understand most of the questions well, while the bicycle unit about 1, they are still confused to make graphs. For bicycle unit about 2, they are still confused about the determine the meaning of the information of the picture is less clear.

Based on the results of the expert review and one to one researcher decided to revise the matter so as to produce a prototype 2. The researcher revised the existing image of a bicycle unit and refined the existing language on question 1 and 2.

### Small Group Phase

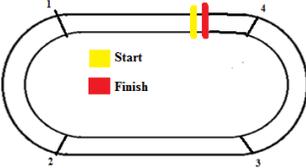
After about 2 declared invalid prototype, the researchers continued on to the stage of a small group to see any practical the matter of prototype 2. The phase of small-group it involves 6 X class senior high school Indo Global Mandiri Palembang consists of two high-ability students, 2 medium ability students, and 2 low-ability students.

At this phase, researchers began learning by providing an apperception of the Asian Games, sports at the Asian Games, statistical materials and links to sports at the Asian Games. Then the researchers distributed the activities of prototype 2 units 1 and 2 to students and students were required to understand in advance the activities that had been distributed. Then the students did the questions individually for 5 minutes, then discussed in groups where one group consisted of 3 high-ability students, moderate, and low. After the discussion, the researchers asked representatives of each group to present their work.

The result of the small group that student can understand and see the image well done. There was little difference in response between groups. Researchers also decided to revise the 6 matter and the matter of the prototype 2 so that obtained valid and practical question prototype 3. On the bicycle unit about 1 question researcher improved the word of "graph" becomes to the word "line chart" in order students are not confused about the meaning of the picture. This is one of a prototype 3 has been ready to use:

*Cycling Road*

Cycling Road is one of the sports in the Asian Games 2018. Cycling Road is a Cycling racing where is the athletes start competing at the same time and the winner is the athlete who can reach the finish line for the first time.

<http://media3.architecturemedia.net>

**Question 1**  
 From the picture above, draw a line diagram for the speed's enhancement and the speed's decline of the athletes on the track? Give your reason.

**Question 2**  
 Based on the picture above, when will the athletes drive it at high speed? Give your reason.

**Figure 3.** Prototype 3

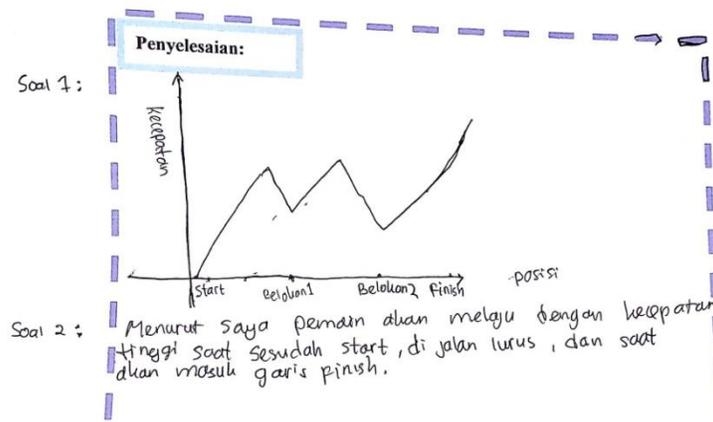
**Discussion**

This study produces 4 units of matter consisting of 8 math types of PISA on the content of uncertainty and using data context of sports bikes and aquatic at the Asian Games are valid and practical. This study was conducted based on stages of the preliminary evaluation and formative evaluation.

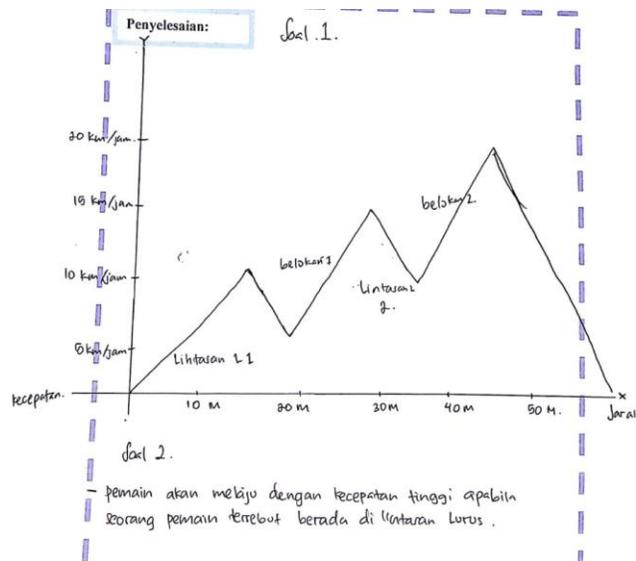
Problem is said to be valid through the stages of expert review and one to one. Problem is said to be valid in terms of content because it is in accordance with the characteristics of the problem domain of mathematical literacy in frameworks, PISA 2015 indicators of students' literacy and basic competences of material present. Problem is said to be valid constructs views of prediction level and competency process according to framework PISA 2015 and in accordance with the capability of X. grade students

about the type of practical said PISA developed through the stages of a small group where most of the students have a good understanding and interpreting the intent of the question along with pictures contained in each unit of matter. The situation contained in the matter is also close to the students so that students can understand the questions well.

Overall, the result of the student's answer sheet analysis obtained that some students could solve the problem well. However, there was a student who was able to solve the problem but the student confused to give a reason and argumentation to explain their solution. There was one of the student's answers who had difficulties in giving reason and argumentation of their solution:



**Figure 7. One Answer Student One to One**



**Figure 8. One Answer Student Small Group**

Figure 7 and Figure 8 were one of the answers of the student who had difficulties in giving a reason and argumentation to explain their solution. It was in accordance with the research of Chandra, Zulkardi, and Yusuf (2017) stated that the students found it difficult to make a conclusion in interpreting mathematical solutions appropriately.

## CONCLUSION

Based on the result and discussions that had been described previously, it could be concluded that PISA-like mathematics problems on uncertainty and data content had fulfilled the valid and practical criteria. The valid criteria had fulfilled in term of content, construct, and language. While the practical criteria had fulfilled because the students can use the problems well such as the context of the problems could be recognized by students, and it were in accordance with the their thinking.

## ACKNOWLEDGMENTS

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