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Exploring Teachers' Perspectives on Implementation of STEM-Inquiry Integrated with Disaster Mitigation

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ABSTRACT
Students understanding of teaching materials depended on the views and attitudes of the teacher in providing explanations during learning. This descriptive research aimed to explore teachers' perspective on implementation of STEM-Inquiry integrated with disaster mitigation. A number of 70 participants consist of 48 females and 22 males, Physics Teacher in Java Island, Indonesia involved in filling out the questionnaire. The questionnaire instrument distributed consists of several demographic surveys (such as age, gender, education level, and length of teaching) and 18-items Likert scale survey that asked teachers' perspective on the implementation of STEM-Inquiry integrated with disaster mitigation. The result showed that most of the teachers gave positive views on implementing STEM-Inquiry Integrated with disaster mitigation. The main challenge of the implementation is the difficulty in connecting disaster mitigation with Physics materials to appropriate and feasible teaching materials. Lack of students' knowledge in disaster mitigation and its integration in science might become a constrain that made low students' active participation during learning. Therefore, the teachers suggested that they increase knowledge about STEM-Inquiry learning and disaster mitigation to prepare suitable teaching materials in Physics by workshop and discussion with another teacher.

INTRODUCTION

The rapid development of information and technology due to industrial revolution 4.0 has impacted the expansion of knowledge in all aspects of life. Quality Human resources are needed in this era, and Science has a significant role in preparing them [1]. Four primary skills needed by someone in entering the world of work in the 21st century are inventive thinking, effective communication, high productivity, and literacy skills [2]. To pursue those skills, education in Indonesia needs to do some innovation.

Education in Indonesia is required to innovate to master factual, conceptual, procedural, and metacognitive knowledge in several aspects such as technology. One of the fundamental subjects that can prepare for the needs of the 21st century is Physics. As a primary science discipline, Physics requires experimenting, questioning, and extraordinary thinking [3]. Primarily, students often think that Physics is abstract and conceptually tricky as well as an uninteresting subject. Therefore, students need to engage in innovative and creative learning approaches for better achievement [4]. Physics learning in the 21st century aims to develop reasoning skills and increase deep conceptual understanding [5] to find solutions to problems in everyday life [6]. One of the problems in Indonesia is natural disasters.

Geographically, Indonesia is located at the confluence of four tectonic plates, namely the Asian continental plate, the Australian continental plate, the Indian continental plate, and the Pacific Ocean plate [7]. It causes Indonesia to have a high potential for natural disasters such as earthquakes and tsunamis. Therefore, it is necessary to have early knowledge for all Indonesian citizens to be more alert to disasters [8]. This knowledge will lead to disaster awareness that can reduce losses and the existence of disaster victims. Education can be one way to convey this information to the entire academic community.

Teaching disaster mitigation to students needed innovative learning. The teacher should teach the material by implementing active learning methods more relevant to students' needs and interests by motivating students [9]. Not only that, teaching methods had to be by the demands of the times. In fact, learning nowadays is still teacher-centered and does not involve students actively. For example, physics learning is currently still focused on mastering mathematical concepts and formulas [10]. A preliminary study states that students use textbooks as a learning resource with minimal integration with disaster mitigation, around 7% [7]. This condition does not meet the needs the demands of 21st-century education. The life of the 21st century requires students to solve various problems through creative thinking and using technology wisely. One suitable learning approach is the Science, Technology, Engineering, and Mathematics (STEM) approach. Learning with a STEM approach will facilitate students to learn concepts in an integrated manner related to problems in everyday life [11]. By allowing students to explore STEM, they will develop their passion and prepare multidimensional abilities to pursue jobs in the future [12] [13].

The STEM learning approach could be combined with other learning models to maximize learning outcomes. This learning approach is an integrated education that could be combined with scientific inquiry [14]. STEM learning will enable the development of students' knowledge structures like experts through involvement in inquiry and problems solving activities. Effective and meaningful inquiry learning can help students develop comprehensive skills in science. Learning with the inquiry model will actively involve students in an authentic discovery process by dividing complex scientific processes into simpler parts [15]. Furthermore, it is connected to direct students' thinking skills to help students understand science by solving problems based on data and facts. So, students can acquire knowledge and develop skills in the investigation process to find solutions to problems, such as natural disasters, through Inquiry-based STEM learning integrated with disaster mitigation.

