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DESIGNING PISA-LIKE MATHEMATICS TASK USING ASIAN GAMES CONTEXT

Ratu Ilma Indra Putri, Zulkardi

Universitas Sriwijaya, Palembang, Indonesia
Email: zulkardi@gmail.com

Abstract

This study aimed to produce a set of valid, practice and had potential effects of PISA-like mathematics tasks using Asian Games context to support students learning. Design research and lesson study were used as the method both during the design and implementation stages. Target users are 15th years old middle school students from PMRI pilot schools in Palembang. Results show that a set of PISA-like problems on uncertainty and data content are valid, practical, and had a potential effect. Students were doing mathematics in a collaborative, and the learning process becomes meaningful and easily.

Keywords: PISA-like Mathematics Task, Design Research, Asian Games

Abstrak

Penelitian ini bertujuan untuk menghasilkan soal matematika tipe PISA menggunakan konteks Asian Games yang valid, praktis, dan memiliki efek potensial untuk mendukung pembelajaran siswa. Penelitian ini menggunakan metode *design* research dengan sistem *lesson study* selama tahap pendesainan dan implementasi. Subjek penelitian merupakan siswa sekolah menengah berusia 15 tahun yang tergabung didalam sekolah uji coba PMRI di Palembang. Berdasarkan hasil penelitian menunjukkan bahwa soal matematika tipe PISA pada konten *uncertainty and data* telah valid, praktis, dan memiliki efek potensial. Selain itu melalui soal tipe PISA menggunakan konteks Asian siswa dapat belajar kolaboratif sehingga proses belajar menjadi bermakna dan mudah.

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

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Several people use uncertainty and data content to solve the problems which are closely related to daily life (Johar, 2012; Permatasari, et al. 2018). Also, the content can be used to looking for the possibilities that can happen (Yanti, et al. 2016). The PISA's result in 2015, Indonesia was ranked 63 out of 70 countries in mathematics literacy (OECD, 2016).

Students were learning mathematics using textbooks that do not provide opportunities for students to learn mathematical procedures in solving context-based problems such as PISA (Wijaya, 2016). Also, Indonesia still using a low-level problem in the evaluation system, so that the student's abilities to solve non-routine problems become weak (Stacey, 2010; Novita, et al. 2012; Permatasari, et al. 2018; Nizar, et al. 2018; Pratiwi, et al. 2018).

In PISA, the problems were presented mostly in real-world situations, so it can feel the benefit of mathematics to solving the issues of daily life (Putri & Zulkardi, 2018; Jannah, et al. 2018). Furthermore, Zulkardi (2010) suggested to design the PISA-like mathematics problems and use them in the learning of mathematics in the class. However, in reality, the teachers have a problem when designing and implementing lessons so that the necessity of collaborating between math-educators

and teachers using the lesson study community.

In lesson study, the activities group of teachers collaboratively and continuously carry out, observe, and report learning outcomes (Putri & Zulkardi, 2019). According to Sato (2014), lesson study for learning community will make teachers eager to improve the quality of teaching from within, so it will later continue to strengthen their professionalism.

In 2018 Indonesia hosted the Asian Games. Wulandari and Atmojo (2014) stated that Asian Games was a sporting event of Asia countries on everwhich is held every four years. The kind of the sport at the Asian Games was the games that most students did or watched like weightlifting, swimming competitions, football, table tennis, long jump, bike, aquatic, volleyball, taekwondo, karate, and bowling. Sport context can make the learning process more interesting because relate to students' daily activity (Nizar, et al. 2018; Yansen, et al. 2018; Pratiwi, et al. 2019; Jannah, et al. 2019; Rawani, et al. 2019; Efriani, et al. 2019). The purpose of this paper is to produce a set of valid, practice, and have the potential effect of PISA-like mathematics problems using bowling context in Asian Games through lesson study.

METHOD

This research used design research method with development studies type through two stages (Zulkardi, 2002). Firstly, the preliminary stage with focuses on the preparation and design, literature review, designed instruments such as lattices, question cards and rubric assessment together with teacher by the 2015 PISA framework. Secondly, formative evaluation that includes the stage of self-evaluation, expert reviews, on-to-one, small group and field test (Zulkardi, et al. 2019).

