The prototype of PISA-like digital mathematical tasks

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The prototype of PISA-like digital mathematical tasks

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Abstract. This article describes a part of study aimed to develop digital mathematical tasks like PISA which are valid, practice, and having potential effect to secondary students' 21th century competencies. The discussion of this article is limited to the description of the first prototype of PISA-like digital mathematical tasks. Design research type development study is chosen as research methodology in this study that consisted of three stages namely preliminary stage, prototyping stage, and evaluation stage. Data were gathered using printed documents such as curriculum document, PISA framework, and PISA problems and digital documents including mathematical tasks in the form of digital video. The first prototype was produced after experiencing changes in the choice of context, content, mathematical process, and conformity with the level of the PISA problem.

Keywords: Design Research, PISA, Mathematical Tasks, Digital Videos

1. Introduction

Mathematical problems have potential roles in improving students' mathematical knowledge [1]. The problems meant are not just algorithms, but they are really problematic to be solved [2]. In solving that kind of problems, students need to use their previous mathematical knowledge and think deeply. PISA-like mathematical task is one example of tasks that can be used to develop students' mathematical thinking [1, 3]. The type of questions are contextual and non-routine problems that provoke students to formulate solutions according to their mathematical abilities [4, 5]. The abilities needed to solve PISA questions are abilities that are relevance with 21 century competencies such as mathematical literacy, scientific literacy, reading literacy, financial literacy, and problem solving skills [6]. However, it becomes a matter for students who are not used to working on such questions because they are commonly able to solve low order thinking tasks [5]. This condition happens to Indonesian students as indicated by the PISA results [1, 2].

Many prior studies in Indonesia related to PISA were conducted. Some studies took the initiative to seek efforts to train students' mathematical skills through developing PISA-like mathematical questions [4-9]. Then, studies done by Bidasari [10], Novita [11], Silva [12], Sari [13], and Kurniati [14] each described students' mathematical reasoning, creativity ability, problem solving ability, argumentation ability, and students' high-level thinking skills in solving PISA type problems. In accordance with the demands of the development of technology, Hoyles [15-17], Drijvers [18], and Oldknow [19] adduced about the use of digital technology in mathematics education. International studies suggested that digital mathematics environment makes students learn mathematics effectively [20-22]. However, studies about digital-oriented PISA teaching material in Bahasa Indonesia are no available

Considering the advantages of digital teaching materials and the limitations of previous researches in Indonesia related to PISA, this study aims to develop PISA-like mathematics tasks in the form of digital tasks. This kind of technology is expected to help Indonesian students to develop abilities which are relevance with 21 century competencies.

Method

The method used in this research is design research type development study that purposes to develop digital mathematics tasks like PISA tasks in the form of digital videos. Digital video is digital media that presents a series of images - images that are read sequentially in a certain time so that it looks like a moving image.

The study itself consisted of 3 stages namely preliminary stage, prototyping stage, and evaluation stage. In the first stage, PISA problem characteristics including context, content, and mathematical process were analysed. Then, in the next stage, prototype of digital videos was designed according to the characteristics of PISA problems. Like PISA problems, the digital video itself contains a contextual mathematical problem presented in certain duration. In the third stage, the prototype of digital videos designed were evaluated. Specifically, this article is limited into the prototype description of PISA-like digital mathematics tasks in the self-evaluation step.

Data were collected by using both printed documents and digital documents. The printed documents were curriculum document, PISA framework, and PISA problems. Digital documents meant were mathematical tasks in the form of video digital.

3. Result and Discussion

To develop PISA – like mathematical tasks in the form of digital video, in the preliminary stage, PISA frameworks were analysed. There were some items considered in PISA problems namely mathematical processes, mathematical contents, and mathematical contexts [23].

The mathematical processes are categorized into 3 types namely formulating, employing, and interpreting. Formulating means that students are able to recognize and identify opportunities to use mathematics and then provide mathematical structure for problems that are presented in some contextual form. Employing means that students are able to apply mathematical concepts, facts, procedures, and reasoning to solve mathematical problems and to formulate problems to get mathematical conclusions. Interpreting means that students are able to describe mathematical solutions, results or conclusions and interpret them into the context of real-life problems.

