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The Elementary teacher readiness toward STEM-Based contextual learning in 21st Century Era

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Abstract. Learning in the 21st century is expected to advance knowledge and improve student learning achievement, including at the elementary school level. In addition, learning in the 21st century is also expected to prepare students with 21st century skills that they should have. One learning approach that can be used is STEM-Based contextual learning. Therefore, this study aims to analyze the readiness of elementary school teachers to implement STEM-Based contextual learning in schools. The purposed-design survey method was used in this study. Questionnaire and observation were used to collect the data. The questionnaire consisted of eighteen open-ended questions to find out the learning process conducted by the teacher, their perceptions of integrated contextual learning, and how the readiness of teachers towards the implementation of STEM-Based contextual learning. Respondents' involeved in this study were 32 elementary school teachers in Bandung, West Java, Indonesia. The result of the study indicated that elementary school teachers were ready to implement STEM-based contextual learning. However, the main problem faced by the teachers to implement STEM-based contextual learning was the difficulty of integrating the subjects and providing contextual aspects related to students' real life. This study was expected to provide an overview of the problems and possibilities in implementing STEM-based contextual learning at the elementary school level.

Keywords: 21st Century Skills, Contextual learning, Elementary Student, STEM

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INTRODUCTION

Education in the 21st century is in a time of accelerating information and increasing knowledge supported by the application of digital media and technology. Educational institutions are required to be able to innovate in order to facilitate students to have the skills needed in the 21st century (Care, Griffin, & Wilson, 2018; Griffin, Care, & McGaw, 2012; Shidiq & Yamtinah, 2019; Trilling & Fadel, 2009; Urbani et al., 2017). Research-based knowledge about 21st century skills is dynamic and developing (Fadel, 2016). In line with the increasing interest in teaching and assessing 21st century skills, educational researchers have made significant efforts to improve the quality of learning, especially about cognitive processes in students who emphasize context in learning and assessment. These changes led to the development of a variety of contextual teaching methods in education (Klassen, 2006). Contextual learning and teaching are based on situations of cognition that construct the construction of students' thought processes such as critical thinking, inquiry and problem solving which are adjusted according to the intellectual and social conditions of students. This contextual learning prepares students to learn to face complex problems in the future (Glynn & Winter, 2004).

Students' ability to solve problems has been the focus of learning today. However, in the 21st century there are several things that need to be integrated to produce logical problem solving. The Science, Technology, Engineering, and Mathematics (STEM) approach can be used as an alternative to develop students' skills. STEM is an interdisciplinary approach that focuses on educating students in four disciplines - science, technology, engineering and mathematics - and integrating these disciplines into contextual problems (Wang, Moore, Roehrig, & Park, 2011). The

greater STEM approach opportunities in helping students to solve real world problems by applying concepts from various disciplines as well as critical thinking skills, collaboration, and creativity (Burrows & Slater, 2015). There have been many integration of STEM with learning in the classroom conducted by researchers (Khatri et al., 2017). Such as the implementaton of STEM in Biology in high school (Saptarani, Widodo, & Purwianingsih, 2019), in learning chemistry (Sudarmin et al., 2019), and in various laboratory and learning activities (Blotnicky, Franz-odendaal, French, & Joy, 2018; Burrows & Slater, 2015; Porter, 2018; Shin, Rachmatullah, & Roshayanti, 2018). The implementation of STEM mostly conducted at the level of high school and university level. Even so, that does not mean STEM cannot be taught at the elementary school level. STEM learning can implemented at the elementary level, but the level of difficulty is not as high as the university level. So it becomes interesting to know the readiness of elementary school teachers to implement STEM-based contextual learning.