In self-evaluation the researchers have analyze the instrument by ourselves. After that, the prototype was validated by experts based on content, constructs and language. Along with validations with experts, a one-to-one stage performed. This stages involving three students with high, medium, and low-ability. From the expert reviews and one-to-one phase, the instruments was valid.

Small group stage was conducted to find out the practicality of problems developed involving six students with various abilities. Then, the last stage was the field test involving 15th years old students in junior and senior high school as PMRI or Indonesian version of Realistic Mathematics Education pilot school in Palembang, Indonesia. The results of field test were analyzed to see a potential effect emerging from PISA-like problems using bowling 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 produce a sharing and jumping task using Asian Games context. On the sharing task, PISA-like mathematics problem using football context and jumping task using bowling context. The stages of research implementation are preliminary involving lesson study socialization and plan stage. In this stage, the researchers analyzed PISA frameworks, curriculum 2013, designing a PISA-like using Asian Games context and making predictions of the students' answers with mathematics teachers choose a model teacher in the field test. Design result of sharing and jumping task can be seen in Figure 1.

There are 4 rounds of football match competition, that are the first round, the quarterfinals, the semifinals, and the final. On the first round, the football teams are divided in groups where for every team one group will play with each team in that group. The football team in group B are:

Group B
Uzbekistan
Hong Kong
Bangladesh
Afghanistan

How many matches will be held in the Group B? Show the scheme of the matches in a table form!

Question 1
Pin formation in the bowling game can be seen below:



What position of the ball in order to fall all the pin?

(a) Sharing task using football context

(b) Jumping task using bowling context

Figure 1. Design result of sharing and jumping task

After plan stage, the task used in the expert reviews and one-to-one stage were conducted in parallel to see the validity of problems. The problems were validated by expert from Brunei Darussalam University, Universitas Sriwijaya, and mathematics teachers in the part of the content, constructs, and language. While the one-to-one and small group stage involved three students with high, medium, and low-ability. The revision results at that stage can be seen in Figure 2.

Football

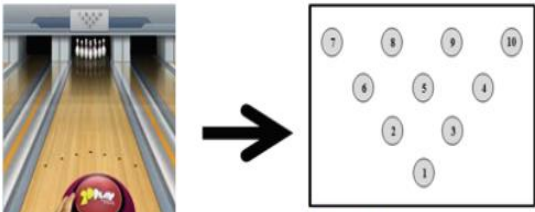
Question 1

In Asian Games 2014, the men's football match are participated by 29 countries in Asia. In the first round, the football teams are divided into 8 groups. Each team in one group plays each other once. Here is the team of group B.

Group B
Uzbekistan
Hong Kong
Bangladesh
Afghanistan

What is the total number of matches played?

Question 1
Pin formation in the bowling game can be seen below:



Source: www.google.com

Figure 1. Pin formation when viewed from above

What position should the ball be shot by the player in order to strike all the pin?

Figure 2. Revision results of the jumping task after validation

Based on the comment at the expert reviews and one-to-one stage, the researchers decide to revise the sharing and jumping task. On the sharing task the researchers change the name of country with the familiar on student's thinking. The researchers also change the question, so the student can explore their answer. On the jumping task the researchers change the picture of pin formation and revise the question. The experts said that if the figure of pin formation was seen from above, it would make it easier for students to think and imagine the direction of the bowling ball.

In the small group stage, students were first asked to solve the problem individually before discuss with their friends in the group. Then, if they have difficulties to solve the problem, they might ask for help from their friends. The norm is by saying "Please Teach Me" and then the students who asked for help must teach it. The jumping tasks can create learning activities among students such as dialogue, interaction, and effective collaboration (Sato, 2014; Putri & Zulkardi, 2019).



Figure 3. Students ask for help with his friend

In the field test stage, almost students couldn't solve the problems well. It's reflected in Figure 2 that students are confused and scratching his heads while trying to solve the problem. But, after they collaborated and ask for help with their friend who understands, the student can explain it well. The analysis results of PISA-like mathematics task using football context is as follows in Figure 4.

