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# Elementary school teacher's perspectives towards developing mathematics literacy through a STEAM-based approach to learning

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**Abstract.** This research aimed to investigate teacher's views about developing mathematical literacy through a STEAM-based approach to learning. The study used descriptive, qualitative data collection through observation, questionnaires, and interviews. The study involved fifth-grade elementary school teachers who have educator certificates and are mathematics expert teachers in Banda Aceh. The results show that the teachers agreed that the STEAM Project should start from an elementary school level of skills necessary for the project, but they did not yet understand the STEAM Project concept as a multidisciplinary learning approach nor they have the knowledge needed to implement it. They argued that the procedural demands during the implementation of the project were confusing, resulting in the achievement of content material taking precedence over developing students' mathematical literacy. They were also not used to connecting mathematics with the context of everyday life problems, so further guidance for teachers is essential for this approach to be successful. The results of this study are expected to provide teacher's views about student mathematical literacy and STEAM Project so that it becomes a reference in facing challenges in the global scope.

## 1. Introduction

The Program for International Student Assessment (PISA) aims to measure literacy, mathematics, and science literacy achievements. Indonesian students' mathematical literacy competence increased from 375 points in 2012 to 386 points in 2015 [1]. Survey results from Trends in Mathematics and Science Study (TIMSS) also show that Indonesian students' science and mathematics competencies are weak. The score for mathematics was 397, placing Indonesia in the 45th place out of 50 countries [2]. The results from PISA and TIMSS indicate that Indonesian students, especially in Aceh, are not competent at solving mathematical problems and providing solutions to issues based on real-world models. Another data that reinforces the above results is the Mathematics of the National Science Olympiad (OSN) for elementary school students. In 2017, only two students from Aceh participated to compete at the provincial level. In 2018, two participants represented Aceh to compete for the national and provincial levels. The OSN data showed an indication of weak competency in students' reasoning and mathematical literacy skills in Aceh [3,4].

Indonesia has need for future workers to be experts in science, technology, engineering, mathematics whilst preserving a connection to culture [5–9]. STEAM-based learning is considered a scientific approach that integrates the disciplines of Science, Technology, Engineering, Arts and Mathematics to meet the 21st century needs. The approach enables positive relationships to be built



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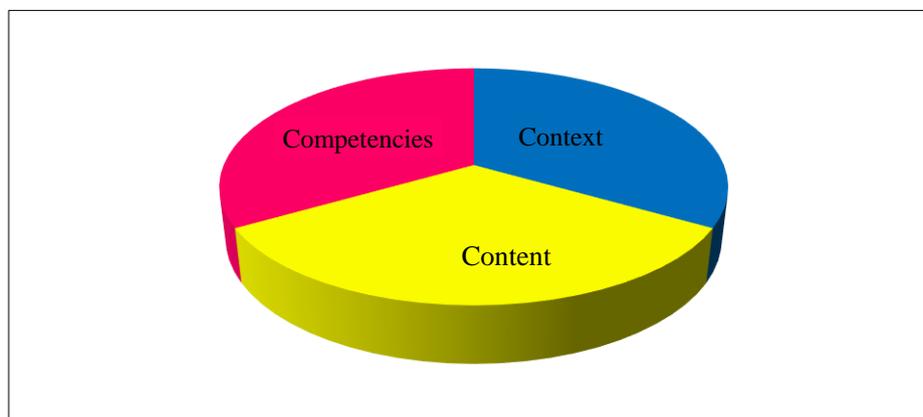
with and between students while developing collaborative attitudes [10-15]. Mathematical literacy can be developed through a STEAM approach because STEAM-based learning uses the context of daily problems that require mathematics and science concepts, procedures and mindsets. In addition, the approach uses engineering methodology design combined with appropriate technology in a teamwork-based learning environment [16–18]. Important focuses on the context of this research related to mathematical literacy and teacher perspective regarding STEAM projects.

