Primary school teachers’ awareness on STEAM learning: A starting point to develop STEAM-CB textbook

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STEAM learning is an approach which integrates multidisciplinary knowledge while enriching students’ skills to explore, try, ask, find, and build innovation, namely science, technology, engineering, art, and mathematics. We found that the learning resources of STEAM in Yogyakarta is very limited due to lack of knowledge about it. On the other hand, using local contexts as the starting point of learning is also important to foster character building. This preliminary research aims to provide insight on the teachers’ awareness on STEAM learning and textbook, as well as the design we figured out after discussing it with the teachers. It was a descriptive qualitative research involving 214 primary school teachers. We collected the data through questionnaire and focus group discussion. The results suggest that STEAM is quite a new concept for most of primary school teachers in Yogyakarta. Not many teachers used to or have developed the STEAM learning resources, especially the one integrated with the character building. Therefore, a STEAM textbook needs to be developed to fulfill the need. Furthermore, the design of the textbook could have the characteristics of integrating all components of STEAM (science, technology, engineering, art, mathematics), starting from local context to develop characters, improving creative and critical thinking, having knowledge and skill assessment, and using project-based learning model.

Keywords: Character building, Primary school teacher, STEAM learning

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Introduction

Starting in 2019, the Indonesian Ministry of Education and Culture applies the emancipated learning which provide flexibility for schools and students to explore and maximize their potential (Mustaghfiroh, 2020). Therefore, teachers, especially in primary schools, are encouraged to implement the case-based, problem-based, or project-based learning (Yamin & Syahrir, 2020). One of the promoted learning approaches is the Science Technology Engineering Art Mathematics (STEAM).

The STEAM learning integrates multidisciplinary knowledge while enriching students’ skills
to explore, try, ask, find, and build innovation, namely science, technology, engineering, art, and
mathematics (Dejarnette, 2018; Azizah et al., 2020). The implementation of this learning has
several approaches, namely a separate approach (silo), embedded approach, and integrated
approach (Muhtadi, 2020). On embedded approach, teachers should choose one binding domain
for STEAM learning in which other domains are embedded in the binding material. It is also in
harmony with thematic learning in elementary school. In this study, we chose the embedded
approach, where mathematics is chosen as the binding material for science, technology,
engineering, and the arts and assessment students focused on the basic competencies of
mathematics. STEAM learning is believed to be able promote creativity in contexts close to
students, but teachers face the challenges of the difficulty of designing STEAM lessons and the lack
of learning resources (Park et al., 2016). Therefore, the existence of textbooks with STEAM
nuances, both student books and teacher's book, is one solution in promoting STEAM learning.

Despite the importance of STEAM learning to foster the students’ creativity, the number of
STEM or STEAM textbook at schools is very limited. So far, students in primary schools use a
student book provided by the government, but less teachers develop it with various approaches.

On the other hand, the use of context familiar to students is also important when
implementing STEAM (Dejarnette, 2018). One of the potential contexts is the local wisdom and
character education. Character education aims to foster and oversee the formation of attitudes,
behavior, and Indonesian national identity in order to be able to preserve Indonesian cultural
values (Rachmadayanti, 2017). Education character must be accustomed from an early age because
caracter is a value that is embedded in the long time. Krathwohl's taxonomy shows the stages of
a student's learning experience until the formation of character (lstihapsari et al., 2019), namely:
(1) developing awareness of an idea or phenomena, (2) willing to actively participate in
responding to an idea, (3) willing to appreciate an idea or behavior, (4) harmonize the values that
have begun to be embedded in behavior, (5) practice behavior that has become a character (habit).

Based on Regulation of the Minister of Education and Culture of the Republic of Indonesia Number
22 of 2016 concerning Process Standards states that aspects of attitude spiritual and social
attitudes in core competencies are taught by indirect teaching, that is, character education is not
taught as a separate subject, but is embedded in cognitive materials such as mathematics and
science (Kemdikbud, 2016).

Yogyakarta is full of local wisdom. Local wisdom must be taught to children from an early
age because this wisdom is the basic capital of students to play a role in building society
(Kurniawan, 2018). Students who are well acquainted with the identity of the nation and its people
will have good loyalty and are willing to participate in building and preserving noble values nation.
In mathematics education, there is a study of ethnomathematics. Ethnomathematics is a science
that studies mathematics in culture (Prabhmana & Istiandaru, 2021). Mathematics as a human
activity lead to the fact that mathematics can be found in various activities that have been
entrenched, both traditions, goods, and values embedded in them. Ethnomathematics is very
relevant as a framework of study in promoting local wisdom in the universe of mathematical
discourse. In this study, the local wisdom raised and compatible with STEAM activities are the
values that exist in the typical house structure in Javanese people, especially Yogyakarta. The
people of Yogyakarta generally build houses with the form of Joglo or Limasan (Fajrina et al.,
2017). The Joglo house, for example, has a similar building structure full of meanings ranging from
pendapa, pringgitan, ndalem, dhapur, gandhok, and gadri which form and its function has a noble
meaning (Djono et al., 2012). This meaning is expected to be explored in learning STEAM.

Based on the above explanation, it is needed to develop learning resources for the
implementation of STEAM learning by using local wisdom of Yogyakarta as its context. Before the development, it is also important to know the teachers’ awareness of the STEAM learning. The awareness is important as part of the need analysis in developing the STEAM with character building (STEAM-CB) textbook. This preliminary research aims to provide insight on the teachers’ awareness on STEAM learning and textbook, as well as the design we figured out after discussing it with the teachers.