The type of mathematical contents is quantity related to numbers and measurements; space and shape related to geometry; change and relationship related to algebra; and uncertainty and data related to statistic.

Then, the mathematical contexts are differed into personal, societal, occupational, and scientific. Personal means that the context that comes closest to the life of the student himself. Societal means that the context on the perspective of the community. Occupational means that this context can occur in the school environment and in the workplace or centered on the world of work. Scientific means that contexts classified in the scientific category relate to the application of mathematics to nature and the issues and topics related to science and technology.

Moreover, PISA problems have a main characteristic that the problems are real life problems that enhance students' ability to solve problem. Beside PISA framework analysis, researchers also considered the characteristics of digital technology and levels of higher order thinking skills. The characteristics of digital technology in the form of practicality and media readability. The digital technology content refers to three levels namely analysis level, evaluation level, and creativity level. Thus, according to those characteristics, PISA-like mathematical tasks in the form of video digital were designed. The following figure shows one example of digital video of PISA-like mathematical tasks designed.

Figure 1. One of digital videos designed according to PISA framework, uncertainty and data content type

Figure 1 shows that digital video designed contains PISA-like mathematical tasks using car context. The content used is Uncertainty and Data. The context type is Personal. The question asked about comparison of two car weight. This context seems a fake context since this problem rarely happens in everyday life. When it was evaluated through self-evaluation, researcher determined to do revision. The result of revision is showed in figure 2.

Figure 2. Revised digital videos with uncertainty and data content type

The digital video figure showed in figure 2 is a revised digital video after self-evaluation did. The problem asked about comparison of mobile phone weight. The problem given also used images of two mobile phones that are compared. Related to HOTS level, it is categorized into analysis level since students are expected to be able to think mathematically and reasoning.

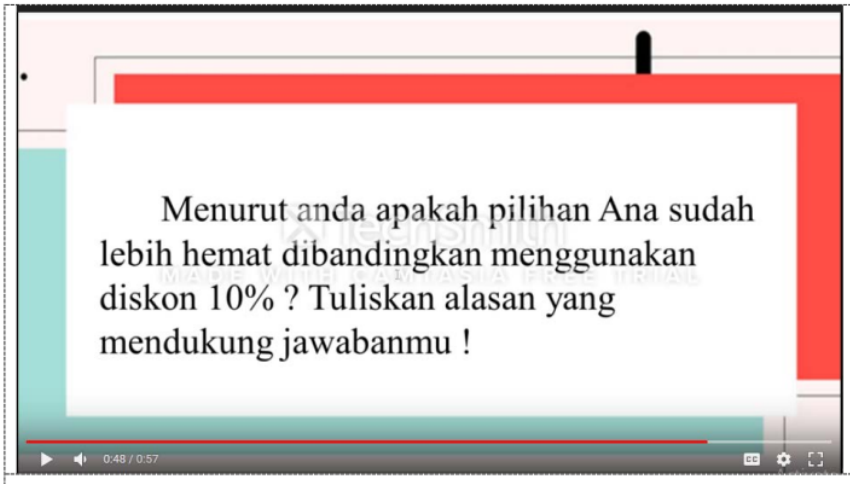

Figure 3. Digital videos with change and relationship content type

Figure 3 shows that digital video designed contains PISA-like mathematical tasks described in some sentences. The content used is Change and Relationship. The context type is Personal. The question was presented using sentence narratives. It used a little animation to move the writing. Human sound was inserted purposing to describe the problem. When it was evaluated through self-evaluation, researcher determined to do revision. The result of revision is showed in figure 4.

Figure 4. Revised digital videos with change and relationship content type

Figure 4 shows the changes after digital video about change and relationship revised. The problem given is not only described in sentences but also is inserted some pictures, animation, and human sound. The visualization of problem is expected to be able to support students' understanding of the problem given. The problem given is categorized into evaluation level since Students are expected to be able to develop and work with models for complex situations, identify obstacles and clarify guesses.