A STEAM-based approach to learning is the focus of the 21st Century Minds industry (21CM), which aims to support innovation by preparing students with '21st-century skills' for future work. The skills include the ability to think intelligently and creatively, to solve problems, and to collaborate [9–11]. Developing a mathematical literacy framework could be done through the STEAM context [19,20]. STEAM project is integrated through modification of project-based learning models. Furthermore, an essential step in using a STEAM approach to develop mathematical literacy is to also develop collaboration skills, the ability to receive and apply feedback constructively, to represent objects and situations, and to communicate the results of problem-solving.

Previous studies show that STEAM, as a scientific approach to mathematics learning, serves as a means to activate and stimulate students' reasoning skills, thereby helping them to integrate the concepts of science and mathematics into inquiry [21–23]. Therefore, the purpose of this study was to find out teachers' view of using a STEAM-based approach to develop mathematical literacy in elementary schools in Banda Aceh, Indonesia.

## 2. Method

This study used descriptive, qualitative data collection through observation, a questionnaire, and interviews. The questionnaire consisted of 30 questions which had been previously validated and was supported by interviews. The questionnaire items were developed based on the dimensions as shown in Figure 1.



**Figure 1.** Mathematical literacy components (Source: Modification [24–26])

The survey was conducted with 30 teacher participants with maximum age 45 years old. Out of 30 teachers, 15 were selected for interview based on the following three categories: 5 participants had taught for five years, 5 participants had taught for a maximum of ten years, and 5 participants had taught for a maximum of fifteen years.

Table 1 describes the description of items for each dimension of mathematical literacy.

**Table 1.** Descriptions and examples for each dimension of mathematical literacy.

Dimension	Description	Item
Content	The extent to which mathematics teachers provide knowledge to students consisting of mathematical material: 1) Space and Shape related to the subject of geometry. 2) Change and relationship related to the subject matter of algebra. 3) Quantity relating to the relationship of numbers and number patterns. 4) Uncertainty relating to statistics and opportunities that are often used in society.	Consists of 10 questions for the teacher to explain related to the implementation of learning in class.
Context	The extent to which the teacher helps students bridge the knowledge gap from concrete to abstract, related to solving problems in everyday life.	Consists of 10 questions related to teachers helping students to solve mathematical problems in daily life that require reflective, realistic, and creative approaches.
Competencies	The extent to which teachers require students to develop and use five basic mathematical abilities: mathematical understanding, mathematical problem solving, mathematical communication, mathematical connection and mathematical reasoning.	Consists of 10 questions to the teacher to reflect on teacher-related responsibilities.

Prior to data collection, an interview protocol was developed. The semi-structure interview protocol was designed to provide insights into teachers' understandings of the STEAM project, mathematics literacy, a teacher's personal experience, the professional teacher in the learning process, and teachers' views of mathematical literacy knowledge. All interviews were recorded and immediately transcribed.

After data collection was completed, the Miles and Huberman model was used to analyze the data. Reduction of data was used to determine relevant data and focus data that leads to meaning. After the reduction phase is complete, data presentation was conducted to combine information that provides an overview of the situation. Then conclusions from the results of the data were presented.

### 3. Result and discussion

Questionnaires comprising of 30 questions were given to the participants who were asked to choose their answers by marking each item according to their situation and opinion using a 5-point Likert scale ranging from 1 (Never), 2 (Seldom), 3 (Sometimes), 4 (Often) and 5 (Always). The results of the questionnaire were analyzed using SPSS version 24. The validity and reliability of the questionnaire statement items are shown in Table 2.

