Designing mathematical problems task through COVID-19 context

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Abstract. This study aimed to produce PISA model mathematical problems for junior high school students using a valid and practical Covid-19 context. The research method used is design research with the type of development study. At the preliminary stage, a review of literature and design has been reviewed. Meanwhile, the formative evaluation phase only reaches the stage of self-evaluation, one to one, small group. Data collection techniques used were walkthrough, document review, and online interview. The problem developed in this study is related to the number of hand sanitizers that can be made based on available ingredients. The data analysis applied is descriptive. The result of the research is in the form of mathematical problems using a valid and practical PISA model COVID-19 context with 3 items in total. From the validation result in terms of content, constructs, and language based on the validator and one to one assessment, the PISA type mathematics problem with the context of Covid-19 has valid content, construction, and language. Practically, based on small group trials where all students can understand the purpose of the problem well, the students' thoughts easy to read and do not lead to diverse interpretations.

1. Introduction
One that underlies the change of Indonesian education curriculum into the 2013 Curriculum is that students' literacy skills are low in aspects of reading, mathematics, and science when compared to benchmarks in international studies at PISA. It is essential to prepare our children's interests in the future so that they can compete with other countries in the era of globalization [1-3]. The breakthrough for independence became one of the new policies for Education and Culture. One of the points in independent learning is that the National Examination is replaced by the Minimum Competency Assessment (MCA) for 4th, 8th, and 11th-grade students, where MCA questions with characteristics such as PISA are literacy and numeracy testing. So, introducing items with features like PISA is very important to train students today [4].

The position of Indonesia from 2000 and finally in 2018 has always been in the position of the 5th to the 10th largest bottom [5]. Low PISA results are certainly caused by many factors. One of the contributing factors among other students is generally their lack of understanding in solving questions with contextual PISA questions [6-11]. Indonesian students need to be accustomed to working on PISA questions so they can improve the quality of Education in Indonesia. One step that can be taken is to develop questions with PISA characteristics that are adapted to contexts that are close to Indonesian students.
The use of context in learning mathematics can make mathematical concepts more meaningful because the learning that is done allows students to make abstract mathematical concepts transformed into representations that are easily understood by students, problems using context will facilitate students in mathematical situations [12-18]. the importance of using context, this is in line with [19] that the context in mathematics learning needs to be presented in which situations that have been experienced by students both in the family, school, community and situations related to mathematics itself. Context questions are able to attract and motivate students so they are challenged to solve problems, and provide stimulus to students to think critically using their own reasoning in their solution [20-22].

Learning that emphasizes context or situation as a starting point is the PMRI Approach. PMRI is very important to be used for the formation of concepts, access, and motivation towards mathematics, the formation of models, notations, providing tools for thinking using procedures, drawings and rules, reality as a source and domain of application, and training specific abilities in certain situations and in accordance with 2013 curriculum [23-26]. One context that can be used for now is corona which can be called Covid-19. One interesting context to be implemented in mathematics learning is the phenomenon of the Covid-19 outbreak which has become a pandemic for the whole world. Based on the description the purpose of this study is to develop mathematical problems using the PISA model Corona context which is valid and practical and has potential effects.

Some related researches have been carried out using the sports context contested in the 2018 Asian Games such as sailing [27], taekwondo [28], basketball [29], and bowling [30]. However, there are no PISA questions that use this unique phenomenon related to the Covid-19 Pandemic. Therefore, researchers are interested in developing questions with PISA characteristics using the Covid-19 Pandemic context in quantity content.

2. Method
This study involved the third-grade students of SMP Negeri 4 Palembang using design research methods with the type of development studies through two stages namely: preliminary and formative evaluation. In the preliminary stage which covers preparation and design, the researcher analyzes the 2013 curriculum, examines mathematical problems that are in accordance with the PISA Framework. Then, the researchers designed a research instrument consisting of question cards, question lattices, and scoring rubrics based on the PISA 2018 Framework on Quantity content.

The next stage is formative evaluation which includes self-evaluation, expert review, one to one, small groups and field tests [29]. However, in this study only focuses on the small group stage in accordance with the given problem statement.

In the self-evaluation stage, the researcher analyzes and evaluates the initial instrument developed which is then called Prototype I. Furthermore, prototype I is validated by experts who are experienced in developing PISA questions. In validating this expert, the researcher used 2 methods in the validation process, namely: a review panel with a mathematics education lecturer at UIN Raden Fatah Palembang and several colleagues who had experience in developing PISA questions; mail review with math teacher. Along with the validation of the experts, the researchers also carried out a one-to-one phase. The one to one phase involved three students with heterogeneous abilities (high, medium, low). From the results of expert reviews and one to one produces a valid prototype called Prototype II.

The small group phase was conducted to determine the practicality of the problem developed by involving 9 students with diverse abilities (3 high category students, 3 medium category students, 3 low category students). The result of this phase is called Prototype III which is valid and practical. Data collection techniques used include walkthroughs, document reviews, interviews conducted online through Zoom and WhatsApp. Then, the data were analyzed descriptively to illustrate the results of each stage of development carried out.
3. Result and Discussion

3.1. Preliminary

In the initial stage, researchers conducted student analysis, curriculum analysis, and analysis of PISA questions. Analysis of students is done to find out students who have high, medium, and low abilities and to find out students who are 15 years old. Curriculum analysis is carried out to determine Competency Standards (SK) and Basic Competencies (KD) of number material in the 2013 curriculum. Analysis of PISA questions are carried out to develop PISA type mathematical problems on number content based on the PISA 2018 framework. Then, the next stage is formative evaluation.

