

Mathematical literacy in pre-service teacher-designed mathematics comics

Zetra Hainul Putra^{1*}, Gustimal Witri¹, Syahrilfuddin²

¹Faculty of Teacher Training and Education, University of Riau, Pekanbaru, Indonesia

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ABSTRACT

Mathematical literacy is a key point of the Program for International Student Assessment (PISA) study, and indeed it becomes a concern for some studies in many countries. This study aims at investigating mathematics literacy presented in mathematics comics, and it focuses on mathematical contexts and contents presented in thirteen pre-service teacher-designed mathematics comics. The findings show that personal is the most favourable contents, while quantity and change and relationships are mostly contexts chosen by the pre-service teachers in their designed mathematics comics. The implication of this study is that teacher-designed mathematics comics still emphasis on a daily life context that closed to students' life.

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Corresponding Author:

Zetra Hainul Putra

Gedung Prodi PGSD/Pendas FKIP Universitas Riau, Jl. Binawidya Km. 12,5 Simpangbaru, Kec.

Binawidya, Pekanbaru, Riau, Indonesia 28293

Email: zetra.hainul.putra@lecturer.unri.ac.id

INTRODUCTION

Textbooks become the main resource for teaching and learning in mathematics and other subjects. Most teachers heavily depend on textbooks to decide what topics should be taught and how to explain them to students (Beaton et al., 1996). Some studies focusing on textbook content analyses have found some characteristics of textbooks presented in different countries (Alajmi, 2012; Wijaya, van den Heuvel-Panhuizen, & Doorman, 2015). Alajmi (2012) has analysed how fractions are presented in textbooks designed for the elementary grades in Kuwait, Japan, and the USA, and he found that all those textbooks focus on standard algorithms as the main computational methods but within different approaches, using linear models and connecting fractions with measurement in Japan, using concrete materials in the USA, and using some pictorial representation of the area model in Kuwait. While, Wijaya et al., (2015) have investigated Indonesian textbooks and found only 10% of the tasks in the textbooks are context-based tasks, and only 2% of those tasks are reflection tasks, which they consider as tasks with the highest level of cognitive demand.

Besides mathematics textbooks, some studies also investigate and analyse books supporting mathematics learning, e.g., mathematics picture books (Trakulphadetkrai, 2017). Trakulphadetkrai's study focused on the analysis of the gender issue on 64 mathematical picture books, and she found a gap between male and female characters on those books. Other studies tend to focus on how mathematics picture books used to support students' mathematical learning (e.g. van den Heuvel-Panhuizen & Elia, 2011). Van den Heuvel-Panhuizen and Elia (ibid) found that there was a significant influence between reading math picture books and kindergarten students' ability of measurement in general. While, our study also analysis mathematics picture books, but we focus on the mathematical literacy presented in mathematics picture books designed by pre-service teachers. This means that the mathematics picture books could reflect pre-service teachers' mathematical knowledge and mathematical literacy.

MATHEMATICAL LITERACY

Mevarech and Fan (2003) argued that the concept of "mathematical literacy" relates to the use of mathematics in human life, rather than apply some mathematical facts and use some algorithms to solve mathematical problems. Mathematical literacy provides students' curiosity to solve problems and meaningful learning.

Mathematical literacy is a key point of the Program for International Student Assessment (PISA) study (OECD, 2016). The mathematical literacy defines as students' capacity to formulate, employ and interpret mathematics in a variety of contexts (OECD, 2016). PISA distinguishes four contexts that can relate to mathematics, namely personal, occupational, social, and scientific. The personal context is related to a task focusing on activities of one's self, one's family or one's peer group such as food preparation. The occupational context is a task centred on the world of work such as costing and ordering materials for building. The Social context is related to a task on one's community (whether local, national or global) such as voting systems. Finally, the scientific context is a problem relating to the application of mathematics to the natural world and issues and topics related to science and technology such as weather or climate (OECD, 2016).

Besides referring to the contexts, mathematical literacy also refers to mathematical contents. The contents consist of four strands: namely change and relationship, space and shape, quantity, and uncertainty and data analysis, (OECD, 2016). The change and relationship display the multitude of temporary and permanent relationships among objects and circumstances, such as the growth of an organism. Space and shape encompass a wide range of phenomena that are encountered everywhere in our visual and physical world such as representations of objects. The quantity incorporates the quantification of attributes of objects, relationships, situations and entities in the world, understanding various representations of those quantifications, and judging interpretations and arguments based on quantity such as measurement and counts. Finally, the uncertainty and data include recognizing the place of variation in processes, having a sense of the quantification of that variation, acknowledging uncertainty and error in measurement, and knowing about chance (OECD, 2016).