Method
This preliminary research used descriptive qualitative approach. We involved 214 participants in an initial assessment of primary school teachers consisting of: (1) Universitas Ahmad Dahlan (UAD) partner primary school teachers, (2) alumni who work as primary school teachers, and (3) primary school teachers currently took professional development program in UAD. We collected the data through questionnaire and focus group discussion (FGD). The FGD invited teachers from Muhammadiyah primary school teachers in Bantul Regency, Indonesia, practitioners of STEM/STEAM learning from SEAMEO QITEP in Mathematics, and experts on ethnomathematics and philosophy of mathematics. The FGD focused on validating the results of a questionnaire to assess the need for STEAM textbooks and formulating an appropriate prototype design for the textbook to be developed. The textbook design that will be developed consists of student books and teacher books with a focus on geometry and measurement in grades 4, 5, and 6.

Results and Discussion
The results of this preliminary research can be structured in two sections. First, the results of the need analysis of STEAM textbook which represents the primary school teachers’ awareness. Second, the design of the STEAM textbook.

Primary school teachers’ awareness
The first assessment is intended to determine the experience of teachers in implementing STEM/STEAM learning. The results of the assessment show that the majority of teachers have no experience in implementing STEM/STEAM learning, even though this learning is one approach that is being recommended by the Ministry of Education and Culture of the Republic of Indonesia to be implemented in elementary schools. The complete results can be seen in Figure 1.

![Figure 1. Percentage of teachers experienced in STEM/STEAM learning.](image)

Second, the results of this preliminary study indicate that the majority of teachers do not understand what and how STEM/STEAM learning is implemented (See Figure 2). This illustrates that socialization about STEM/STEAM should be done first to teachers. Therefore, we designed a Focus Group Discussion (FGD) activity to be held on October 30, 2021, one of which aims to socialize the concept and practice of STEM/STEAM learning.
Third, this initial study found that although teachers were inexperienced and did not really understand the concept and practice of STEM/STEAM in learning mathematics, teachers were interested in trying to apply STEM/STEAM in their respective classrooms. This can be seen in the results of the questionnaire presented in Figure 3.

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**Characteristics of STEAM textbook design**

We formulated some characteristics of the STEAM-CB textbook. First, STEAM applied to the textbook is an integrative learning approach which is defined as learning where there is a meaningful integration of concepts and procedures of mathematics, art and science, as well as engineering and technology principles, to solve real problems (Dejarnette, 2018). The integration can be illustrated in Figure 4.

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**Figure 2.** Percentage of teachers understand the concept of STEM/STEAM in mathematics learning.

**Figure 3.** Percentage of teachers interested to develop STEM/STEAM in mathematics learning.

**Figure 4.** The integration of science, technology, engineering, art, and mathematics in STEAM learning.
Second, STEAM-CB is a combination of STEAM and Character Building. Character formation in this context is in the socio-cognitive aspect of learning mathematics. The characters developed in the textbook are creative and critical characters (Suyitno & Suyitno, 2018; Kim et al., 2019; Suyitno et al., 2019). Third, the textbook was developed based on the Project Based Learning model. Project Based Learning can improve students’ creative thinking. Project Based Learning can improve students’ creative thinking (Fitriyah & Ramadani, 2021). Forth, the project given to students is a project based on local wisdom. Fifth, the forms of assessment used in the textbook are knowledge assessment, skills assessment, critical thinking assessment and creative thinking assessment in the STEAM framework. Figure 5 is an assessment model with the STEAM framework developed in the textbook adopted from Arlinwibowo et al. (2020).

![Assessment model](image)

**Figure 5.** Assessment model of (a) knowledge, (b) skill, (c) creative thinking, and (d) critical thinking (Arlinwibowo et al., 2020).

Meanwhile, the design of the STEAM-CB textbook is structured as follows. (1) STEAM-CB at a glance. This section provides a brief overview of the STEAM character building concept. (2) Instructions for using the book. This section will provide instructions for using the book for readers. (3) Basic Competence Analysis. The basic competence analysis is used as a basis for developing certain themes in packaging material in mathematics, science, and arts and culture subjects. (4) Learning design. This section describes the syntax or steps for project-based learning within the STEAM framework based on local wisdom. (5) Student Worksheet. This section provides a guide to activities that will be carried out by students in completing the project given by the teacher. (6) Student Assessment Guide, an assessment guide is given to conduct an assessment to determine the achievement of the predetermined indicators. (7) Hypothetical Learning Trajectory: What might happen in your classroom? This section will give the teacher an overview of the things that will be possible in the classroom and the design of the solution. (8) STEAM-CB Corner. This will provide information about STEAM-BC that can help teachers and students in carrying out learning activities. For example, it will provide information related to...
technology that can make learning easier. Information that will provide another alternative if the plans written in the learning design are not available or cannot be implemented.

Conclusion
Based on the discussion, we can conclude that STEAM is quite a new concept for most of primary school teachers in Yogyakarta. Not many teachers used to or have developed the STEAM learning resources, especially the one integrated with the character building. Therefore, a STEAM textbook needs to be developed to fulfill the need. Furthermore, the design of the textbook could have the characteristics of integrating all components of STEAM (science, technology, engineering, art, mathematics), starting from local context to develop characters, improving creative and critical thinking, having knowledge and skill assessment, and using project-based learning model. The structure of the STEAM textbook could follow: (1) STEAM-CB at a glance, (2) Instructions for using the book, (3) Basic Competence Analysis, (4) Learning design, (5) Student Worksheet, (6) Student Assessment Guide, (7) Hypothetical Learning Trajectory, and (8) STEAM-CB Corner.

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