**Table 2.** Questionnaire validation results.

Dimension	Item	Mean	Standar Deviation	Pearson Correlation	$r_{\text{tabel}}$	
Content	1	2.50	1.358	0.921	0.361	Valid
	2	2.47	1.252	0.923	0.361	Valid
	3	2.40	1.329	0.940	0.361	Valid
	4	2.40	1.221	0.943	0.361	Valid
	5	2.57	1.251	0.875	0.361	Valid
	6	2.60	1.380	0.892	0.361	Valid
	7	2.47	1.306	0.917	0.361	Valid
	7	2.60	1.276	0.700	0.361	Valid
	9	2.57	1.251	0.875	0.361	Valid
	10	2.67	1.422	0.881	0.361	Valid
Context	11	2.37	1.299	0.654	0.361	Valid
	12	2.77	1.406	0.374	0.361	Valid
	13	2.20	1.472	0.543	0.361	Valid
	14	2.53	1.613	0.464	0.361	Valid
	15	2.47	1.383	0.422	0.361	Valid
	16	2.20	1.472	0.543	0.361	Valid
	17	2.47	1.383	0.422	0.361	Valid
	18	2.37	1.299	0.654	0.361	Valid
	19	2.60	1.522	0.499	0.361	Valid
	20	2.77	1.406	0.374	0.361	Valid
Competencies	21	2.47	1.383	0.746	0.361	Valid
	22	2.47	1.383	0.746	0.361	Valid
	23	2.37	1.299	0.545	0.361	Valid
	24	2.60	1.522	0.474	0.361	Valid
	25	2.47	1.383	0.746	0.361	Valid
	26	2.20	1.472	0.385	0.361	Valid
	27	2.47	1.383	0.746	0.361	Valid
	28	2.33	1.348	0.528	0.361	Valid
	29	2.57	1.569	0.439	0.361	Valid
	30	2.77	1.406	0.374	0.361	Valid

Based on the above calculation, it could be concluded that all items in the instrument are valid. The reliability test was then performed. The results are shown in Tables 3, 4 and 5.

**Table 3.** Reliability results of the content dimension.

		N	%
Cases	Valid	30	100.0
	Excluded <sup>a</sup>	0	.0
	Total	30	100.0

<sup>a</sup>Listwise deletion based on all variables in the procedure.

## Reliability statistics

Cronbach's alpha	N of Items
.660	10

Table 3 shows that there are 10 questions with a Cronbach's Alpha value of  $0.660 > 0.60$ . It can be concluded that all the questions are reliable.

**Table 4.** Reliability results of the context dimension.

		N	%
Cases	Valid	30	100.0
	Excluded <sup>a</sup>	0	.0
	Total	30	100.0

<sup>a</sup>Listwise deletion based on all variables in the procedure.

Reliability statistics

Cronbach's alpha	N of Items
.651	10

Table 4 shows that there are 10 questions with a Cronbach's Alpha value of  $0.651 > 0.60$ . It can be concluded that all the questions are reliable.

**Table 5.** Reliability results of the competencies dimension.

		N	%
Cases	Valid	30	100.0
	Excluded <sup>a</sup>	0	.0
	Total	30	100.0

<sup>a</sup>Listwise deletion based on all variables in the procedure.

Reliability statistics

Cronbach's alpha	N of Items
.651	10

Table 5 shows that there are 10 questions with a Cronbach's Alpha value of  $0.651 > 0.60$ . It can be concluded that 10 questions or all question items on the content dimension are declared reliable.

The following sections describe teachers' views on the STEAM Project and Mathematical Literacy. The discussions were based on two topics: STEAM Project and Mathematical Literacy.

*3.1 Teachers have a sense of responsibility for learning mathematics.*

A sense of responsibility to provide and design learning processes that support student needs was expressed by all respondents. Some of the interviews are presented as follow.

Rumiati: "Teachers have the responsibility to provide a pleasant learning experience. The students usually think that mathematics is tricky and a lot of homework. A Teacher should make students feel comfortable".

Hasna : "learning outcomes should be seen from the changes in the cognitive, affective, and psychomotor domains of a student. The government must give freedom to teachers to design learning processes that suit the characteristics of their students".

These views strengthen the opinion that a teacher's main task is to develop a learning process in accordance with the students' needs [27,28].

*3.2 The teacher's view of mathematics material is more important than mathematics literacy.*

The teachers assume that there are complex procedural demands in the implementation of learning. This means the mastery of material takes precedence over the development of students' mathematical literacy. Ani, an expert teacher in mathematics, revealed that:

Ani : "The essence of learning mathematics is not how many students understand math material. However, with the experience students get from everyday life as fundamental knowledge, then the school becomes a place to bridge students' experience towards abstract knowledge".

This view was supported by the opinion that learning mathematics in elementary school must go through a gradual process from simple concepts to more complex concepts [29]. Another teacher stated as follow.