Success in applying approaches and learning models in the classroom is influenced by many factors, one of which is the role of the teacher. Teachers played an essential role in the education system because students' success in achieving high academic standards depended on qualified teachers to provide appropriate learning [16]. Students understanding of teaching materials depended on the views and attitudes of the teacher in providing explanations during learning. The competence possessed by a teacher affects the teacher's view of a lesson. Teacher with high ability in teaching, student assessment, classroom management, and good personal qualities will have linear implications for student learning outcomes [17]. It is not enough for teachers to only have competence in cognitive aspects, such as skills and knowledge, but also have strong beliefs related to learning, motivation, and self-regulation [18]. That is, the professional competence of teachers involves aspects of knowledge, skills, beliefs, and self-motivation that will determine the extent to which a teacher can master the situation in learning. This view is then related to the attitude of a teacher. Attitude is a spontaneous

attitude produced by a person when faced with a situation resulting from careful consideration of previous experiences [19]. Based on this understanding, it requires in-depth knowledge from a teacher so that he can express a good attitude spontaneously. This knowledge is essential for teachers because the demands of the right and fast decision-making process are related to learning problems. That happened in STEM learning. Teacher perspective, emotion, and attitude in STEM are essential since they significantly impact the outcome of learning, such as teaching effect and instructional behaviors [20] [21]. Therefore, an in-depth study is needed regarding the perspective, emotion, and attitude of teachers in STEM to provide an overview regarding the possibility of implementing STEM to improve the quality of learning correctly.

STEM has many kinds of integration that made different perspectives, and it often caused debate. That problem was expected to continue because reaching an agreement on a common perspective is quite challenging [22]. A survey should be done to ask doers of STEM education, STEM teachers about their perspective on STEM. Teachers' views are important because it would affect their teaching. Driven by that problem, researchers explore teachers' perspectives on the Implementation of STEM-Inquiry Integrated with Disaster Mitigation for Education in Indonesia. This study aimed to analyze teachers' perspectives in implementing STEM-Inquiry integrated with disaster mitigation and inform STEM education stakeholders of the design of STEM professional development programs that fit teachers' thinking.

METHOD

This research employed Qualitative Research Design to gain teachers' perspectives on implementation of STEM-Inquiry integrated with disaster mitigation. Qualitative methods can be used to obtain the intricate details about phenomena such as feelings, thought processes, and emotions that are difficult to extract or learn about through more conventional methods [23]. The methods used for this study was descriptive case study that relied on multiple sources of evidence and benefits from prior development of theoretical propositions.

Participants of this this research were 70 physics teachers' that selected by purposive sampling technique. The participants were recruited using survey through google form questionnaire by two techniques: (1) individual school personnel's distribution of questionnaire, (2) Participant referral snowballing technique, whereby participants distributed survey through google form to other teachers who might express different perspectives or had had different experiences in teaching. Based on the form that had been spread, it was known the participants have been teaching at public or private high schools for an average of 4 years. The demographics of participants are described in Table 1.

Table 1. Demographics of Participants

Proportion	n
Female vs Male	48 vs 22
Bachelor's vs Master's Degree	52 vs 18
Public School vs Private School	40 vs 30

The questionnaire instrument distributed consists of several demographic surveys (such as age, gender, education level, and length of teaching) and an 18-items Likert scale survey that asked teachers' perspectives on the implementation of STEM-Inquiry integrated with disaster mitigation. All participants were asked to fill out a questionnaire with a scale of 1-4, representing "strongly disagree" to "strongly agree." Besides, two descriptive questions asked two questions asking STEM implementation challenges and suggestions for effective STEM learning. Data analysis was carried out by grouping responses from closed questions grouped according to a certain choice scale. The data were then averaged and analyzed descriptively and then presented in a bar chart. Meanwhile, for open-ended questions, the analysis was carried out interactively including collecting data, classifying data, and verifying information to determine general patterns. The questionnaire statements are presented in

Table 2.