Elementary school teachers usually have the responsibility to teach all subject areas, this is one of the advantages in developing student skills and their professional skills, because teachers can plan teaching across fields of study (Bush & Cook, 2019). Integrated contextual learning has a special role for teachers and students in elementary schools. Through integrated contextual learning the teacher can make learning more meaningful, motivate students and improve their skills (Cook & Bush, 2018). Most educational research focuses on improving the skills possessed by students, the education curriculum and educational assessment. But few pay attention to the readiness, views and attitudes of teachers in teaching (Shidiq & Yamtinah, 2019; Tetenbaum & Mulkeen, 1986). Readiness, views and attitudes of teachers will affect the way they do learning in the classroom (Adams & Krockover, 1997; Haney, Lumpe, Czerniak, & Egan, 2002; Harlen & Holroyd, 2007; Jones & Levin, 1994; Ucar, 2012). Therefore, the purpose of this study was to analyze the elementary school teachers' readiness to implement STEM-based contextual learning. This study was intended to answer three questions on how the learning management in the classroom carried out by the teacher; the teacher's perception of integrated contextual learning implementation; and the teacher's readiness in implementing STEM-based contextual learning in elementary schools. By conducting this research, it is expected to provide an overview of the problems and opportunities for implementing STEM-based contextual learning at the elementary school level.

METHOD

Reseach Method

The purposed-design survey method was used in this study. The survey was intended to analyze the readiness of elementary school teachers to implement STEM-based contextual learning. This survey included observing teachers' learning instruction and distributing questionnaires to analyze their readiness and perceptions on STEM-based contextual learning in elementary school level.

Data collection technique and analysis

This study used questionnaire and observation to collect the data. The questionnaire consisted of eighteen open-ended questions to reveal the learning process carried out by the teachers, their perceptions of integrated contextual learning, and their readiness to implement STEM-based contextual learning in elementary schools. This questionnaire was designed to answer research questions and to provide comparative data for the observation. The questionnaire blueprint for this study is presented in Table 1. Data from observations and questionnaires were analysed qualitatively and quantitatively. Qualitative data analysis was used to describe the result of observations and questionnaires, while quantitative data analysis technique was used to determine the distribution of questionnaire results.

Table 1. *Questionnaire blueprint*

Focus of the question	Indicator	items
Learning management in the classroom	Teaching instruction used	2
	Learning process in the classroom	3
Teacher's perception of integrated contextual learning implementation	Contextual learning conducted in the classroom	1
	Teacher's perception of the problems and possibilities in implementing contextual learning	1
Teacher's readiness in implementing STEM-based contextual learning in elementary school	Teacher's knowledge about STEM	4
	Teacher's perceptions on STEM-based contextual learning	3
	The Problems and possibilities in implementing STEM-based contextual learning	2
	Teacher's readiness in implementing STEM-based contextual learning	2

Respondents

The Respondents involved in this study were 32 elementary school teachers in Bandung, West Java, Indonesia. These participants came from 23 different elementary schools. Participant selection uses a random sampling technique. The respondents' descriptive data is presented in Table 2.

Tabel 2. *Respondents' descriptive data*

Characteristic	Category	N	%	SD
Gender	Male	4	12.5	16.9
	Female	28	87.5	
Education Level	Bachelor degree	27	84.3	15.5
	Master degree	5	15.6	
School Status	Private	3	9.4	18.4
	State	29	90.6	
Teaching grade	Grade 1	4	12.5	2.9
	Grade 2	4	12.5	
	Grade 3	4	12.5	
	Grade 4	3	9.4	
	Grade 5	6	18.7	
	Grade 6	11	34.4	

RESULTS

Data was obtained from two instruments, namely the learning observation sheet and a questionnaire containing open questions. The result of the teacher learning observation sheet is presented in Table 3, while the result of the teacher's questionnaire is presented in Table 4, 5, and 6, and Figure 1 and 2.

Table 3. *Implementation of learning management*

Classroom teacher	Learning Management Aspects in Classroom	
	Learning Media	Learning methods
Teacher of 1st Grade	Prepare a Thematic-based lesson plan, with the textbook package that has been provided	Using lecture and peer tutoring methods
Teacher of 2nd Grade	Prepare a thematic-based lesson plan, with the textbook package that has been provided	Using the cooperative method with the help of visual aids
Teacher of 3rd Grade	Prepare a thematic-based lesson plan, with the textbook package that has been provided	Problem-based learning method by displaying videos according to theme
Teacher of 4th Grade	Prepare a thematic-based lesson plan, with the textbook package that has been provided	Using problem-based and project-based learning methods
Teacher of 5th Grade	Preparing thematic-based lesson plans, assessment instruments and assessment guidelines and also use textbook package that has been provided	Using a scientific approach and problem based learning
Teacher of 6th Grade	Preparing thematic-based lesson plans, assessment instruments and assessment guidelines and also use the textbook package that has been provided	Using a scientific approach and problem-based learning by utilizing digital multimedia

