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PISA-LIKE: FOOTBALL CONTEXT IN ASIAN GAMES

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Abstract

This study aimed to develop a set of PISA-like mathematics problems on uncertainty and data content using football as a context which was valid, practical and had potential effects on students' mathematical literacy ability. The method used in this study is design research with development studies type which had two stage: the preliminary and formative evaluation. Tenth-grade students of senior high schools in Palembang were involved in this research. This study produced a set of PISA-like mathematics problems at 3, 4, and 5 level. In this case, student's strategies used some ability in solving one of the problems, namely mathematizing, representation, and communication ability. There were 16 out of 35 students using mathematizing and communication ability, 10 out of 35 students using representation and communication ability, and 9 out of 35 students only using communication ability. Also, the results of the interview with some students showed that they liked to do such PISA-like mathematics problems because they could improve their literacy ability in solving the PISA-like problem.

Keywords: PISA-Like Mathematics Problems, Design Research, Asian Games

Abstrak

Penelitian ini bertujuan untuk mengembangkan soal matematika tipe PISA menggunakan konteks sepak bola yang valid, praktis, dan memiliki efek potensial terhadap kemampuan literasi matematika siswa. Metode penelitian yang digunakan dalam penelitian ini adalah *design research* tipe *development studies*, yang memiliki dua tahap: *preliminary* dan *formative evaluation*. Siswa SMA kelas X di Palembang dilibatkan dalam penelitian ini. Penelitian ini menghasilkan soal matematika tipe PISA pada level 3, 4, 5, dan 6. Dalam kasus ini, ada banyak strategi siswa yang melibatkan beberapa kemampuan dalam menyelesaikan satu masalah, yaitu kemampuan mematematisasi, representasi, dan komunikasi. Terdapat 16 dari 35 siswa yang menggunakan kemampuan mematematisasi dan komunikasi, 10 dari 35 siswa menggunakan kemampuan representasi dan komunikasi, dan 9 dari 35 siswa hanya menggunakan kemampuan komunikasi. Selain itu, berdasarkan hasil wawancara dari beberapa siswa diketahui bahwa mereka senang menyelesaikan soal tersebut, karena dapat meningkatkan kemampuan siswa dalam menyelesaikan soal seperti PISA.

Kata kunci: Soal Matematika Tipe PISA, *Design Research*, Asian Games

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Football is one of the sports that will be competed in the Asian Games. Asian Games is a sporting event held every four years and participated by Asian Countries who are members of the Olympic Council of Asia (OCA) including Indonesia. On August 8, 2018, the 18th Asian Games will be held in Jakarta and Palembang. Accordance to Zulkardi and Putri (in Sumsel Post Online, 2015), mathematics learning can be more interesting, fun, and meaningful for students through the sports games in the Asian Games as a context in the learning process. Wijaya (2012) pointed out that the context of mathematics learning could present the abstract mathematical concepts to be more easily understood by students. Also, the use of context as a starting point for students could develop a sense of mathematics as well as a source of mathematical applications (Zulkardi & Putri, 2006; Prahmana, Zulkardi, & Hartono, 2012).

Sport Sport is one of the fields when solving of the problems using probability or in PISA it is called the uncertainty and data content, especially in football (Johar, 2012; Yanti, Nusantara, & Qohar, 2016). But in reality, the students' low mathematical literacy ability in translating daily conversations into mathematical sentences made the students difficult when solving the problems of uncertainty and data content (Mahyudi, 2016). The Indonesian evaluation system still using a low-level problem and rarely using context was one of the factors resulted from the lack of students' ability in solving the problems such as PISA (Stacey, 2010; Novita, Zulkardi, & Hartono, 2012).). It is accordance with the low of Indonesian PISA's results on uncertainty and data content of 2003 whose score was 285 and ranked 63 out of 65 countries having the score of 384 in 2012 (OECD, 2004; OECD; 2014).

The low of Indonesian PISA's result was the basis for the development of the curriculum 2013 requiring teachers' creativity in forming the students to be creative in thinking, solving problems, making decisions, reasoning, and conveying ideas in activities (Kemendikbud, 2013). Some studies were done to develop PISA-like problems by, among others, Charmila, Zulkardi, and Darmawijoyo (2016), using Jambi context on quantity, change and relationship, space and shape content, etc. Oktiningrum, Zulkardi, and Hartono (2016) used Indonesia natural and cultural heritage context to develop students' mathematical literacy ability. Roni, Zulkardi, dan Putri (2017) used swimming context when designing a learning trajectory. It is in line with Putri and Zulkardi (2017) stating that the use of shot-put context in learning could help students to understand a concept. Based on these, this study used a football context in Asian Games with the aim of producing PISA-like mathematics problems on uncertainty and data content which was valid, practical, and had potential effects to students' mathematical literacy ability.

