Higher-order thinking skill problem on data representation in primary school: A case study

R I I Putri¹,a and Zulkardi Z¹
¹Faculty of Teacher Training and Education, University of Sriwijaya, Jalan Srijaya Negara FKIP Bukit Besar Palembang, Indonesia

aE-mail: ratu.ilma@yahoo.com

Abstract. This article aimed at reporting research result on a case study of a lesson using a HOTS problem. The task was about data representation using baby growth context. The study used a design research method consisting of three stages: preparing for an experiment, experiment in the classroom (pilot and teaching), and retrospective analysis. Participants were sixth grade students who were learning data representations in a Primary School in Palembang Indonesia. A set of instructional activities were designed using Indonesian version of Realistic Mathematics Education (PMRI) approach. The result showed that students were able to solve the problem and present their solution in front of the classroom. The conclusion indicated that that HOTS problem using the growth of a child as the context could lead students to use their mathematical thinking. During the learning activities along with teacher orchestra’s guidance, and discussion, students were able to solve the problem using line graph although some of them used a bar graph. In the future, teachers are necessary to focus on the role of real-world figure in mathematics learning.

1. Introduction
Statistics is the very important topic as statistics is a part of a curriculum in primary and secondary school. Also, quality of teachers is probably the most important factor in education, but teachers need books with well thought out mathematical problems [1]. Data Representation is a part of statistics topic which always uses in daily life. In fact, during students learning data representation, teachers mostly give examples and their solution without students knowing how to represent the data. Hence in teaching data representation, teachers have to use the right theory. Furthermore, teachers can fine right context. It also stated by [2], that data representation was suggested depend on a type of data, sense of researcher, and the use of data. According to [1], at the heart of the process of designing for mathematics education is the choice of suitable problems, for example, graphs of the growth of a sunflower or a child.

The new curriculum aims at developing 21st-century competencies as mathematical thinking, problem-solving by observing, questioning, listening, and communicating the solution to the problem [4]. Curriculum implementation is described, to reach the goal effectively, learning activities need to use principle, one of them is to provide many learning experiences through meaningful and interesting strategy and instructional method [5]. Accordingly with that one of consistent approach is Indonesian version of Realistic Mathematics Education PMRI. PMRI is an instructional theory that fostering students to communicate, argue and justify their solution [6, 2, 7, 17].

Since Indonesia has been joint PISA (Program for International Student Assessment) since 2000, Indonesian students were not able to solve HOT problems [8]. PISA results in mathematics, have been...
instability. In the year 2000, PISA mathematics, Indonesia was ranked 39 of 41 countries in mathematics. Then in 2003, the rank was 38 of 40 countries. Then the worst result in PISA 2012 that is ranked 64 out of 65 in PISA 2012 [9,15]. This result shows that Indonesian students weak on mathematics literacy, its mean the competence of students in problem-solving, critical and creative thinking in general still low. This article reports a design research that focuses on how grade five students discuss using HOT problem about baby growth on the choice of data representations in a Primary School in Palembang Indonesia.

There are four problem areas where graph types were developed namely (1) spatial organization; (2) discrete comparison; (3) continuous distribution with histogram and line graphs; (4) multivariate distribution and correlation with three-dimensional charts and correlation diagrams [3].

Higher Order Thinking is thinking on the higher level such as mathematical thinking and reasoning, communication, critical attitude, interpretation, reflection, creativity, generalization and mathematizing [10,18]. According to [11,19,20], to assess higher-order thinking are: see how students understand the problems and let students construct their response. Also, give some suggestions for stimulating students to construct mathematical models and have them to make predictions, describe patterns, and provide explanations.

To facilitate interactivity in the classroom, mathematics social norms are used. In Indonesian classrooms, we use the norm to support students learning in both answering and giving reasoning and justification of their answer [4]. The social norms guide the class on how to communicate, to give reasoning and proof of the solution. In mathematical learning, socio-mathematical norms mean use of norms deal with the difference mathematical solution and strategies [2]. The purpose of this study is to develop a local instruction theory based on the Realistic Mathematics Education Theory [13,4,16].

2. Method
2.1 The research design
The subject of this research is 30 students of fifth grade primary PMRI pilot school in Palembang Indonesia. Three steps of design research: design, teaching experiments, and retrospective analysis are reported. We observed and watched the interaction in the video and analyzed the samples of students’ work. Our analysis focused on the HOT problem of representation data. We gave students of 10 and 11 years old a problem about a girl. The students were asked to draw a graph that would show how the girl had grown [1]. Figure 1 shows the table with the data.

![Figure 1. Graphs of the growth of a child problem](image)

Activities during the research, the team, analyzed and designed the lesson, observed the student activities, discussed the observations results, and analyzed the data. Here, the research team focused on the following mini design cycle [14].

1. Design: planning, anticipating, and predicting students’ thinking and how the teacher guide the
growth and development of students.
2. Teaching experiment where students investigate the problem supported by the teacher.
3. Doing retrospective analysis and revise the lesson

Figure 2. Three phase of design research and its activities

3. Results and Discussion

This part describe three phases of the design research.

3.1 Design Phase

The graphs of the growth of a child problem (see Figure 1) was given as a starting point of the lesson. Then the discussion after the teacher asked for students’ to solve the problem. The discussion focused on exploring the students’ solutions and strategies.

3.2 Teaching Phase

After Ms. Evi, the teacher, gave the task to all 25 students, they worked in small groups. Students discussed and solved the girl grown problem. The research team observed the class, one research member for each team.

During the discussion, students focused their attention on the graph. One group engaged using bar graph which showed a good understanding of the problem. Others groups also using bar graph although students do not understand the problem. These can be seen in Figure 3.
One of the interesting of the problems, the students, produced solutions in different strategies that were reflecting the reasoning of the students. But the teacher's reactions make students confused. Group 2 was able to solve the problem correctly. However, they still confuse about zero. This will be discussed below.

T: look, Fina, why zero here and zero there the difference?
S: zero here for year, and zero there for centimetre
T: Look at the position, are you sure?
S: (still confuse…..)

In this fragment, shows that students confuse with the problem due to her unfamiliar with the problem. Teacher moved around and guided students during the group discussion. Many students interested and agreed that the problem is meaningful. However, some students confused with double zero. In another word, they confused on how to put notation zero in the line graph. It came as no surprise that most students did choose some form of a bar graph. One of the solutions was rather surprising because one group choose a line graph. Then the teacher helps students by reintroducing the problem and asking them to draw graphs of the growth of a child. One group drew the representation of the growth of a child as shown in figure 3c. This illustration indicated students understand the problem using the line graph.

3.3 Retrospective Analysis Phase

In this phase, the team analysed and agreed that teachers guided students to solve the problems using their strategies. In the beginning, the students initially attempted to fit on data representation. Then, many of the solutions were not meaningful. Hence, it is important to support students to retreat from the unimportant concept so that students could develop their understanding.

The discussion in groups gave more space and time for students to discuss their strategies constructively. Finally, we noticed that many students actively in communicating, giving their reasoning...
and justification to their solutions and strategies.

4. Conclusion
The data in this study shows that HOT problem about the growth of a child powerful in bringing out mathematical thinking and communication amongst students. The teacher plays a central role in eliciting the discussion that allows students’ thinking to grow.

During the learning activities of this design research study, students can solve the problem using line graph although some of them using the bar graph. In the future, teachers need to focus on the role of the graph in daily life.

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