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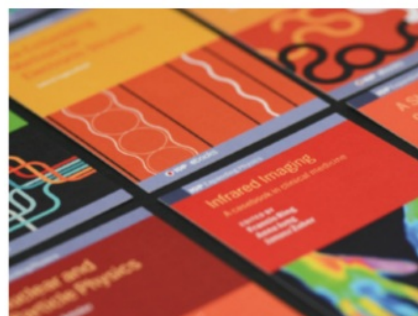
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Mathematical Literacy Training (MLT) through Virtual based Mathematics Kits (VMK) for best mathematics performance

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Abstract. Mathematical literacy bridges mathematics with real-world contexts. This study aims to enhance mathematics performance by MLT through VMK. The study involves grade 4 elementary school students in 4 classes. The MLT has been held 5 weeks (90 minutes each week) as extracurricular activities in 4 classes. The MLT focus on students' ability to reason, convey ideas effectively and solve math problems. Various math problems represented by VMK (digital-based media). The VMK used for stimulating students' thinking. The enhancement seen by comparing student' mathematics performance before and after MLT activities. The MLT gives an enhancement for student' mathematics performance and mathematical literacy. The use of VMK can stimulate students' ability to reason and solve math problems. In convey ideas effectively, student still needs help in making an idea. This study shows the VMK in MLT activities enhance student' mathematics performance.

1. Introduction

Mathematics is a thing that often avoided by most students. Often students question about the use of mathematics in everyday life. The question is how to design, mathematical activities so that mathematics can be a thing that students like and provide answers to mathematical activities in everyday life. In mathematics learning, mathematics presented to have a function in real-world [1–3]. Ideas that involve mathematics in real-world contexts are mathematical literacy [4,5]. Mathematical literacy is an individual's ability to identify and understand the usefulness of mathematics in the real world [6,7]. Mathematical literacy is also seen as the ability to formulate, employ, and interpret mathematics in various contexts [6,8]. Including mathematical reasoning and the use of mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena [9,10]. Based on the definition, mathematical literacy can be a thing that makes students understand how to use mathematics in real life.

Mathematical literacy related to the cognitive process [11]. Students' ability in learning mathematics related to their mathematical literacy [12]. Previous studies state that good mathematical literacy makes students' mathematical performance better [12–15]. However, the study held in higher education and never been doing in elementary school. The previous study also improves mathematical literacy by using mathematics learning model and integrated in regular mathematics classes [2,16]. The regular mathematics classes have their own mathematics objectives. If mathematical literacy objectives integrated in regular mathematics classes, then to achieve all objectives require a long time. Furthermore, the previous study still not using digital media, which is trending at this time. Based on



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the description, this study designed activities outside the regular mathematics classes to improve student' mathematical literacy. The activities supported by digital media. The digital media used in this study was VMK. VMK used to present mathematical problem and able to manipulate mathematics objects. The use of this media is expected to support the MLT activities.

Developing mathematical literacy in elementary schools is very important [16–18]. This study aims to determine effectiveness MLT activities using VMK and also to determine mathematical literacy and mathematical performance of elementary school students. The first research question is how MLT activities can improve student' mathematical literacy when comparing before and after activities MLT. The second research question is can MLT activities improve student' mathematics performance by comparing performance before and after activities. The mathematics performance meant mathematical abilities that have been gained during attending mathematics learning in elementary school.

2. Method

2.1. Participant

The study involves grade 4 elementary school students in 4 classes from 4 elementary schools. Total students participate in this study was 76 students (mean age = 9.2; range age = 8.7 – 10.3; 36 males & 40 females). The students teach by 2013 curriculum (latest curriculum in Indonesia) in school. School selection based on school rankings using national exam data for the last 3 years. Selected school was a medium grade (interval of mean $6.705 \leq \bar{X} \leq 7.735$).

2.2. Material

Two instruments used to measure mathematical literacy and mathematics performance.

2.2.1. Mathematical literacy instrument. Mathematical literacy instrument (MLI) created by viewing mathematical literacy indicators [6]. The mathematical literacy instrument also adjusted by student' cognitive development and 2013 curriculum that applied by the school. The instrument consist 60-items multiple choice in two sections (MLI section 1 & MLI section 2; 30-items for each section). The reliability score of MLI section 1 and MLI section 2 was 0.72 and 0.74.

2.2.2. Mathematics test. Mathematics test was administered to measure student mathematics performance before (MT section 1) and after (MT section 2) MLT activities. The test includes mathematical material that has been taken in school. The test consist 40-items multiple choice (20-items for each section). The difficulty level of this test was in the middle level (mean score of difficulties level = 0.53). The reliability score of MT section 1 and MT section 2 was 0.71 and 0.73.

2.3. The use of VMK and structure of MLT activities

2.3.1. Virtual Mathematics Kits (VMK). VMK was a collection of software products used for 1) presents mathematical problems; 2) transform mathematical concepts into devices that can be manipulated (dynamic mathematical object); and 3) stimulate students to make problem solving ideas. VMK was created to support MLT activities. VMK was used through hardware such as laptops and projectors. Software used to make VMK was Geogebra, Matlab and office mix.

