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Mathematical literacy as the 21st century skill

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Abstract. In the 21st century, the problems encountered in the daily life are increasingly difficult and complicated. It is important for each individual to know and understand the role of mathematics in real life so that the individual is able to appropriately evaluate and consider the use of mathematics for meeting the needs of being a society member who is constructive, caring, and willing to think. This skill is called mathematical literacy skill. This article reviewed seven articles which focus on what competencies indicate that students have mathematical literacy. The competencies consist of mathematical thinking and reasoning, mathematical argumentation, mathematical communication, modelling, problem posing and solving, representation, symbols, and tools and technology. This article aims to describe the mathematical literacy importance to other researchers, teachers, or preservice mathematics teachers on in researches or mathematics learning processes.

1. Introduction

In the 21st century, the problems encountered in daily life are increasingly difficult and complicated. The demands of the problem solving skill in an occupation also increase rapidly. Based on some earlier studies, the modern society in this century not only requires content knowledge, but also requires skills including critical thinking, problem solving, creativity, innovation, communication, collaboration, flexibility, adaptability, initiative, self-diversion, social, cross culture, productivity and accountability, leadership and responsibility, and information literacy [1-4]. Mathematical literacy is one of the components needed to construct the 21st century skills [5].

Mathematical literacy is relatively unfamiliar to some people. Previous researches revealed that mathematical literacy is still foreign to some societies, yet it is important for the society in the 21st century [6]. Mathematical literacy is still a major challenge in basic mathematics education and it is a key issue and a trend in mathematics education researches [7]. This is because a person must be able to prepare his role as a subject who studies independently for his or her whole life [8] and to solve real world problem that requires him to use the skills and competencies acquired through experiences in schools and daily lives. The fundamental process on this is called mathematization, a process which makes the students shift from the real world context to the mathematics context and it is required to solve problems. Mathematization enables students to interpret and evaluate problems, then to reflect the solution to believe that the discovered solution matches the real situation of the problem.

Therefore, the unfamiliarity of mathematical literacy must be finished soon, and the community must know and master the competencies in mathematical literacy to deal with daily problems. This literacy is an important issue that needs to be discussed. Based on the description, this article describes what



competencies indicate that students have mathematical literacy which include mathematical thinking and reasoning, mathematical argumentation, mathematical communication, modelling, problem posing and solving, representation, symbols, and tools and technology.

2. Method

Data in this article was collected using literature review method. Literature review can be in the form of combining literature, setting them up into a series of interrelated topics, and summarising them by showing the central issues [9]. In this article, the literature review method aims to collect all relevant information from the written documents such as journals and books published in 2002-2017. Documents are tracked by websites such as: googlescholar, springerlink and sciencedirect. This reviewed seven articles and books with keywords of “competencies of the 21st century” and “mathematical literacy competencies”.

3. Results and Discussion

3.1. The Definition of Mathematical Literacy

In the English Oxford Dictionary, “literacy” is defined as: (1) the ability to read and write; and (2) the competency or knowledge in a specified area.” This means that someone, who has mathematical literacy is able to read and write and has competencies or knowledge in a particular field, for example: having competencies in the field of mathematics [10].

According to the assessment and analytical framework of Programme for International Student Assessment (PISA), mathematical literacy is the skill of a person to formulate, apply, and interpret mathematics in a variety of contexts such as the capability of mathematical reasoning and utilising concepts, procedures and facts to describe, explain, or predict a phenomenon or an event [1]. Mathematical literacy is the needs as well as the knowledge that must be known and applied in the form of mathematics bases for daily life [11,12]. To support this, the basic knowledge and mathematical skill are absolutely necessary.

Students are informed and given an understanding of the role of mathematics in the modern world through mathematical literacy. Mathematical literacy is the skill that supports the application of mathematics dealing with lives. This allows students to develop the skills and confidence to think numerically and spatially to interpret and critically analyse daily situations and to solve problems [13].

According to the description, mathematical literacy is the skill to understand how mathematical functions are in the world and how to use them to make decisions and live a life that has complete purposes. Thus, the skills, to enable mathematical literacy for solving problems encountered in everyday life, are important.

3.2. Mathematical Literacy Competencies

A competency is an individual underlying characteristic that is causally related to criterion-referenced effective and/or superior performance in a job or situation [14]. The competencies required in the 21st century are described in Table 1.