Table 4. *Teachers' perception toward the implementation of integrated contextual learning*

Classroom teacher	Teachers' perception toward on the implementation of integrated contextual learning
Teacher of 1st Grade	Integrated contextual learning is adjusted using learning methods that are appropriate to the character of students
Teacher of 2nd Grade	Delivered using learning media and utilizing the environment as a learning resource
Teacher of 3rd Grade	Integrated contextual learning should be delivered in an integrated manner without separating per subject
Teacher of 4th Grade	Learning must be based on an integrated curriculum
Teacher of 5th Grade	Integrated contextual learning is delivered through presentations, observations, discussions, designs, and evaluates
Teacher of 6th Grade	Learning methods and models are adapted to the theme and must be able to choose material that is intertwined between various fields

Table 5. *Teachers' views on the implementation of STEM-based contextual learning*

Classroom teacher	Teachers' views on the implementation of STEM-based contextual learning
Teacher of 1st Grade	STEM-based contextual learning can be implemented by looking for the subject matter that is appropriate
Teacher of 2nd Grade	STEM-based contextual learning can be implemented, but the teacher must be creative and master the content of science, technology, engineering, and mathematics
Teacher of 3rd Grade	STEM-based contextual learning can be adjusted to the needs of the subject matter to be delivered
Teacher of 4th Grade	STEM-based contextual learning can be implemented but there must be an adjustment of basic competencies in the curriculum, because not all basic competencies in the curriculum can use STEM approach
Teacher of 5th Grade	STEM learning can be carried out depending on the school readiness since all teachers must understand STEM first and the facilities and infrastructure must be available
Teacher of 6th Grade	STEM learning can be integrated into the learning process through themes that integrate science, technology, engineering, and mathematics

Table 6. *Problems and Possibilities faced by the elementary school teacher to implement STEM-Based Contextual Learning*

Problems	Possibilities
Dificulty in integrating subjects and provide contextual aspects related to students' real life	Making teachers and students become more creative and innovative, improving students' citical thinking skill, logic, and communicative skill in accordance with the skills needed in 21st century
Not all students understand and are capable to formulate problems systematically so that the STEM-based contextual learning was not optimum	Students learn to solve their problems
Require a lot of time and supportive facilities	Students and teacher are involved in creative, inovative, communicative, dan colaborative learning process
Mathematics and Science are separated subjects in elementary school	Students are trained to analyse problems using various approaches: Science, technology, engineering, arts, or Mathematics.
Teachers need extended guidance and training on STEM-based contextual learning process	Teachers are more developed. They teach students to be independent to find new things in education to prepare their future.