Table 2. Questionnaire Statement in Survey

Statement	Sentences
Statement 1	I have implemented learning approach that suitable to 2013 Curricula
Statement 2	I have heard the term STEM learning
Statement 3	I know the abbreviation for STEM
Statement 4	I know the STEM learning in detail
Statement 5	I have implemented the STEM approach in learning
Statement 6	STEM integration in learning is important
Statement 7	STEM learning approach aimed to connect learning material in school with students' daily live
Statement 8	STEM learning approach is suitable to be implemented in Physics subjects
Statement 9	STEM learning approach is suitable to be integrated with learning models
Statement 10	STEM learning approach is suitable to be integrated with Inquiry learning models
Statement 11	STEM learning approach has the potential to be implemented in online learning during the COVID-19 Pandemic
Statement 12	I understand that Indonesia has areas that are prone to natural disasters
Statement 13	I know the types of natural disasters and how to deal with them
Statement 14	The environment around the school is prone to disaster
Statement 15	Schools plan safe shelters when natural disasters occur
Statement 16	Schools have disaster mitigation programs
Statement 17	I understand that natural disasters are related to physics subjects
Statement 18	Disaster mitigation education needs to be integrated into learning in schools

RESULTS AND DISCUSSIONS

The finding of the teachers' perspective in STEM-Inquiry integrated with disaster mitigation are organized as follow.

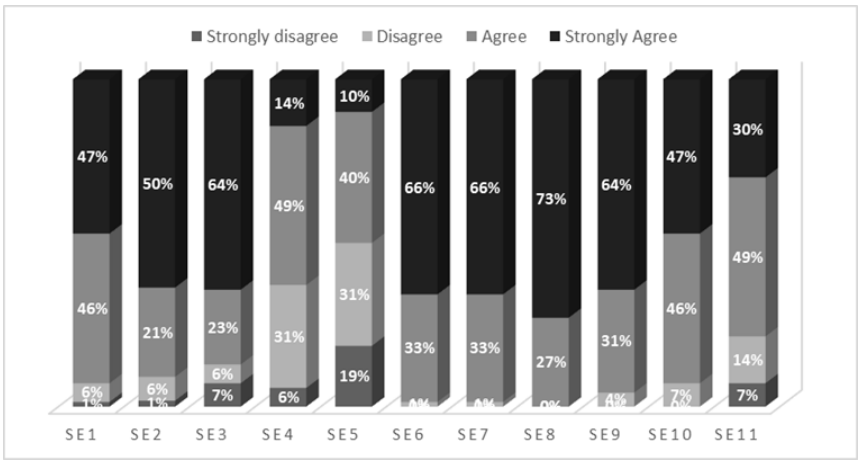

Fig 1. *The Teachers' Response for the Perspective in STEM-Inquiry Learning in Physics*

Based on Figure 1. It is shown that most of the teachers had implemented a learning approach that was suitable to the 2013 Curricula (SE1), heard the term STEM learning (SE2), and knew the abbreviation for STEM (SE3). Nevertheless, several teachers did not know the term STEM in detail (SE4) and had not implemented it in learning (SE5). Most of the teachers gave positive views on STEM learning; it was shown on statement 6 that 66% of teachers very agree that STEM integration in learning is essential.

These results provide a good overview of the implementation of learning with the STEM approach to students. Educators are the doers who will apply STEM through the teaching and learning process in the classroom. When teachers have a positive perspective on STEM, they will apply the STEM approach according to their perspective, both cognitively and affectively [22]. That way, the teacher will find it easier to control the planned learning [24].