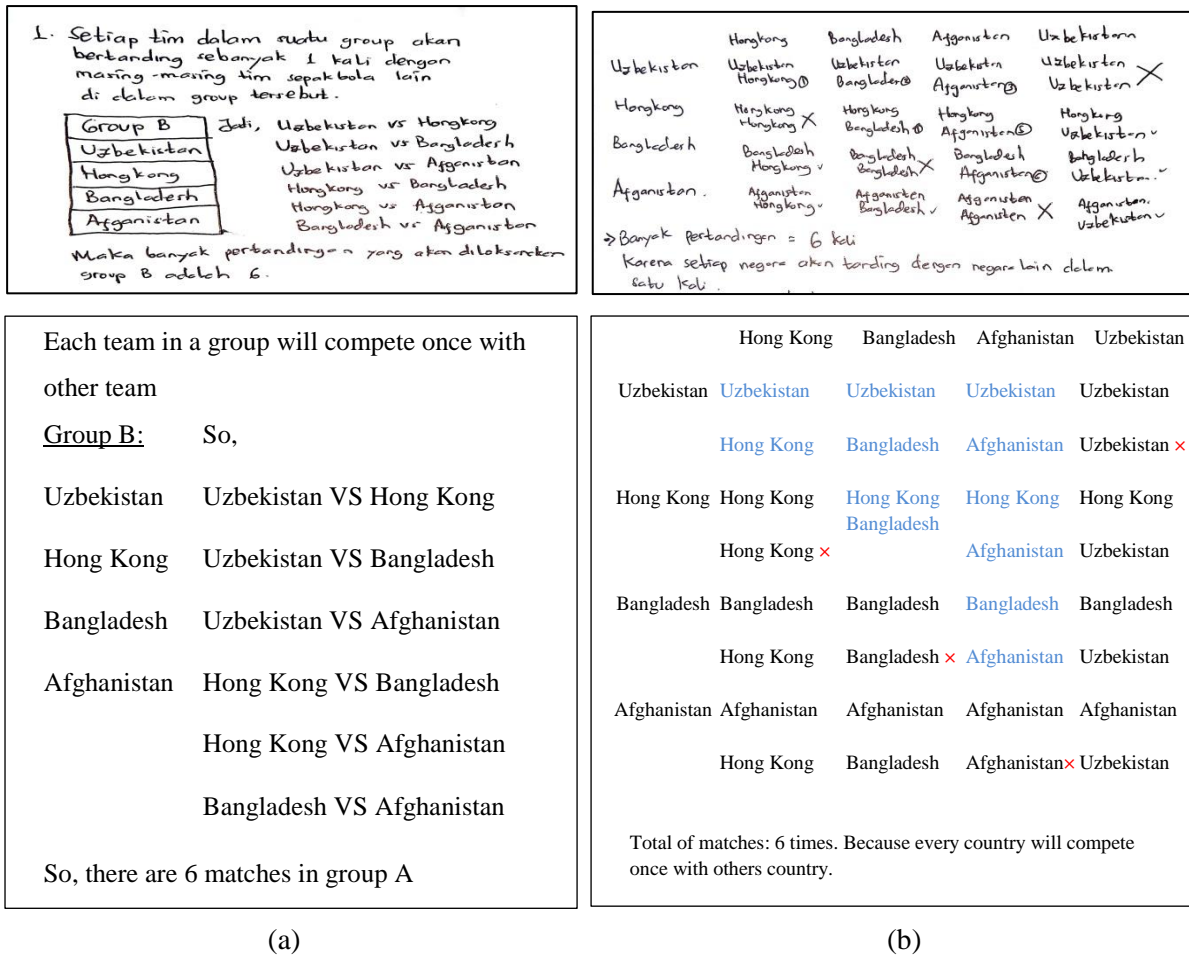


Figure 4. Students' answer sheet of sharing task

Based on the Figure 4 (a), the student make the assumption that each country will compete once with other countries, so that there are 6 matches in group A. In the Figure 4 (b) the students make the prediction all the matches that will be held from each country, after that he eliminate the repetitive matches, so there are 6 matches. Accordance with Murtafiah and Lukitasari (2019), the learning should be emphasized in the development of student thinking.