Based on the 2015 PISA framework, a student could be said to have mathematical literacy ability if they can formulate, employ, and interpret mathematics in various contexts involving seven fundamental mathematical capabilities: communication; mathematizing; representation; reasoning and argument; devising strategies for solving problems; using symbolic, formal and technical language and operations; and using mathematical tools (OECD, 2016).

METHOD

The method of the study used design research with development studies type which comprises two stages: preliminary and formative evaluation (Zulkardi, 2002). It involved the tenth-grade students of senior high school.

The preliminary stage covered the preparation and design stage. It was prepared by analyzing the curriculum, students, and PISA's problems. The analysis result was used to determine the research subject in the one-to-one, small group, and field test stage with a teacher's help. Then, a set of problems was designed such as lattices, question cards, scoring guidelines, lesson plans (RPPs), and teacher's instruction. While the formative evaluation stage included self-evaluation, expert reviews

and one-to-one, small group, and field test stage (Zulkardi, 2002; Tessmer, 1998).

The self-evaluation was the first stage of formative evaluation in which the initial prototype design was evaluated by ourselves regarding content, construct, and language. If in the process of designing there were typing errors, inappropriate or lack of word selection, the design was revised to produce the first prototype.

The next stage was the expert reviews and one-to-one. This stage was conducted in parallel to get the validity of the problems. The validation process in the expert review stage was conducted three methods: (1) mails review with Masitah Shahrill (Brunei Darussalam University); (2) panel review attended by lecturers of mathematics education, Sriwijaya University and some of the peers that had experience in developing of PISA-like problems; (3) face-to-face with Dian Fitriana, as mathematics teacher. Then, validation process of the one-to-one stage was conducted with tenth-grade students.

The small group stage was conducted to find out the practicality of the problems developed by involving six tenth-grade students consisting of two students of high-ability, two students of medium-ability, and two students of low-ability. Then, the last stage was the field test involving tenth-grade students of senior high school consisting of 35 students. The result of the field test was analyzed to see a potential effect emerging from PISA-like problems using football context through students' answer sheets.

The data collection techniques used walkthrough, documentation, observation, interview, and test. The data were analyzed by using the qualitative descriptive method to describe the result of each step of the development.

RESULTS AND DISCUSSION

This study produced nine items of PISA-like mathematics problems using sports games context in Asian Games which was valid, practical, and had potential effects on students' mathematical literacy ability. The developed items consisted of 6 units: football unit (3 items), basketball unit (1 item), golf unit (1 item), volleyball unit (1 item), cricket unit (1 item), and bowling unit (2 items). However, in this study, the researcher covered only PISA-like mathematics problems on football unit, existing various strategies of the student answers in solving the problems.

Preliminary

The preliminary stage determined three students in one-to-one, six students in the small group, and the class that was the subjects of the field test. Then the 2013 Curriculum used in the school was analyzed. In the 2013 Curriculum, the uncertainty and data content was taught at tenth-grade with the subject of probability and statistics. Also, the analysis of the existing PISA problems was carried out to find out the characteristics of PISA based on the 2015 PISA framework. After the preparation, some of the PISA-like mathematics problems at 3, 4, and 5 level using football context were designed as an initial prototype, and then it was followed by the formative evaluation stage.

Formative Evaluation

In the self-evaluation stage, the developed problems were evaluated. The result of the revision in this stage called prototype I. It was then used in the expert reviews and one-to-one stage. One of the problems of PISA-like using football context in Asian Games is in Figure 1.

Football

In a football game, there are 8 groups in which every game contains 4 teams. In the group stage, every team will play against each other. The rule of points are: 3 points for wining, 1 point for draw, and 0 point for losing.

Question 1

Here is the result of Group A:

Group A		
South Korea	1 – 0	Saudi Arabia
South Korea	3 – 0	Malaysia
South Korea	2 – 0	Laos
Saudi Arabia	3 – 0	Malaysia
Saudi Arabia	3 – 0	Laos
Malaysia	4 – 0	Laos

Which team from Group A will proceed to the next stage? Please show your working in a table!

Figure 1. PISA-like mathematics problems using football context before revision

In the expert reviews stage, the validators examined and evaluated the problems regarding content, construct, and language. While the process of one-to-one involved three tenth-grade students of senior high school having high, medium, and low ability to read, examine and solve the problems, and then the feedback about legibility and clarity of the problems was provided. The validation results from the expert reviews and the one-to-one stage is as follows in Table 1.

Table 1. Comments of experts and students on football unit number one

Validation	Comments/Response	Revise
Expert Reviews (Validators)	• Please try not to use the exclamation mark (!) for any statements or questions. • The informations provide inclompleteness. '*What's the relation of the total points calculation rules with the winner of the team in the games'*. Add information about it • Revise the first sentence on the question • Replace the instruction that states the work is made in a table form so that students can solve the problem in their way.	• Add information to the problem • Revise the sentence to '*In a football game, there are eight groups. Every group contains four teams*' • Change the problem instruction to '*Explain your answer*'
One-to-One (Students)	• I don't understand what the meaning of the rule? • How many teams will qualify for the next stage?	