Furthermore, no one of the teachers disagreed that the STEM learning approach aimed to connect learning material in school with students' daily life (SE7) and STEM suitable to be implemented in Physics learning (SE8). Most teachers thought that STEM learning is suitable if it is implemented with model learning, such as Inquiry (SE9-10). Since Inquiry-based modules are available on the smartphone via apps, it would facilitate and ease online learning [25]. By integrating virtual laboratories and students' worksheet, maybe into a module that had been validated, it will also enhance learning to be more efficacious [26].

Moreover, it still has the potential to implement STEM in online learning during the Covid-19 Pandemic. Teachers can use simple technology in students' daily life to provide a qualified learning process that can improve the quality of education [27]. In this case, the teacher's perspective and belief in using new technology in learning are very important. Teachers play a role in introducing new technologies to learning. In addition, the teacher's perspective will also convince students of the success of the learning being carried out [28] [29]. Some simple technologies can be created from objects widely available in the environment, so it will not burden students to provide them.

Another information that can be obtained from the survey result is teachers' resources; knowledge on STEM. The participants know the term Science, Technology, Engineering, and Mathematics (STEM) in various resources that can be seen in Figure 2.

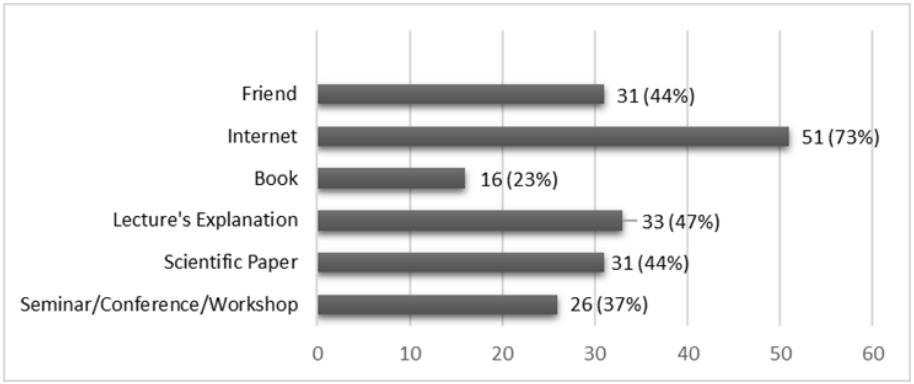

Fig 2. *The Resources of Teachers' Knowledge on STEM*

Based on Figure 2. It is known that most of the teachers knew the term of STEM from the internet (73%), lecturer's explanation (47%), scientific paper (44%), friends (44%), Seminar/conference/ workshop (37%), and the minor presentation is from books (23%). It shows that the internet plays a potential role in improving and exchanging information at all education levels, both for teachers and students [30] [31]. The use of the internet could support teaching to be more effective and help to improve the quality of content and pedagogy [32]. Although internet take the first position to spread information on STEM, it should be remembered that carefulness is needed in retrieving information from the internet. It is necessary to cross-check the information from many resources to produce complete and comprehensive knowledge.

These results in Figure 2. show that knowledge about STEM from lecturer's explanations and scientific papers is still low. Meanwhile, there is no common understanding or agreement about the nature of STEM education as an integrated or multidisciplinary endeavor, few guidelines and models exist for teachers to follow on how to teach using an integrated STEM Approach [33]. Therefore, as a

large country, Indonesia needs to prepare educators with the proper knowledge about STEM [34]. There is a need to consider implementing STEM knowledge in the curriculum in universities. In addition, a more comprehensive study or research is needed on STEM so that scientific articles on STEM are formed that have been tested for quality.

We also explore the teachers' perspective on the implementation of disaster mitigation's integration in Physics learning. The result can be seen in Figure 3.

