

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

Uswatun Khasanah^{1*}, Afit Istiandaru¹, Dwi Astuti¹, Mazlini Adnan², Martyana Prihaswati³

¹Universitas Ahmad Dahlan, Jl. Jend. Ahmad Yani, Tamanan, Bantul, DIY 55711, Indonesia

²Universiti Pendidikan Sultan Idris, 35900 Tanjong Malim, Perak, Malaysia

³Universitas Muhammadiyah Semarang, Jl. Kedungmundu Raya 18 Semarang, Indonesia

*Corresponding E-mail: uswatun.khasanah@pmat.uad.ac.id

ARTICLE INFO

ABSTRACT

Article History

Received 14 November 2021

Revised 16 January 2022

Accepted 16 January 2022

Keywords

Character building
Primary school teacher
STEAM learning

How to cite this article:

Khasanah, U., Istiandaru, A., Astuti, D., Adnan, M., & Prihaswati, M. (2021). Primary school teachers' awareness on STEAM learning: A starting point to develop STEAM-CB textbook. *Bulletin of Applied Mathematics and Mathematics Education*, 2(1), 11-18.

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.

This is an open access article under the [CC-BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license.



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 to 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 (Rachmadyanti, 2017). Education character must be accustomed from an early age because character 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 (Istihapsari 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 (Prahmana & 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.

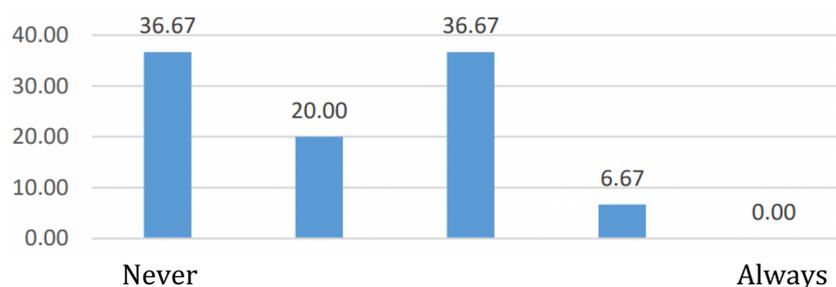


Figure 1. Percentage of teachers experienced in STEM/STEAM learning.

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.

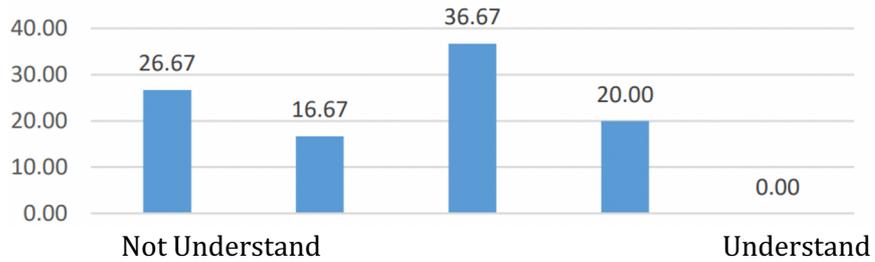


Figure 2. Percentage of teachers understand the concept of STEM/STEAM in mathematics learning.

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.

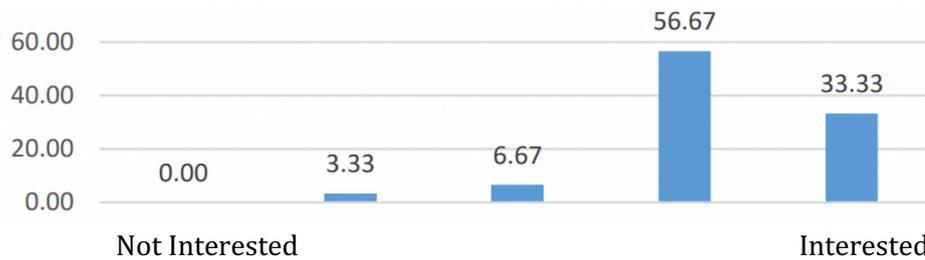


Figure 3. Percentage of teachers interested to develop STEM/STEAM in mathematics learning.