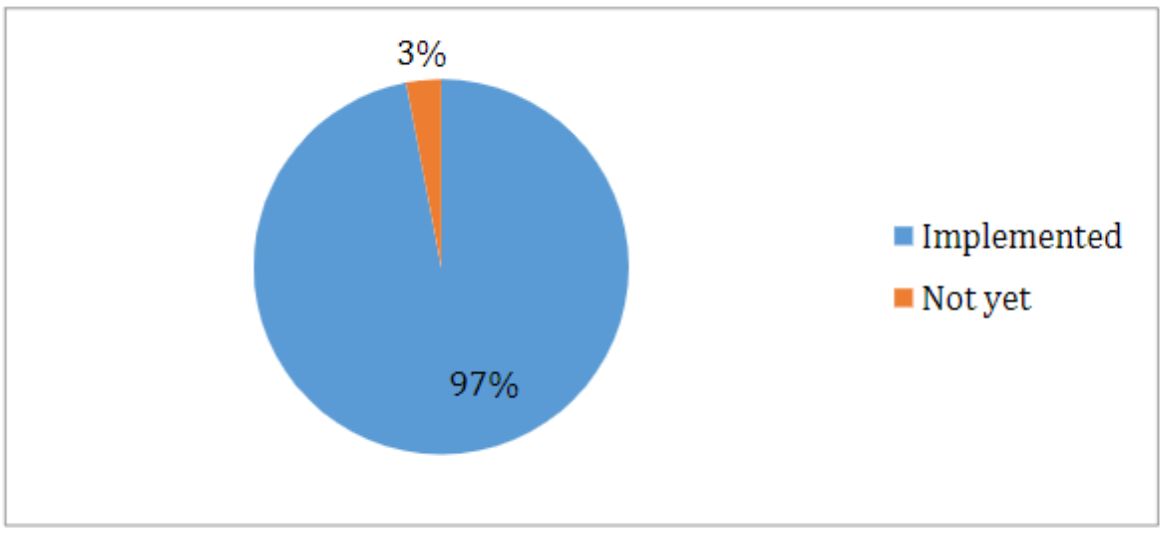

FIGURE 1. *Teachers' Integrated Thematic Learning Implementation*

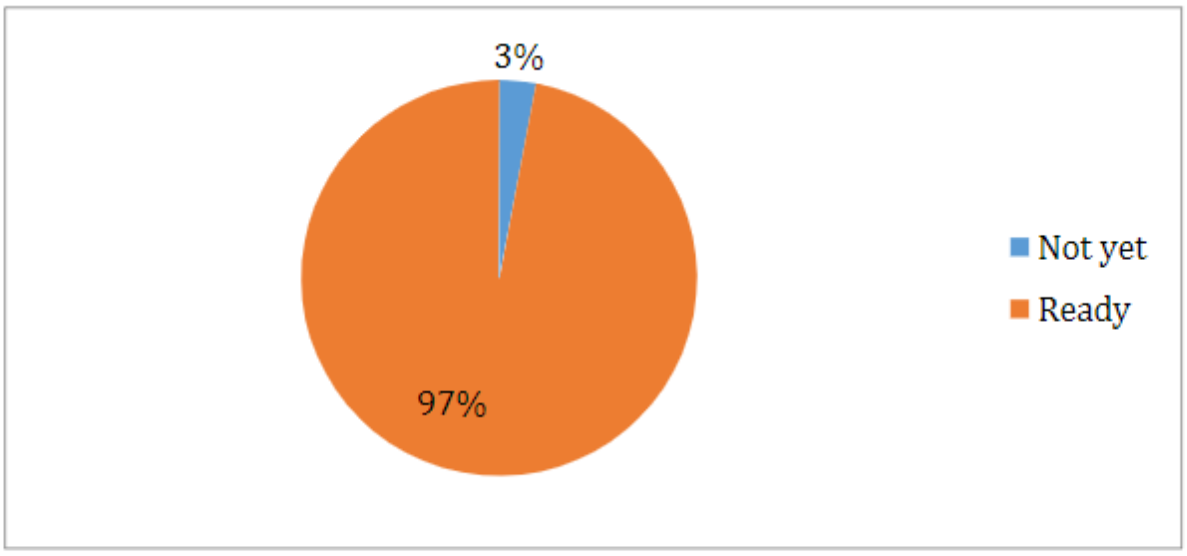

FIGURE 2. Teachers' Readiness to Implement STEM-based contextual learning

DISCUSSION and CONCLUSION

The learning process that has been used by the teacher

Indonesian curriculum policy requires elementary schools to implement contextual learning integrated with a theme or what is commonly referred to as thematic learning. Thematic learning is assessed as a way to contextualize material from various subjects. In addition, integrated thematic learning can also orient students' learning ways to be more concrete and facilitate students and teachers to get cooperative and interactive learning opportunities in the classroom (Lesgold, 2004; Min, 2012). The learning process in elementary schools in Indonesia has implemented this integrated contextual learning with themes. Themes provide benefits to students because the subject matter presented is closer to their daily lives (Rahma, 2018). The theme for each level from grade 1 to grade 6 is determined by the government through distributed textbooks. The books distributed are used by the teacher as a guide for planning and evaluating the learning undertaken (Ain & Rahutami, 2018).

Research by Atmojo & Kurniawati (2018) showed that embedding certain concepts in students can be packaged in the form of books that cover all of these concepts. In addition to the proper use of books, the appropriateness between planning and applying methods in class also needs to be considered. So that the material contained in the thematic books can be delivered properly. In this study, observations were made on the management of learning undertaken by teachers and their responses to integrated contextual learning. The results of research on learning management conducted by teachers are presented in Table 3.