Almost students can solve the sharing task using their communication skills. The students writing down the process of achieving a solution by making a list of teams that will compete based on existing rules to get 6 matches correctly and completely. Students can also make conclude of mathematical results accordance with the existing situation, namely the number of matches that will be held in group A. Meanwhile, the analysis result of jumping task using bowling context is as follows in Figure 5.

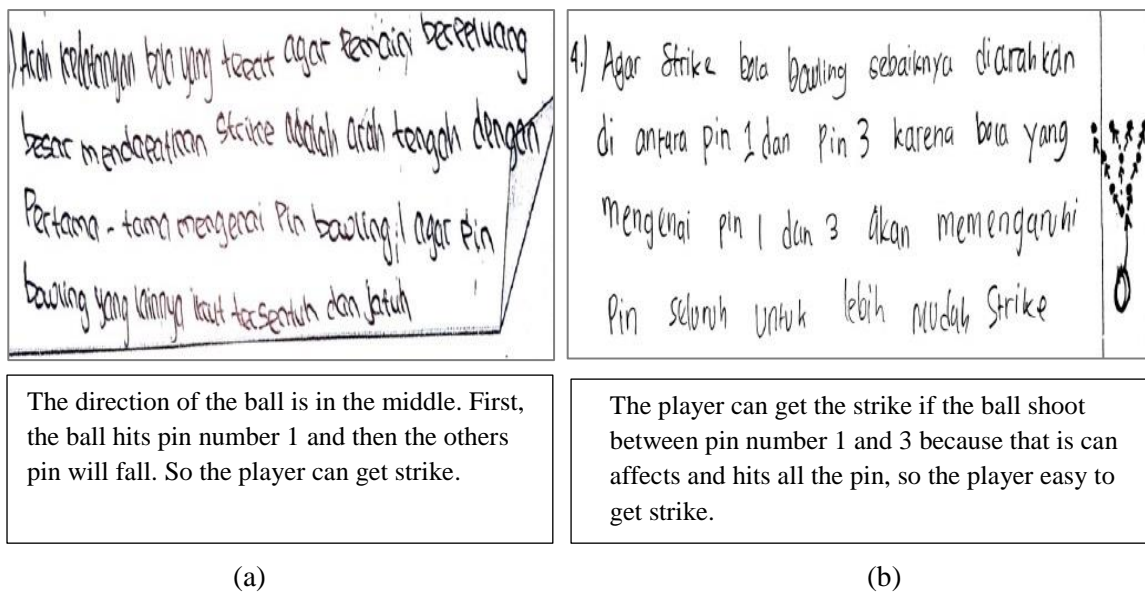


Figure 5. Students' answer sheet of jumping task

Figure 5 (a) student makes a mistake possible next happen of the problem. Students make predictions that the ball should be thrown toward the center of the pin so that players get a strike. In Figure 5 (b), the student with high ability makes a reflection, argumentation, and reasoning when solving the problems. The student answer that the player must shot the ball between pin 1 and 3 so it will hit another pin on end. The students that have good reasoning ability can solve the problems correctly and adequately (Ahyar, et al. 2014; Permatasari, et al. 2018).

After the field test, the researchers and teachers doing a reflection about the lesson. This stage aims to find the advantages and disadvantages of the implementation of learning that has been carried out. The model teacher as an object starts the discussion by conveying her impressions, experiences, constraints, and opinions regarding the implementation of the learning (Nuraida & Putri, 2018). Furthermore, observers explain what they find during the lesson. From the reflection, it can be concluded that during solve the PISA-like problems, students working collaboratively in their groups although they still have a mistake. Students with low-ability were guided and connected to ask problems to their peers with high-ability (Putri & Zulkardi, 2018). Accordance with Sato (2014), the students have already learned in their groups.

Based on the result of the interviews with some students, they felt happy and interested to solve problems such as PISA-like mathematics problems using Asian Games contexts such as football and bowling. The students also said that developed problems could help them improve their mathematical thinking. The use of context in mathematics learning was very important because it could present the abstract mathematical problems to the form of representation that was easily understood by students (Permatasari, et al. 2018; Fajriyah, et al. 2017; Yansen, et al. 2019).