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.

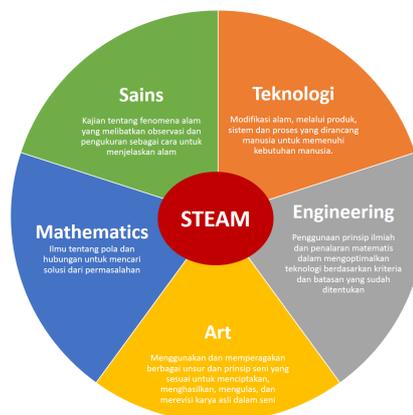


Figure 4. The integration of science, technology, engineering, art, and mathematics in STEAM learning.

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 test book 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).

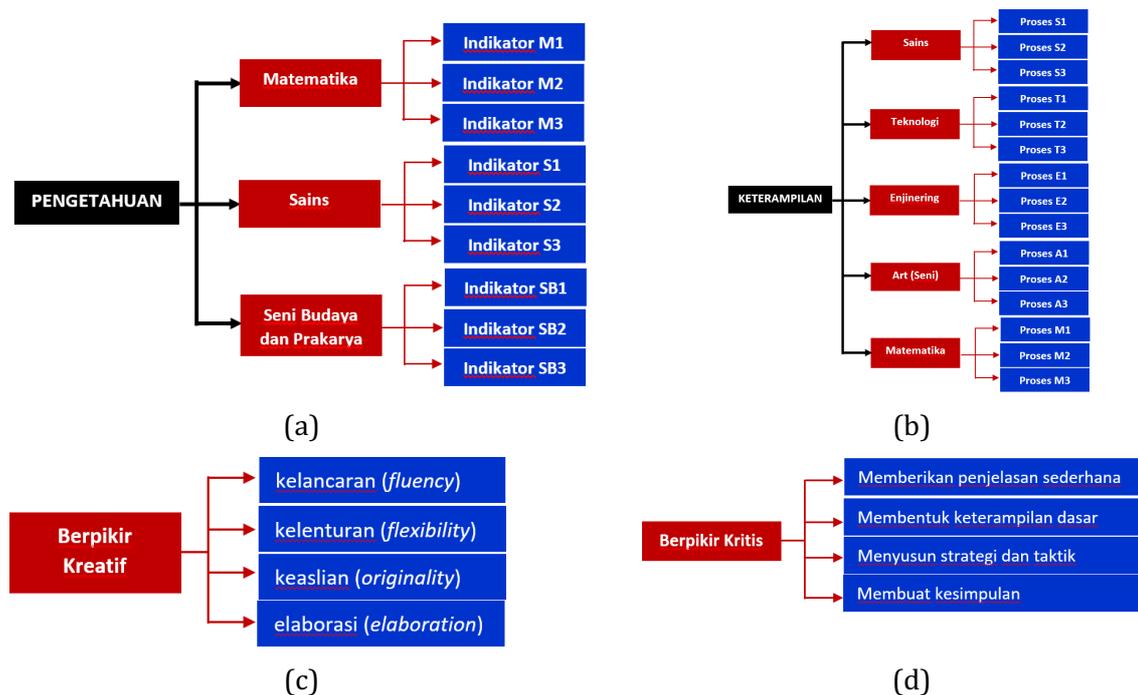


Figure 5. Assessment model of (a) knowledge, (b) skill, (c) creative thinking, and (d) critical thinking (Arlinwibowo et al., 2020).

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.

Acknowledgement

We thank the Lembaga Penelitian dan Pengabdian kepada Masyarakat Universitas Ahmad Dahlan for providing the research grant under the scheme of Penelitian Kerja Sama Luar Negeri ASEAN Number PKLNA-189/SP3/LPPM-UAD/VI/2021. We also thank the research colleagues from Universiti Pendidikan Sultan Idris and Universitas Muhammadiyah Semarang who have collaborated under the research of Geran Penyelidikan Sepadan 2021.