Nur : "Honestly, I still need to get much of information regarding mathematical literacy and design HOTS problems, one part of consistent with math literacy programs".

Furthermore, Sukma explained that:

Sukma : "We have a moral burden about class administration if the subject matter is not as written when the supervisor or headmaster supervises the class".

*3.2.1. The implementation of the curriculum doesn't develop thinking skills.* Up to 20 participants argued that current curriculum implementation does not allow students to develop thinking and problem-solving skills to a high level. The students have not developed a habit of reading while thinking and working.

Helmiah : "The students' awareness to learn at home with their parents' guidance at home is very lacking. The students should already have basic knowledge before learning in the class".

This comment strengthens the opinion that family literacy can enhance active learning [30]. The results of interviews showed that 15 teachers considered that there is a need for guidance in designing questions related to mathematical problems in everyday life. This is as stated by a participant:

Anto : "...honestly, we need a tutor related to developing HOTS questions".

*3.3 View that a STEAM approach provides a fun learning environment.*

The participants were asked to watch a video about the STEAM Project. They all agreed that a STEAM Project is a fun learning process. They agreed that a teacher should facilitate students' collaborative attitude. This is as stated by the participants with cheerful expression:

Sukma : "by applying STEAM we can make students be confident and happy in the learning process".

Dewi : "STEAM Project should be cultivated since elementary school to nurture the scientific attitude of students from an early age".

The teachers' views are in accordance with the view that a STEAM approach is highly recommended from an early age, which is the times of rapid growth and development in children, and throughout elementary school education [31,32].

*3.3.1 A multidisciplinary STEAM Project requires more in-depth pedagogical and content knowledge.* The participants' feedback indicated that they felt the need to know more about the subjects and how to assess them. They felt that it was challenging to implement a multidisciplinary STEAM Project.

Nita : "It started with Science, Technology, Engineering, Arts, or Mathematics?"

Dewi : "Then how do we design a multidisciplinary assessment? Are we evaluating everything?"

*3.3.2 A STEAM Project can help implement mathematics learning.* A STEAM Project could develop the abilities and talents of students in facing the 21<sup>st</sup> century problems. Learning in elementary schools based on themes developed through STEAM projects are expected to produce a final output in the form of products and designs made by students that address real-world problems. A participant argued as follow.

Ani : "STEAM Project is a very complex approach that could bridge the scientific field, not only synonymous with science, but mathematics is also handy."

This opinion is in line with the view that mathematics is interdisciplinary and universities should educate mathematics teachers to be able to solve mathematical problems using transdisciplinary STEAM models [33,34].

In traditional learning models, the students do not engage in a learning process that provides essential 4C skills (Creative, Critical thinking, Communicative, and Collaborative). A STEAM-based learning can foster the 4C skills, creative and critical thinking skills[35–40]. Preparing students with the 21st century skills through a STEAM approach is essential, especially at the elementary level [32,41,42]. Teachers need to learn how to apply a STEAM approach in the classroom. Research reinforces that the teachers who implement a STEAM-based approach are flexible, open to change, collaborative, and aware of the latest trends in teaching and learning [43,44]. Furthermore, teachers who implement a STEAM approach have a teaching philosophy in line with their understanding of education as an ongoing need.

#### 4. Conclusion

The results of the study revealed that the teachers' perspectives of a STEAM Project and Mathematical Literacy are as follow. First, the teachers agreed that a STEAM Project must start at the elementary school level to equip students with the necessary skills for their future. Second, the teachers do not understand the concept of STEAM project learning as a multidisciplinary learning approach, so more in-depth knowledge is needed. Third, the students need to be accustomed to the implementation of a STEAM Project in mathematics learning. Fourth, complex procedural demands in the implementation of learning meant that the achievement of content material took precedence over developing students' mathematical literacy. Fifth, the teachers' mathematical literacy levels influence whether mathematics is developed within the context of everyday life problems. Therefore, the mathematics teacher requires further support and guidance to ensure they are prepared to carry out the important role of preparing students with the 21st century skills.

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