CONCLUSION

This research has produced mathematics PISA-like problems using the Asian Games context, which valid and practical. The validity reflected based on the comment of experts and students in the on-to-one stage, in terms of content has according to the domain of mathematics literacy in PISA. In terms of construct, the problem has been accorded with characteristics of the PISA problem level and abilities of the target group. In terms of language, the problems in accordance with enhanced spelling and didn't have a variety of meanings. The practically reflected from the small group stage, the problem could be understood as learning uncertainty and data, and easy to use. The potential effect of students' answers when they were solving PISA-like problems in uncertainty and data content. Especially in communication, representation, and mathematization. Also, through lesson study and design research can make students collaborate well so that mathematics learning becomes meaningful.

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REFERENCES

- Ahyan, S., Zulkardi, & Darmawijoyo. (2014). Developing mathematics problems based on PISA level. *Journal on Mathematics Education*, 5(1), 47-56. <https://doi.org/10.22342/jme.5.1.1448.47-56>.
- Efriani, A., Putri, R.I.I., & Hapizah. (2019). Sailing context in PISA-like mathematics problems. *Journal on Mathematics Education*, 10(2), 265-276. <https://doi.org/10.22342/jme.10.2.5245.265-276>.
- Fajriyah, M., Putri, R.I.I., & Zulkardi. (2017). Dayung Context in Fraction. *Proceeding in 5th South East Asia Design Research (SEA-DR) International Conference*.
- Jannah, R.D., Putri, R.I.I., & Zulkardi. (2018). PISA-like mathematics problem: The context of basketball in Asian Games. *Journal of Physics: Conference Series*, 1088(1), 012019. <https://doi.org/10.1088/1742-6596/1088/1/012019>.
- Jannah, R.D., Putri, R.I.I., & Zulkardi. (2019). Soft tennis and volleyball context in Asian Games for PISA-like mathematics problems. *Journal on Mathematics Education*, 10(1), 157-170. <https://doi.org/10.22342/jme.10.1.5248.157-170>.
- Johar, R. (2012). PISA task domain for mathematics literacy [in Bahasa]. *Jurnal Peluang*, 1(1), 30-41.
- Murtafiah, W., & Lukitasari, M. (2016). Developing pedagogical content knowledge of mathematics pre-service teacher through microteaching lesson study [in Bahasa]. *Jurnal Pendidikan Matematika*, 13(2), 201-218. <https://doi.org/10.22342/jpm.13.2.7663.201-218>.
- Nizar, H., Putri, R.I.I., & Zulkardi. (2018). PISA-like mathematics problem with karate context in Asian Games. *Journal of Physics: Conference Series*, 1088(1), 012063. <https://doi.org/10.1088/1742-6596/1088/1/012063>.