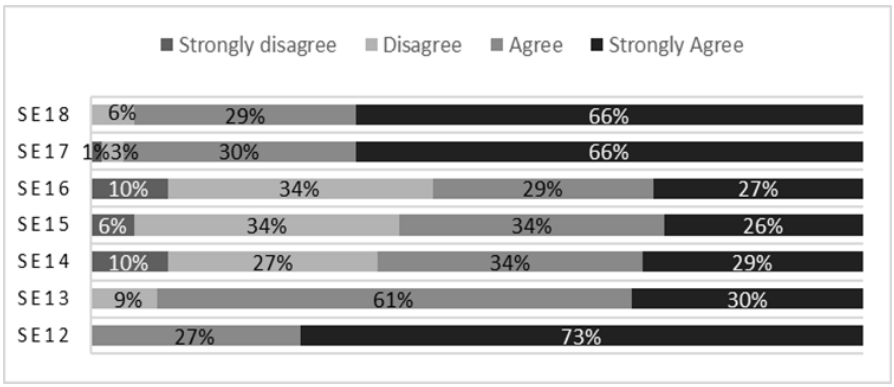

Fig 3. *The Teachers' Perspectives in Integration of Disaster Mitigation in Physics Learning*

It can be seen from Figure 3 that most of the participants realize that Indonesia has areas that prone to a natural disaster (SE12) and know the types of natural disaster and how to deal with that (SE13). 34% of the participants agree that the environment around the school is prone to disaster (SE14), so schools plan safe shelters when natural disasters occur (SE15). However, 34% of participants stated that the school had not had disaster mitigation programs (SE16). Besides, the participant positively viewed implementing disaster mitigation in schools, especially in Physics subjects (SE17). Physics is related to problems in everyday life, from the simplest to the complex, so it will be easier to solve a problem through a Physics approach.

The last part of the questionnaire was aimed to know challenges, constraints, and suggestions about STEM-Inquiry implementation integrated with disaster mitigation. The Challenges and constraints are presented in Table 3. From the table, it is known that the biggest challenge is the difficulty in connecting disaster mitigation with physics material to appropriate and feasible teaching materials. Besides, a lack of students' knowledge in disaster mitigation and its integration in science may become a constrain that make low students' active participation during learning.

Table 3. Teachers' Opinion on Challenges and Constraints in STEM-Inquiry Implementation with Integration of Disaster Mitigation in Physics Learning

Aspect	Constraint	n	%
Students	Lack of Students' motivation in learning physics.	6	4%
	Low students' understanding of Physics concepts.	6	4%
	Low students' creativity in learning.	2	1%
	Low students' active participation during learning.	9	6%
	Low student's critical thinking in learning Physics.	1	1%
	Low student' mastery of physics concepts.	2	1%
	Low level of students' literacy.	2	1%
	The Unpreparedness of students in accepting new learning approaches.	4	3%
	Different environmental backgrounds, experiences, and knowledge of students in disaster.	6	4%
	Lack of students' knowledge in disaster mitigation and its integration in science.	9	6%
	Perception of students that disaster is something scary.	3	2%

Teacher	Lack of Understanding about STEM in detail.	7	5%
	Difficulty in combining STEM components.	4	3%
	The Low ability of teachers in the field of technology.	2	1%
	Lack of teachers' understanding in integrating disaster mitigation and Physics.	8	5%
Learning Materials	Requires an appropriate and feasible teaching materials.	15	10%
	Requires appropriate learning materials' combination between STEM-Inquiry and disaster mitigation.	3	2%
	The difficulty of connecting disaster mitigation with physics material.	17	11%
	Lack of learning materials based on disaster mitigation.	4	3%
Facilities and Infrastructure	Lack of facilities and infrastructure in schools that support the learning process.	8	6%
	Requires online facilities, especially for student.	3	2%
Learning Strategies and Methods	Lack in integrating STEM into problems in everyday life.	2	1%
	The difficulty in monitoring and evaluating learning.	5	3%
	Requires simulation of disaster mitigation in learning.	5	3%
	Requires an excellent preparation to be implemented in online learning.	3	2%
	Limited teaching time.	7	5%
	It takes a long time to prepare teaching materials.	5	3%
	Requires a long adjustment time before being implemented in learning.	2	1%
	Total	**150**	**100%**