Table 3 shows that all teachers had used the textbook package that had been provided at the planning stage of the learning tools. So they have guidelines in presenting learning. In addition, teachers also prepare instruments and assessment guidelines. But what varies in Table 3 is when implementing learning. The results of observation show that the higher the grade level, the more complex the method used. At grade 1, the lecture method and peer tutors are chosen. The peer tutoring method is a place for students to develop the ability to find and develop concepts. Because in the learning process interaction occurs between students in solving problems from the teacher (Ahdiyat & Sarjaya, 2015) The 21st century skill that is being taught at this stage is communication. This skill is very important because this skill is used to express thoughts, ideas or any information (Redhana, 2019).

A 21st Century skill, collaboration, began to be trained at grade 2 using cooperative method. Good collaboration encourages active student participated in generating more flexible thinking and finding steps to solve a problem (Le, Janssen, & Wubbels, 2018). By learning to work together, the purpose of learning is not just looking for value, but understanding concepts, self-confidence, life experiences and social interactions that will help students live their lives (Rosita & Leonard, 2015).

At grade 3 through grade 6 the teacher begins to include problems in his learning. This is intended to practice 21st century skills, namely creative thinking and critical thinking skills. At the grade 3 and grade 4 levels, these skills are developed with the help of problems whose solution makes a project. Mayasari et al (2016) research results showed that Problem based learning and project-based learning are learning models with constructivism approaches and have been reported to be able to train 21st century skills to students. The teacher chooses simple problems so that it is easy for students to make their solutions. At the grade 5 and 6, the skills are re-trained using a scientific approach. This approach makes students learn to do a systematic process to get a conclusion (Dewantara, 2020).

Based on the observation sheet it can be seen that the teacher begins to gradually practice 21st century skills. In addition, Table 3 also shows that learning conducted in elementary schools in Bandung has led to an integrated contextual thematic learning. Figure 1 showed that 97% of the teachers had implemented integrated contextual thematic learning. However, there were differences for the preparation of learning and learning methods used at each grade level. Scientific learning methods only appear in grades 5 and 6. Likewise, the use of multimedia is only in grade 6. Another problem arisen was the use of thematic textbooks provided by the government. This makes the lack of creativity of teachers to provide themes that are closer to

student life. A theme raised from natural and social phenomena that are close to students will make learning intact and more meaningful (Ain & Rahutami, 2018; Hayes, 1989; MacQuarrie, Nugent, & Warden, 2015).

Research on thematic learning has been conducted by many experts, such as research on the success of integrated thematic learning to improve the quality of learning (Lipson, Valencia, Wixson, & Peters, 1993), Thematic learning with inquiry methods that can improve student literacy (Shanahan, 1997), theme mapping with thematic maps in elementary schools (Michaelidou, Nakos, & Filippakopoulou, 2007; Trifonoff, 1995) and research on the effects of thematic learning, direct science teaching with a textbook approach for students (McCarthy, 2005).

The lack of variety of learning media and learning methods used by teachers is an indicator of teacher readiness to conduct thematic learning. Innovations in the media and learning methods have been done by researchers, such as the use of game methods to improve the literacy of elementary school students (Amir, Mufarikhah, Wahyuni, Nasrun, & Rudyanto, 2019), use scientific methods to improve geometric thinking skills (Novita, Putra, & Johar, 2019), use a five-tiered assessment instrument to identify elementary school students' misconceptions (Anam, Widodo, Sopandi, & Wu, 2019), the use of contextual learning approaches (Glynn & Winter, 2004; Selvianiresa & Prabawanto, 2017; Yuliana, Wiryawan, & Riyadi, 2018) and application of STEAM (*Science, Technology, Engineering, Art, and Mathematics)* (Yoon & Baek, 2018).