- Nizar, H., Putri, R.I.I., & Zulkardi. (2018). Developing PISA-like mathematics problems using the 2018 Asian Games football and table tennis contexts. *Journal on Mathematics Education*, 9(2), 183-194. <https://doi.org/10.22342/jme.10.1.5248.157-170>.
- Novita, R., Zulkardi, & Hartono, Y. (2012). Exploring primary student's problem-solving ability. *Journal on Mathematics Education*, 3(2), 133-150. <https://doi.org/10.22342/jme.3.2.571.133-150>.
- Nuraida, E.M., & Putri, R.I.I. (2018) Implementation lesson study in mathematics learning on multiplication and division of integers [in Bahasa]. *Proc. National Conf. of the Mathematics Education in Universitas Ahmad Dahlan* (pp. 42-47). Yogyakarta.
- OECD. (2014). *PISA 2012 results: What students know and can do – student performance in mathematics, reading and science* (Volume I, Revised edition, February 2014). Paris: OECD Publishing.
- OECD. (2016). *PISA 2015 assessment and analytical framework: Science, reading, mathematics and financial literacy*. Paris: OECD Publishing.
- Permatasari, R., Putri, R.I.I., & Zulkardi. (2018). PISA-like: Football context in Asian Games. *Journal on Mathematics Education*, 9(2), 271-280. <https://doi.org/10.22342/jme.9.2.5251.271-280>.
- Permatasari, R., Putri, R.I.I., & Zulkardi. (2018). Uncertainty and data content in bowling: Task design. *Journal of Physics: Conference Series*, 1088(1), 012010. <https://doi.org/10.1088/1742-6596/1088/1/012010>.
- Putri, R.I.I. & Zulkardi (2018). Noticing students thinking and quality of interactivity during mathematics learning. *Proc. 1st Conf. of the Int. Indonesian Communication Forum of Teacher Training and Education Faculty Leaders on Education 2017 (ICE 2017)*. Vol 174. (pp, 549-553). <https://doi.org/10.2991/ice-17.2018.118>.
- Putri, R.I.I., & Zulkardi. (2019). Designing jumping task on percent using PMRI and collaborative learning. *International Journal on Emerging Mathematics Education*, 3(1), 1-8. <http://dx.doi.org/10.12928/ijeme.v3i1.12208>.
- Pratiwi, I., Putri, R.I.I., & Zulkardi. (2018). PISA-like mathematics problems using the context of athletics in Asian Games 2018. *Journal of Physics: Conference Series*, 1088(1), 012047. <https://doi.org/10.1088/1742-6596/1088/1/012047>.
- Pratiwi, I., Putri, R.I.I., & Zulkardi. (2019). Long jump in Asian Games: Contexts of PISA-Like mathematics problems. *Journal on Mathematics Education*, 10(1), 81-92. <https://doi.org/10.22342/jme.10.1.5250.81-92>.
- Rawani, D., Putri, R.I.I., & Hapizah. (2019). PISA-like mathematics problems: Using taekwondo context of Asian Games. *Journal on Mathematics Education*, 10(2), 277-288. <https://doi.org/10.22342/jme.10.2.5243.277-288>.
- Sato, M. (2014). *Communication and Collaboration in the Middle School: Learning Community Practice [in Bahasa]*. Jakarta: Pelita.
- Sato, M. (2014). *Concept School Reform and Learning Community Practice [in Bahasa]*. Jakarta: Pelita.

- Stacey, K. (2010). Mathematical and scientific literacy around the world. *Journal of Science and Mathematics Education in Southeast Asia*, 33(1), 1-16. <https://pdfs.semanticscholar.org/c48a/333b0dc6f336e41508443b15d9e5d9761be9.pdf>.
- Wijaya, A. (2016). Students' information literacy: A perspective from mathematical literacy. *Journal on Mathematics Education*, 7(2), 73-82. <https://doi.org/10.22342/jme.7.2.3532.73-82>.
- Wulandari, D., & Atmojo, D. (2014). *Fresh Update Top No. 1 CPNS Questions* [in Bahasa]. Jakarta: Wahyumedial.
- Yanti, W., Nusantara, T., & Qohar, A. (2016). Error analysis in solving tasks about Permutation and Combination [in Bahasa]. *Proc. National Conf. of the Mathematics Education, Vol. 1* (pp. 97-104). Malang.
- Yansen, D., Putri, R.I.I., & Zulkardi. (2018). Mathematical problems of PISA-like with the 200m swimming contexts in Asian Games. *Journal of Physics: Conference Series*, 1088(1), 012086. <https://doi.org/10.1088/1742-6596/1088/1/012086>.
- Yansen, D., Putri, R.I.I., Zulkardi, & Fatimah, S. (2019). Developing PISA-like mathematics problems on uncertainty and data using Asian Games football context. *Journal on Mathematics Education*, 10(1), 37-46. <https://doi.org/10.22342/jme.10.1.5249.37-46>.
- Zulkardi. (2002). Developing a learning environment on realistic mathematics education for Indonesian student teachers. *Published Dissertation*. Enschede: University of Twente.
- Zulkardi. (2010). How to design mathematics lessons based on the realistic. Available online at <http://www.reocities.com/ratuilma/rme.html>.
- Zulkardi, Putri R.I.I., & Wijaya A. (2020) Two Decades of Realistic Mathematics Education in Indonesia. In: van den Heuvel-Panhuizen M. (eds) *International Reflections on the Netherlands Didactics of Mathematics. ICME-13 Monographs*. Cham: Springer. https://doi.org/10.1007/978-3-030-20223-1_18.