In general, the validators stated that PISA-like problems have been valid regarding content, construct, and language though there was some revision. The validity of the problems in terms of content was in accordance with the domain of mathematics literacy in PISA such as content, context, and mathematical process; construct was in accordance with the characteristics of PISA problems level and capabilities of the tenth-grade students; language was the problem of the use of enhancing spelling (*Ejaan Yang Disempurnakan*), could be understood, and did not have a variety of meanings (Zulkardi, 2006). Furthermore, the results of the validation at expert reviews and one-to-one stage were used to revise the prototype I, to produce prototype II. After that, the prototype II could be used in the small group stage.

In the small group stage, the students were first asked to solve the problem individually, and then they discussed in their group. The result of the analysis of football unit showed that almost all of the students were able to understand and solve the problem well, they were also able to read the table correctly, so it was decided not to revise the problems, but fix the typing error of only one word. Furthermore, the revision of this stage produced the prototype III. The result of the last revision of PISA-like problem using football context is as follows in Figure 2.

Football

In a football game, there are 8 groups. Every group contains 4 teams. In the group stage, every team will play against each other. Only the two highest points from every group will move to the next stage. The rule of points are: 3 points for wining, 1 point for draw, and 0 point for losing.

Question 1

Here is the result of Group A:

Group A		
South Korea	1 – 0	Saudi Arabia
South Korea	3 – 0	Malaysia
South Korea	2 – 0	Laos
Saudi Arabia	3 – 0	Malaysia
Saudi Arabia	3 – 0	Laos
Malaysia	4 – 0	Laos

Which team from Group A will proceed to the next stage? Explain your answer.

Figure 2. PISA-like mathematics problems using football context after revision

Based on the result of revision at the small group stage, the problems on prototype III was practical. The practicality of the problem was illustrated from the result of the small group where the problems could be understood, easy to use, could be administrated, and interpreted well by the students (Zulkardi, 2006). Then, the prototype III was used at the field test involving 35 students to find out the potential effects of the students' mathematical literacy ability.

The field test was the last stage of this study. In the problems number one of football unit, almost all students could solve the problems well. Also, they used different strategies to solve the

problems. The result of the analysis of PISA-like mathematics problems using football context number one is as follows in Figure 3.