3.2. Formative Evaluation

3.2.1. Self-Evaluation

In the self-evaluation phase, the instrument is designed, evaluated and reviewed by the researcher. The revised results of this phase are called Prototype I. Then, it can be continued to the next phase, namely expert review and one to one. One of the PISA questions developed using the Covid-19 Distribution context can be seen in Figure 1.

![PISA 2009 BOOKSHELVES](image1)

To complete one set of bookshelves a carpenter needs the following components:
- 4 long wooden panels,
- 6 short wooden panels,
- 12 small clips,
- 2 large clips and
- 14 screws.

The carpenter has in stock 26 long wooden panels, 33 short wooden panels, 200 small clips, 20 large clips and 510 screws.

**Question 3 : BOOKSHELVES**

How many sets of bookshelves can the carpenter make?

![Development Results](image2)

To make our WHO standard hand sanitizer bottle, the following ingredients are needed:

| Materials      | Type   | Size   |
|----------------|--------|--------|
| Alcohol        | 94%    | 440 ml |
| Hydrogen Peroxide | 3%   | 40 ml  |
| Glycerin       | 99%    | 13 ml  |
| Aquadest       |       | 85 ml  |

**Question 2 :** If someone wants to make a WHO standard hand sanitizer with 540 ml of alcohol ingredients, 94 ml of glycerin, and 130 ml of distilled water. How many bottles can it make?

![Figure 1. PISA problem before and after development](image3)

3.2.2. Expert Reviews and One to One

In expert review stage, Prototype validation 1 was viewed by an expert on material, design, and language. The validation process is performed by emailing the validator with a PISA-type question. HN (UIN lecturer, Raden Fatah) was the validator which validated prototype 1. In addition to the specialist process, the researchers also held a zooming panel discussion and 21 colleagues (Masters of Mathematics Education) and one teaching lecturer participated. Feedback and suggestion from expert review committees and discussion groups are used for concept revision 1. On one-to-one, prototype 1 offers small, medium, and high capacities for 3 students. The three students are YS (high capability), AY (medium capability), and VS (low capability) via the (online) zoom method. Student findings and interview reports have been used to test version 1. The empirical findings were collected by expert reviews, one-to-one interviews, and committees can be seen in Table 1.
Based on expert reviews, panel meetings, and one-to-one parallel comments/suggestions, the issues in prototype 1 have been corrected and updated. The revised question called prototype 2 can be seen in Table 1. Seen from expert comments and the one-to-one phase of constraints and understanding in solving problems.

Based on the content, the questions have been adjusted to the PISA problem and the context used also follows the problem that is happening now that is the Covid-19 pandemic or it can be said that the problem given is in accordance with the domain of mathematical literacy in Indonesia especially for 9th grade students. The questions developed were in accordance with the characteristics of the PISA difficulty level and the ability of IX grade junior high school students. In terms of language, there are only problems with the use of words that are difficult for students to understand so that they are changed with words that are easily understood by students. The revised result of prototype 1 is called prototype II. Changes from prototype I and prototype II are based on expert and one-to-one validation.

### 3.3. Small Group

In the Small Group Level, the practicality is presented and the problem given implemented. Using nine grade 9 students with different capacities at this level, namely AF, AK, EPA, MM, EAN, DA, SN, BC RP. Next, individual problems are solved by the students. After that, students are asked to discuss in their groups. Nearly all students are able to complete the cycle and finish well. Students use various approaches to solve the problems from the findings of the study can be seen in Figure 2.

**Figure 2.** AF’s answer

From the students’ answers in Figure 2, it appears that students have understood the purpose of the problem. To get a lot of bottles is to divide the ingredients with the materials needed. So, after being measured as a whole, then many bottles are 3 bottles based on students' results and discussion in the small group process, the problem being created can be understood, reasons and guidance about the problem can be clearly described and students can correctly address the question.

Based on the results of the analysis of student worksheets shows that most students actually understand the purpose of the problem given only students still have errors in their operation. In solving

| Validation | Comment | Revision |
|------------|---------|----------|
| expert reviews | 1. Add image source | 1. Improve suggested things about writing technique. |
| | 2. $H_2O_2$ equate the picture “Hydrogen Peroxide” | about writing technique. |
| | 3. Provides interesting content and context | 2. Source has been added |
| one-to-one | 1. Confused with the intention of approximately one liter | |
| | 2. The problem given is difficult and requires deep understanding | |
the given problems, students have involved communication skills, reasoning, representation and arguments.

Based on the results of expert validation analysis, one to one and small groups, it can be concluded that the questions developed have been valid and practical. This is reflected in the responses / comments, constraints / difficulties experienced by students when working on a given problem [16]. Students involve their mathematical abilities, namely communication, reasoning and argumentation in providing perception and interpretation of data problems that are presented in the form of a hands-on test problem. The practicality of the questions can be seen from the results of students' work in the small group phase which shows the problems given can be easily understood because they can solve them by stating their arguments according to their perceptions and interpretations [10,11,13].

Interview results show that PISA questions using the context of Covid-19 distribution can improve and familiarize students with reasoning, communication, and argumentation abilities. Students also said that they were happy to learn mathematics in the context of problems that are being experienced all over the world because they could increase knowledge about the Covid-19 pandemic as well.

4. Conclusion

The mathematical problems of PISA-like using the Covid-19 context developed were valid and practical. The validity of the questions is obtained from the validation process at the expert reviews and one to one stage. At the expert review stage, the experts assess and have stated both in terms of content, construct, and language, while in the one to one process it is done to see the clarity and readability of the questions by students. The practicality of the problem is illustrated from the small group stage where all students can understand the purpose of the question well, in accordance with the student's mind line, easy to read, and does not lead to diverse interpretations. The characteristic that was developed in the development of this problem is that the developed question set has the characteristics of the PISA problem and uses the Covid-19 context in which this is a pandemic for the whole world today.

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