2.3.2. Mathematics Literacy Training (MLT). MLT activities administered 90 min every week for 5 weeks period in school (see Table 1). MLT activities designed as extracurricular activities that the activities did outside school schedule of mathematics learning. This activities was carried out collaboratively between teachers and researchers. In MLT class, teacher and researchers encourage students to express idea through VMK. Summary of MLT activities schedule sees in Table 1.

2.3.3. Procedure. MLT and MT section 1 administered to students in the same day. Students must complete each test within 60 min. MLT and MT section 1 test administered to student 3 weeks before MLT activities were conducted. One week after MLT activities were finished, MLT and MT section 2 administered to students. Time for each test was 60 min.

Table 1. Summary of MLT activities.

Weeks	Objectives
1	Formulate problems mathematically (Modeling)
2 – 3	Reason and create ideas for solving problems
4 – 5	Interpret, apply, and evaluate the results of a mathematical process

3. Result and discussion

The results of this study present 1) the correlation between mathematical literacy and mathematics performance; and 2) the effects of MLT activities using VMK. Data representing the effects of MLT activities were analyzed using t-test on section 1 test scores and section 2 test scores [19,20]. From these data, a correlation test was performed between mathematical literacy and mathematics performance.

3.1. Correlation between mathematical literacy and mathematics performance

There is a high correlation between MLI section 1 and MLI section 2 ($r = 0.76$). Correlations in MT section 1 and MT section 2 were also high with a correlation index $r = 0.72$. The correlation between mathematical literacy and mathematics performance was high for each section 1 (0.74) and section 2 (0.73).

3.2. Effect of MLT activities

Means and standard deviations from section 1 and section 2 (mathematical literacy instrument and mathematics test) presented on Table 2.

T-test performed using mean score of MLI and MT. Tests were conducted to determine differences in mathematical literacy and mathematics performance (before and after MLT activities) and gender (male vs. female).

On mathematical literacy test result, there was significant mean difference between MLI section 1 and MLI section 2 ($t = 2.81$, $p < 0.01$, $df = 75$). However, there was no significant mean difference between male and female student ($t = 1.43$, $p = 0.17$, $df = 74$). In the mathematics test results, there also significant mean difference between MT section 1 and MT section 2 ($t = 3.09$, $p < 0.01$, $df = 75$). However, there was no significant mean difference between male and female student viewing by mathematics performance ($t = 1.86$, $p = 0.22$, $df = 74$). The different mean of each test presented on Figure 1. The Figure 1 also presented improvement of mean before and after MLT activities as a result of the MLI and MT for each section. The improvement not only occurs in mathematical literacy, but also in mathematics performance. Thus, MLT activities can provide assistance to students to develop mathematical literacy and also mathematical performance.

Table 2. Means and standard deviation.

Measure	Overall		Data (M)		Data (F)	
	M	SD	M	SD	M	SD
MLI – section 1	20.16	6.04	19.32	5.66	21.84	6.14
MLI – section 2	23.47	6.53	22.30	6.38	23.53	5.06
MT – section 1	9.92	3.44	9.83	2.37	10.09	2.81
MT – section 2	13.89	4.22	13.48	3.72	14.41	3.83



Figure 1. Section 1 and section 2 test mean scores on mathematical literacy and mathematics performance.

Based on the result, researchers analyzed the differences in mathematical literacy abilities. Overall the student's mathematical literacy improves after MLT activities. However, there was no difference in ability when comparing gender (male and female). The result about gender comparison also same as previous research that use training as a way to improve mathematical literacy [21]. Most of MLT activities doing by the change of static mathematical objects to dynamic objects through VMK. This allows students to manipulate objects and interpret problems to create problem solving ideas because a good visualization could support students' thinking [22]. This finding also shows that digital media could motivate and help students solve mathematical problems [23]. However, this activity requires the ability to use technology. Some students have difficulty using VMK. That was because students were not familiar with VMK before. But overall students enjoy MLT activities because we support student to use VMK very well. Computer-based activities were highly correlated with mathematical literacy so that both will support each other [24].

Besides mathematical literacy, researchers also measured the improvement of mathematics performance after MLT activities. Some previous studies also showed similar findings, but at a higher school level [14,16,25]. Previous studies mostly used mathematics learning models to improve mathematics performance [2,16,26]. Meanwhile, MLT activities were designed as an extracurricular activity which implementation takes place outside of mathematics class. This certainly became a differentiator from previous studies that integrated mathematical literacy in mathematics classes [27,28]. MLT activities did not require material preconditions in the content discussed. However, MLT activities

could indirectly support mathematics learning in mathematics classes. Apart from that, MLT activities provides to improve student' mathematics performance.

4. Conclusion

This study concludes that MLT brings students into mathematical activities that can improve mathematical literacy skills. Indirectly, MLT supports students' mathematical performance in regular classroom. Based on the results, MLT can be an alternative extracurricular activity and supporting mathematics learning. The use of VMK in MLT activities makes students have knowledge about digital technology and help them to solve mathematics problems. VMK makes mathematical objects into concrete and dynamic objects (manipulated easily). Therefore the use of technology in schools greatly supports students to be able to understand mathematics easily. In the future research, very important to pay more attention to students' readiness for digital media by doing the introduction of VMK. MLT activities need to be further redeveloped to reach the numerical and spatial domain in a porous manner. Because MLT activities have the potential to improve mathematical performance, then it would be better if MLT activities involve students from various grades which become heterogeneous groups.

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