Digital video designed need to pay attention to the PISA framework which contains mathematical processes, mathematical content, and mathematical contexts. In the form of task presentation, the depictive questions given look more visual than the questions given in a narrative way where the use of sentences is more dominant. According to Hooglad [24], the presentation of depictive questions can support students' understanding of the mathematical problems given. In addition, not all contexts in daily life are good contexts to encourage students to learn mathematics through this context. Good context problems are mathematical problems that can stimulate students to think and work through the questions given [25]. They are able to solve the problems in their way and with many other possibilities.

4. Conclusion

PISA-like digital mathematics tasks in form of digital video were developed based on PISA framework and excellence of technology. The mathematical tasks designed like PISA problems must consider the characteristics of mathematical process, mathematical content, and mathematical context. Not all contexts used are good context to provoke students in learning mathematics. The context used also needs to pay attention to the presence or absence of this context in the lives of students.

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References

[1] Novita R 2012 *Journal on Mathematics Education* **3** 133
[2] Tanujaya B, Prahmana R C and Mumu J 2017 *World Transactions on Engineering and Technology Education* **15** 287
[3] Pulungan D A 2014 *Journal of Educational Research and Evaluation* **3** 2
[4] Kamaliyah K, Zulkardi and Darmawijoyo 2014 *Journal on Mathematics Education* **4** 9
[5] Dayona G and Zulkardi 2019 *Proc. Nasional Seminar on Mathematics Education Ahmad Dahlan* vol. 6 (Yogyakarta: Ahmad Dahlan University)
[6] Oktiningrum W, Zulkardi, and Hartono Y 2016 *Journal on Mathematics Education* **7** 1
[7] Kohar A W, Zulkardi and Darmawijoyo 2014 *Proc. The Second South East Asia Design/ Development Research (SEA-DR) International Conference* (Palembang: Sriwijaya University)
[8] Anisah A, Zulkardi and Darmawijoyo 2013 *Jurnal Pendidikan Matematika* **5** 1
[9] Charmila N, Zulkardi and Darmawijoyo 2016 *Jurnal Penelitian dan Evaluasi Pendidikan* **20** 198
[10] Bidasari F 2017 *Jurnal Gantang* **2** 63
[11] Novita R and Putra M 2016 *Journal on Mathematics Education* **7** 31
[12] Silva E Y, Zulkardi and Darmawijoyo 2013 *Jurnal Pendidikan Matematika* **5** 1
[13] Sari E F P 2015 *Jurnal Pendidikan Matematika* **9** 124
[14] Kurniati D, Harimukti R and Jamil N A 2016 *Jurnal Penelitian dan Evaluasi Pendidikan* **20** 142
[15] Hoyles C and Noss R 2003 *Second international handbook of mathematics education* (Dordrecht: Springer) pp 323-349
[16] Hoyles C, Noss R, and Kent P 2004 *International Journal of Computers for Mathematical Learning* **9** 309
[17] Hoyles C and Lagrange J B 2010 *Mathematics education and technology: Rethinking the terrain*

(Berlin: Springer)
[18] Drijvers P 2015 *Selected regular lectures from the 12th international congress on mathematical education* (Cham: Springer) pp 135-151
[19] Oldknow A 2011 *Mathematics education with digital technology* (Bloomsbury Publishing)
[20] Clark-Wilson A, Robutti O, and Sinclair N 2014 *AMC* **10** 12
[21] Artigue M 2009 In *Mathematics education and technology-Rethinking the terrain* (Boston: Springer) pp 463-475
[22] Calder N 2012 *Processing mathematics through digital technologies* (Springer Science & Business Media)
[23] OECD 2016 *PISA 2015 Assessment and Analytical Framework: Science, Reading, Mathematics and Financial Literacy PISA* (Paris: OECD Publishing)
[24] Hoogland C P 2016 Images of numeracy: investigating the effects of visual representations of problem situations in contextual mathematical problem solving *Doctoral Thesis* (Eindhoven: Technische Universiteit Eindhoven Publication)
[25] Van Galen F and van Eerde D 2018 *Mathematical Investigations For Primary School* (Utrecht: Freudenthal Institute) Retrieved from http://www.fisme.science.uu.nl/en/impome

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