Teacher readiness to implement STEM-based contextual learning at the elementary school

Contextual learning has a focus on the delivery of knowledge relevant to the concept as well as the student life. The theme used in contextual learning motivates students to make connections between knowledge and its application to social life (Glynn & Winter, 2004). Contextual learning is a learning system based on the philosophy that students can receive lessons if they can understand the meaning of academic material and schoolwork, and they can associate new information with their previous knowledge and experience. This is in line with the conscience of humans who always want to find meaning. Contextual learning invites students to meaningfully link schoolwork in daily life. When students see the meaning in the assignment to be done, students will receive the lesson and remember it (Johar, Agussalim, Ikhsan, & Zaura, 2018). STEM-based contextual learning makes learning more meaningful. STEM learning has been applied at various levels of the school, but there are still not many who conducted it in elementary schools (Akaygun & Aslan-Tutak, 2016; Fassa, Tytler, Freeman, & Roberts, 2013; Jho, 2016; Madden et al., 2013). By considering the success and benefits of STEM learning at various school levels, it becomes important to know the readiness of elementary school teachers to implement STEM integrated contextual learning. Teachers' perception toward integrated contextual learning ware presented in Table 4. Teacher's views on the implemantation of integrated contextual learning STEM ware presented in Table 5

Teachers' views on the implementation of integrated contextual learning were very diverse (Milner, Templin, & Czerniak, 2011). However, these teachers indicated that implementing learning requires support from various aspects. The first-grade teacher said that integrated contextual learning should be adjusted to the character of students. Teacher readiness in recognizing student characteristics is important because it influences the way the teacher teaches (Haney et al., 2002; Yamtinah, Masykuri, & Shidiq, 2017). The second-grade teachers emphasized the use of the environment as a learning resource. In contextual learning it is very important to present learning resources that are close to students, so students are easier to recognize problems and relate them to concepts (O'Sullivan, 2006). The third and fourth grade teachers have the same view which was conveying material in an integrated way. This is intended so that students are more flexible in preparing explanations for each problem given by the teacher. On the other hand, the 5th and 6th grade teachers assume that integrated contextual learning should be taught using scientific methods so that the selection of problems related to other disciplines. The teachers' views were in line with other study which found out that

innovative and contextual approach significantly affect the learning process in elementary school (Glynn & Winter, 2004).

Accuracy in choosing and delivering material has been keys in achieving learning objectives. In the 21st century students need to have special skills that can be developed through learning (Rusdin, 2018). Therefore STEM is an approach that needs to be integrated in learning (Amanda Roberts, 2012). Integrating STEM with contextual learning can be an opportunity for learning approaches which can answer the 21st century challenges. Therefore, it is essential to know the elementary school teachers' readiness, views and abilities to implement this approach.

The teachers argued that 21st century skills can be improved gradually by using integrated conteaxtual learning. However, if it is associated with the STEM approach, students will have better skills. Therefore, Table 5 shows the teacher's views on integrated STEM contextual learning. The teachers have diverse views about the implementation of the learning. Teachers from grade 1 to grade 3 argue that knowledge of material content is the core of STEM learning. Teachers are required to have good content abilities, because they will integrate not only one knowledge but also collaborate with other knowledge (Wang et al., 2011).

The 4th grade teacher has a different view from the three previous teacher levels. Guru kelas 4 percaya pendekatan STEM dapat dilakukan, namun harus memperhatikan kompetensi dasar yang ingin dicapai. Dalam pendekatan STEM, integrasi terjadi dalam konteks mengadaptasi keempat bidang STEM dalam hal konten, atau menggunakan satu area sebagai pusat dan yang lainnya sebagai konteks dalam pembelajaran (Gül & Taşar, 2020). Oleh karena ini, pembelajaran STEM membutuhkan suatu kompetensi dasar sebagai target atau output dari pembelajaran yang dilakukan. Sebagai panduan, keterampilan abad 21 bisa dijadikan acuan sebagai luaran dari pembelajaran STEM (Gül & Taşar, 2020).

Grade 5 teachers have a holistic view when they want to implement STEM-based contextual learning. Teachers at this level argue that the good learning process depends on the readiness of the teacher and the school. Teachers who are content and pedagogically prepared and students who are able to adapt the new learning approach are two essential things that must be prepared in implementing this learning approach (Radloff & Guzey, 2016). STEM learning encourages teachers to create learning environments based on constructivist approaches that allow students to learning by doing (Gül & Taşar, 2020; Toran, Aydın, & Etgüer, 2020). Therefore, teachers' knowledge and readiness to implement STEM-based contextual learning is important.