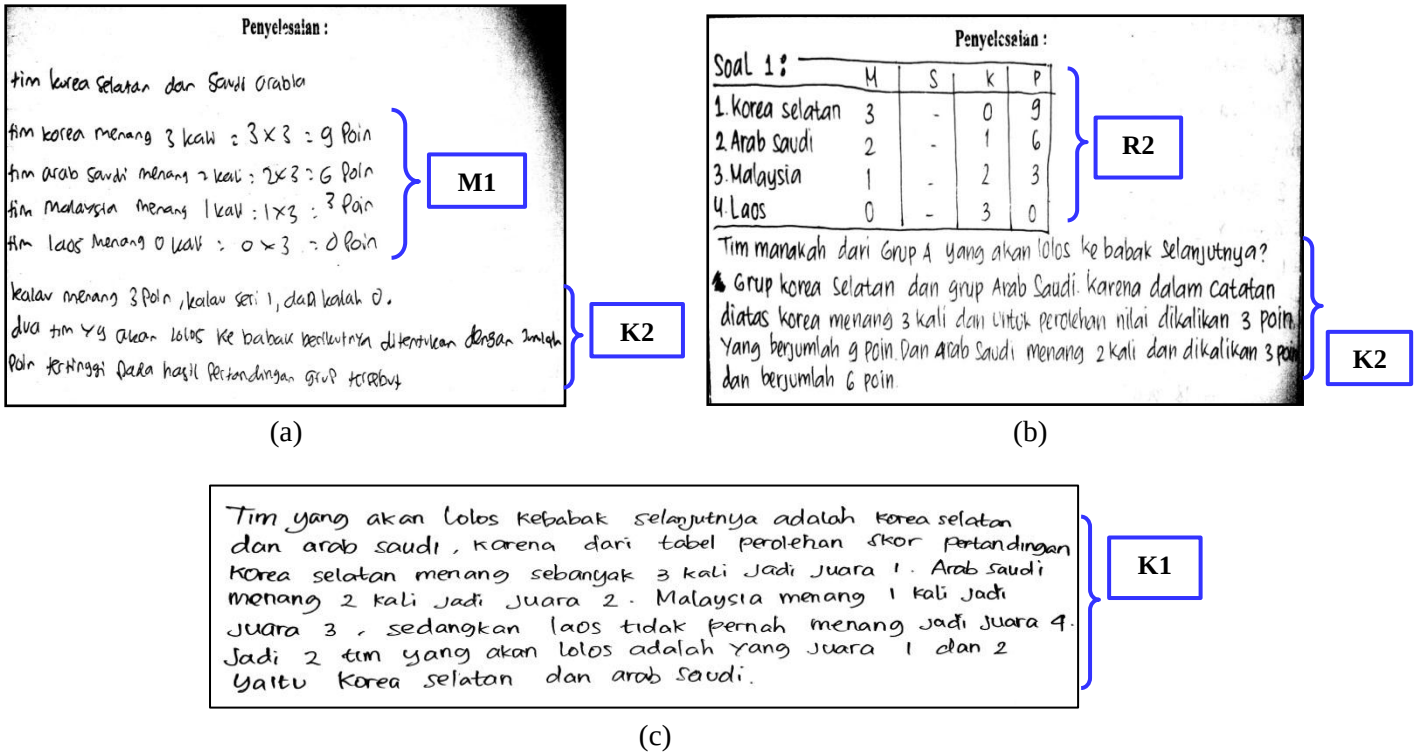

Figure 3. Analysis result of students' answer sheets

Figure 3 shows some of the students' strategies in solving the problems of football unit number one. In figure 3 (a), it appears that students were able to involve mathematizing ability which the indicator of using the concept of context of solving the problems (M1) by calculating the total points of each team based on the rules of the problems. Then, the students also involved the communication ability which was the indicator of concluding the mathematics result (K2) by writing down of the team that would proceed to the next stage based on the result of the previous calculations. Based on the analysis, there were 16 out of 35 students who were able to involve the mathematizing and communication ability, twelve students of them answered correctly and completely, while the other four students answered correctly but not completed yet.

From the figure 3 (b), it appears that the students were able to involve representation ability with the indicator of using various forms of representation in solving the problems (R2) by using the table based on the information of problems. After the students were presented with the data on the tables, they concluded the team that would proceed to the next stage using their communication ability (K2). They also wrote the reason that supported their answers. From the analysis result, there were 10 out of 35 students who were able to involve representation and communication ability in solving the problem number one, four students of them answered correctly and completely, while six students answered correctly but not completed yet.

Figure 3 (c) shows that the students only involved communication ability which was the indicator of writing the process in getting the solution (K1) by writing down the list of the team without using the rules of total point calculations. The students only identified 1st, 2nd, 3rd, and 4th winners based on the match score table. There were 9 out of 35 students only involving communication ability, four students of them answered correctly and completely in solving the problems of PISA-like using football context, while five students answered wrongly.

In general, the learning result showed that almost all students were able to solve the problems well and involved their mathematical literacy ability, such as mathematizing, representation, and communication abilities. However, there were some students still finding the problems difficult in solving the PISA-like mathematics problems because they were not familiar in solving context-based problems. The study of Novita and Putra (2016) revealed that students always got non-routine problems and formal knowledge in their class, so it is the lack of students' mathematics literacy ability. But, when students were given feedback such as a question that led them to find the solution to problems, they quickly responded to resolve them using their concept. It is by the opinion of Cahyono (2010) pointing out that students could easily explain and exchange the understanding of mathematics in social life with feedback given by the teacher.

Based on the result of the interviews with ten students, they felt happy and interested in solving the problem such as PISA-like mathematics problem using football context on uncertainty and data content. Also, they said that the developed problems could help them improve their mathematical literacy. Accordance to Fajriyah, Putri, and Zulkardi (2017), the use of context in learning was very important because a context could present the abstract mathematical problems to the form of representation that was easily understood by students.

CONCLUSION

This study produced a set of PISA-like mathematics problem on uncertainty and data content using football context in Asian Games which was valid and practical in the criteria of 3, 4, and 5 levels. The problems also had potential effects on the students' mathematical literacy ability. The validity was based on the comments of the validators in expert reviews and one-to-one stage, in terms of content (according to the domain of mathematics literacy in PISA), construct (according to the characteristics of PISA problems level and capabilities of the tenth-grade students), and language (according to the enhancing spelling, it could be understood, and did not have a variety of meanings). The practically was based on the result of the small group stage in which the problems were easy to use, could be administrated in learning, and interpreted well by students.

The potential effects of problems were based on the analysis result of the students answer in the field test related to the seven of students' mathematical literacy ability according to the 2015 PISA framework. The analysis result of football unit showed that 16 out of 35 students were able to involve mathematizing and communication ability; 10 out of 35 students were able to involve representation

and communication ability; while 9 out of 35 students only involved communication ability in solving the problems. Based on the interview with 10 out of 35 students, PISA-like mathematics problems on uncertainty and data content using football context in Asian Games could help them to improve students' mathematical literacy ability.

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