References

- Arlinwibowo, J., Kartowagiran, B., Retnawati, H. (2020). *Model Penilaian Capaian Belajar Matematika dengan Framework STEM*. Yogyakarta: UNY Press.
- Azizah, N., Putri, S. U., & Adjie, N. (2020). STEAM berbantuan augmented reality untuk mengembangkan kemampuan bahasa pada anak usia 5-6 tahun. *Research in Early Childhood Education and Parenting*, 1(1), 32-42.
- Dejarnette, N. K. (2018). Implementing STEAM in the Early Childhood Classroom. *European Journal of STEM Education*, 3(3), 18.
- Djono, D., Utomo, T. P., & Subiyantoro, S. (2012). Nilai Kearifan Lokal Rumah Tradisional Jawa. *Jurnal Humaniora*, 24(3), 269-278.
- Fajrina, M. N., Antariksa, A., & Ridjal, A. M. (2017). Pola Ruang Dalam pada Rumah Tinggal Tradisional Jawa di Desa Brayut, Yogyakarta. *Jurnal Mahasiswa Jurusan Arsitektur*, 5(1).
- Fitriyah, A., & Ramadani, S. D. (2021). Pengaruh Pembelajaran STEAM Berbasis PjBl (Project-Based Learning) terhadap Keterampilan Berpikir Kreatif dan Berpikir Kritis. *Jurnal Inspiratif Pendidikan*, 10(1), 209-226.
- Istihapsari, V., Istiandaru, A., & Rohmah, S. N. (2019). *Analisis Kurikulum Matematika SLTA*. Yogyakarta: UAD Press.
- Kemdikbud. (2016). *Peraturan Menteri Pendidikan dan Kebudayaan Nomor 22 Tahun 2016 tentang Standar Proses*. Jakarta: Kementerian Pendidikan dan Kebudayaan RI.
- Kim, D. J., Bae, S. C., Choi, S. H., Kim, H. J., & Lim, W. (2019). Creative character education in mathematics for prospective teachers. *Sustainability*, 11(6), 1730.
- Kurniawan, M. R. (2018). Permainan tradisional Yogyakarta sebagai sumber belajar alternatif berbasis kearifan lokal bagi pembelajaran di sekolah dasar. *Premiere Educandum: Jurnal Pendidikan Dasar dan Pembelajaran*, 8(2), 98-111.

- Muhtadi, A. (2020). *Modul 3 Pendalaman Materi Pendidikan Profesi Guru: Pembelajaran Inovatif*. Jakarta: P3GTK Kemdikbud RI.
- Mustaghfiroh, S. (2020). Konsep “merdeka belajar” perspektif aliran progresivisme John Dewey. *Jurnal Studi Guru dan Pembelajaran*, 3(1), 141-147.
- Park, H., Byun, S. Y., Sim, J., Han, H. S., & Baek, Y. S. (2016). Teachers' perceptions and practices of STEAM education in South Korea. *Eurasia Journal of Mathematics, Science and Technology Education*, 12(7), 1739-1753.
- Prahmana, R. C. I., & Istiandaru, A. (2021). Learning sets theory using shadow puppet: A study of Javanese ethnomathematics. *Mathematics*, 9(22), 2938.
- Rachmadyanti, P. (2017). Penguatan pendidikan karakter bagi siswa sekolah dasar melalui kearifan lokal. *JPSD (Jurnal Pendidikan Sekolah Dasar)*, 3(2), 201-214.
- Suyitno, H., Zaenuri, Sugiharti, E., Suyitno, A., & Baba, T. (2019). Integration of Character Values in Teaching-Learning Process of Mathematics at Elementary School of Japan. *International Journal of Instruction*, 12(3), 781-794.
- Suyitno, H., & Suyitno, A. (2018). Building innovative and creative character through mathematics. *AIP Conference Proceedings*, 1941, 020042.
- Yamin, M., & Syahrir, S. (2020). Pembangunan pendidikan merdeka belajar (telaah metode pembelajaran). *Jurnal Ilmiah Mandala Education*, 6(1), 126-136.

This page is intentionally left blank.