In general, literacy is characterized by several main competencies that are mathematical thinking and reasoning, mathematical argumentation, mathematical communication, modelling, problem posing and solving, representation, symbols, and tools and technology. To achieve this competency, clear indicators are needed. The indicators of each competency will be explained in the next sections.

3.3. Mathematical Thinking and Reasoning

Indicators of achievement are needed to obtain major competencies. Mathematical thinking and reasoning indicators include: 1) posing problems mathematically, 2) knowing a number of answers that can be offered by mathematics, 3) distinguishing among various statements, 4) understanding the breadth and limitations of mathematical concepts and being able to work around them.

3.4. Mathematical Argumentation

Mathematical argumentation indicators include: 1) knowing what is meant by proof, 2) knowing how proof differs from other forms of mathematical reasoning, 3) following and evaluating the order of arguments, 4) having a heuristic understanding, 5) making and expressing mathematical arguments.

3.5. Mathematical Communication

Mathematical communication indicators include: 1) expressing personal selves in various ways such as oral, written and other visual forms, and 2) understanding the work of others.

Table 1. Competencies required for the 21st century.

References	Competencies
Partnership for 21st Century Skills – Learning for 21st Century (2002) [2]	Thinking critically, applying knowledge to new situations, analysing information, comprehending new ideas, communicating, collaborating, solving problems, and making decision.
Trilling & Fadel – 21st Century skills: Learning for Life in Our Times (2009) [8]	Critical thinking and problem solving (expert thinking), communication and collaboration (complex communicating), and creativity and innovation (applied imagination and invention).
OECD – PISA 2012 Mathematical Framework (2010) [15] and Abidin, Mulyati, & Yunansah – Pembelajaran Literasi (2017) [16]	Communication, mathematising, representation, reasoning and argument, devising strategies for solving problems, using symbolic, formal and technical language and operations, and using mathematical tools.
De Lange – Numeracy in the Primary School A Discussion Paper [12]	Mathematical thinking and reasoning, mathematical argumentation, mathematical communication, modelling, problem posing and solving, representation, symbols, and tools and technology.
Turner – The Literacy Idea (2014) [17]	Express mathematical ideas and mount mathematical arguments; understand the mathematical ideas and arguments of other people; reason mathematically; use a variety of different kinds of representations of mathematical phenomena; think strategically, and plan and implement a sequence of mathematical processing steps; recognise and use, or devise and manipulate mathematical models of real-world phenomena; reflect on which elements of their mathematical skills and technical knowledge might be relevant to a particular challenge; and identify when particular mathematical tools (such as computer-based tools, or measuring instruments, or calculating devices) might be useful, and make effective use of those tools.
Hadi – Pendidikan Matematika Realistik (2017) [18]	Thinking mathematically, arguing mathematically, modelling, posing and solving problems, representations, using symbols and formal language, and communication.

3.6. Modelling

Modelling has the following indicators: 1) translating reality into mathematical forms, 2) interpreting mathematical models in context or reality; 3) working with models; 4) validating the model; 5) reflecting, analysing, and offering models or solutions; 6) reflecting the modelling process.

3.7. Problem Posing and Solving

Indicators for posing and solving problems include: posing, formulating, defining, and solving problems in various ways.

3.8. Representation, Symbols, Tools and Technology

Indicators of representation, symbols, tools and technology include: 1) making the codes, and interpreting, differentiating and interpreting various forms of object representation and mathematical

situations; 2) understanding the relationship among different representations, 3) using language and operation symbols formally and technically, 4) knowing and being able to make various kinds of assistance and tools of mathematics; and 5) knowing about the limitations of assistance and tools.

4. Conclusion

Taking this discussion into account, the researchers conclude that mathematical literacy is the skill to formulate, use, interpret, and understand how mathematics benefits are in various contexts of daily life problems efficiently to make decisions. It is also one of the components needed to construct the 21st century skills. Therefore, it is important for each individual to understand mathematical literacy for solving problems encountered in daily life. From reviewing seven articles, mathematical literacy has several major competencies, that are mathematical thinking and reasoning, mathematical argumentation, mathematical communication, modelling, problem posing and solving, representation, symbols, and tools and technology.

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