Grade 6 teachers have a theoretical view on the application of STEM learning. However, the grade 6 teachers focused on the theme selection. Thus, this must also be accompanied by teacher knowledge about the material presented. Learning using STEM which integrates Science, Technology, Engineering, and Mathematics is a difficult job (Bybee, McCrae, & Laurie, 2009; Sanders, 2009). Therefore, at the elementary school level, a careful selection of themes that can integrate STEM components is needed. This is in line with various studies which emphasize that content selection and learning context in STEM are important (Baines, 2015; Harris & de Bruin, 2018; Nedungadi, Raman, & McGregor, 2013). If it can be executed well, it is possible that STEM-based contextual learning will create a competitive generation to compete each other. Basically, a variety of skills in the 21st century can be developed by students through active, creative and innovative learning; therefore STEM-based contextual learning is very relevant. The purpose of STEM-based contextual learning is to prepare students with a particular learning environment to implement their knowledge and skills needed in the 21st century (Bybee et al., 2009). STEM-based contextual learning also provides interdisciplinary knowledge and skills and prepares students to face knowledge-based world economic competition (Koenig, 2011; National Research Council, 2012). In the 21st century, students must be able to generate new knowledge and apply it to new situations and problems rather than using the existing knowledge easily (Gül & Taşar, 2020; Wagner, 2011).

The problems and posibilities faced by elementary school teachers can be seen in Table 6. The main problem faced by the teachers in implementing STEM-based contextual learning was integrating the subjects and providing contextual aspects relevant to the students' real life. Teachers were used to conventional teaching which separate the subjects. This idea is supported by various studies on teachers' difficulty in integrating STEM caused by the teachers' orientation

to their own discipline. Mathematics teacher only oriented to Mathematics, and Sience teachers only oriented to Science (El-Deghaidy & Mansour, 2015; Nadelson et al., 2013; Stohlmann, Moore, & Roehrig, 2012). Accordingly, to overcome those challenges, teachers need to acquire an adequate pedagogical content knowledge (El-Deghaidy & Mansour, 2015). This skill can help teachers to decide the crosscutting concepts and the core idea of the learning (Chesnutt et al., 2019).

Besides problems, teachers were also optimistic to the opportunities for implementing STEM-based contextual learning. They believed that implementing STEM-based contextual learning can help students to think creatively, critically, innovatively and train them to analyze problems using various approaches: Science, Technology, Engineering, and Mathematics. This view is supported by various references from previous studies which proved that STEM learning was able to improve creative thinking skills (Harris & de Bruin, 2018; Megawan & Istiyono, 2019), critical thinking and problem solving skills (Soros, Ponkham, & Ekkapim, 2018), innovation skills (El Mawas et al., 2019; Paredes & Vazquez, 2019) and other skills needed in 21st century (Crumbaugh, Vellom, Kline, & Tsang, 2004; Hurson, Sedigh, Miller, & Shirazi, 2011 ; Munsell, 2020).

The teacher optimism was supported by the survey data presented in Figure 2. There were 97% of teachers were willing to implement STEM-based contextual learning. Therefore, it can be concluded that teachers were ready to implement STEM-based contextual learning in elementary schools. However, the teacher argued that they found problems in identifying themes in elementary school curriculum appropriate for STEM-based contextual learning. Therefore, it is suggested that policy makers and teachers administer content analysis on the current curriculum to create themes which promote STEM-based contextual learning. Furthermore, the teachers also confirmed that the lack of facilities to improve their knowledge and skills in implementing STEM-based contextual learning. Thus, it is recommended to conduct training and education on STEM-based contextual learning for teachers.

This study presents an overview of problems, possibilities and teacher readiness in implementing STEM-based contextual learning. However, the small number of respondents and the limited scope of the survey area could be the limitations of the current study. Incrasing the number of respondents, expanding survey area coverage, and using valid instruments for further research will increase the validity of the data obtained to be generalized. Lastly, further study on the effectiveness of implementing STEM-based contextual learning in elementary schools is still needed.

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