In this study, we investigate the contexts and contents of teacher-designed mathematics picture books based on the PISA framework. We formulate the research

question for this study as “what mathematical contents and context are presented in pre-service teacher-designed mathematics picture books?”

METHOD

This study applies a content analysis within a qualitative approach. According to Cohan, Manion, and Morrison (2007), the content analysis is a research method aiming to investigate the broad spectrum problem where the contents of communication serve as the basis for conclusions. Through this approach, appropriate categories and units of analysis are identified carefully. In the present study, the units of analysis are analysed based on the contexts (personal, occupational, social, and scientific), and the mathematical contents (change and relationship, space and shape, quantity, and uncertainty and data analysis).

Thirteen mathematics picture books (MPB) designed by pre-service elementary teachers are analysed in this study. The MPBs are designed and written by thirteen groups of second-year pre-service elementary teachers from a public university in Riau, Indonesia. The books are final projects from the course of mathematics education for upper grades in the second semester in 2019. Each MPB was written by three pre-service elementary teachers, and during the course, each group got a chance to present and discuss the MPB with other students and a teacher educator (the first author).

RESULTS AND DISCUSSION

The first analysis is to categorise the 13 MPBs into four contexts. Table 1 shows the number of contents presented related to those contexts. It can be seen that MPBs mostly present mathematical situations based on personal contexts, and shopping is the most favourable contexts appearing in MPBs (4 MPBs). Three MPBs present the mathematical situations in two contexts. For instance, the MPB, with the title “Mathematics professor”, presents the social and scientific context. The social context is presented through the activity of the school which organises the traditional fashion show competition to celebrate the Indonesian Independent day. Then, the organisers have a problem to package the present, and thus they need some help from a mathematics professor to solve that problem.

Table 1. The contexts presented in MPBs

No	Contexts	Number of Contexts	Examples of activities or contexts
1	Personal	9	Making bracelet, Dancing, Shopping, Travelling, Food preparation, Traditional game
2	Occupation	4	Harvesting foods, Fishing, Selling fish
3	Social	2	Celebrating of Indonesian independent day, Charity
4	Scientific	1	Mathematics professor

Concerning the mathematical contents, it can be seen from Table 2 that the quantity is the most favourable contents presented in MPBs. None of MPBs is designed based on the content of uncertainty and data analysis. Six MPBs employ two contents, change and relationships and quantity. For instance, The MPB with the title “Aris’ new notebooks”

accommodates the mathematical tasks of ratio and multiplication. The mathematical situation is about a young boy asking his mother to let him buy some notebooks for the new semester of his school. Therefore, his mother gave him two of five-thousand rupiahs and one of ten thousand rupiahs. Then in the bookstore, the price of a notebook is three-thousand rupiah, and he bought six notebooks. Here, the first task is categorized as quantity because it just requires someone to do the addition of numbers, and the second task is clearly about the change and relationships because it requires someone's proportional reasoning to solve such task.

Table 2. The contents presented in MPBs

No	Contents	Number of Contents	Examples of mathematical problems
1	Change and relationships	8	One child will get four clothes. If there are 40 clothes, how many children will get the clothes?
2	Space and shape	1	There are two wooden rectangles with 80 cm long and as wide as a student's feet. They will be used to make <i>Bakiak</i> (Traditional wooden sandals which had rubber straps on them with capacity mostly for 3 people). So, how to make <i>Bakiak</i> ?
3	Quantity	10	Risky and Dayat practice at the dance studio. Risky comes every 6 days, and Dayat comes every 4 days. If they come to the studio today, When will they meet again?
4	Uncertainty and data analysis	0	

CONCLUSION

The mathematical contexts presented in pre-service teacher-designed mathematics picture books are dominated by the personal context. This means that pre-service teachers still consider that the mathematical situations designed in the picture books for students should be related to students' activities of daily life. While the quantity and change and relationship become the common contents appearing in those picture books, and those are related to the mathematical contexts at hands. Then, the next step we need to analyse how mathematical knowledge presented in those mathematics picture books, such as techniques or strategies to solve the tasks.

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