Based on table 3. It can be seen that the teacher experienced several Challenges and Constraints in STEM-Inquiry Implementation with Integration of Disaster Mitigation in Physics Learning. The questionnaire results showed that most of the teachers experienced problems in the aspect of learning materials, namely the difficulty of connecting disaster mitigation with physics material, as many as 11% of respondents and the need for appropriate and feasible teaching materials by 10% of respondents. The fact is that not all Physics materials are suitable to be integrated with disaster mitigation. Educators must be careful in choosing the appropriate topic so that its implementation does not make it more difficult for students to understand Physics. To improve this ability, educators should build relationships with other educators from different schools or regions to exchange opinions and experiences in teaching physics based on disaster mitigation. This relation is significant because isolated physics teachers will experience a lack of support from their professional community [35]. The lack of support can trigger frustration in educators and reduce the educator's confidence in innovative learning [36] [37] [38]. In addition, more research and development are needed regarding integrating Physics material with contextual phenomena, such as natural disasters. Besides, the teachers' suggestions on effective STEM-Inquiry implementation integrated with disaster mitigation in physics learning are presented in Table 4.

Table 4. Teachers' Opinion on Suggestion in STEM-Inquiry Implementation with Integration of Disaster Mitigation in Physics Learning

Aspect	Constraint	n	%
Teacher	Make an engaging learning experience	6	4%
	Monitoring and evaluating in every activity	2	1%
	Discuss with another teacher in the teacher forum	4	3%
	Increasing teacher creativity and literacy	7	5%
	Understand every student's ability	2	1%
	Active as a facilitator in learning	1	1%
	Increasing knowledge about STEM learning and disaster mitigation	11	8%
	Motivate students before study	5	4%
	Give clear guidance for students in learning	2	1%

Learning Materials	Good preparation of suitable teaching materials in Physics	11	8%
	Careful adjustment of learning planning	7	5%
	Adapting to the times by preparing learning media using technology	5	4%
	Integrate learning material in everyday life	9	6%
	Choose the suitable Physics material to be implemented in STEM learning and disaster mitigation	9	6%
	Adjusting to natural disasters in students' respective areas	4	3%
	Add learning materials that integrate STEM-Inquiry and disaster mitigation	4	3%
Facilities and Infrastructure	Fulfill adequate facilities to support learning activity	9	6%
	Use a variety of online learning infrastructure	5	4%
Learning Strategies and methods	Designing learning in detail	2	1%
	Focus on student learning experience	3	2%
	Habituate students with the learning atmosphere	5	4%
	Workshop for teachers about STEM and disaster mitigation	6	4%
	Time management	2	1%
	Additional time to learn about STEM for teacher and student	3	2%
	Provide disaster mitigation simulation for students	5	4%
	Implement suitable learning methods with the condition and the needs of the class	2	1%
	Introduce appropriate basic knowledge about natural disaster	9	6%
	Total	**140**	**100%**

Based on table 4. The teacher gives suggestions related to STEM-Inquiry Implementation with Integration of Disaster Mitigation in Physics Learning. The questionnaire results showed that as many as 8% of respondents suggested Increasing knowledge about STEM learning and disaster mitigation. In addition, there are also suggestions for preparing appropriate Physics teaching materials. Therefore, Indonesia needs to prepare teachers with sufficient STEM education knowledge. These efforts can be made by adding STEM-related courses at universities, adding research related to STEM, and providing training workshops related to STEM implementation by the government. STEM training workshops for educators are considered effective in improving the quality of science teachers in Indonesia [34]. In addition, the application of STEM in schools is also considered necessary. Research shows that countries that score high on PISA, such as Canada, Finland, Japan, the Netherlands, Hong Kong, South Korea, New Zealand, and Switzerland, implement solid STEM curricula in content and practice to prepare 21st-century skills [39]. STEM learning can improve students' problem-solving skills, critical thinking, and analytical thinking, guiding them to better real-world problems [40], such as natural disasters.

STEM learning will continue to meet challenges during the time. The future pedagogy will be governed by how efficiently educators can present their content knowledge using e-learning tools and appropriate learning models. The implementation of Inquiry-based learning in the classroom, integrated with STEM, will provide meaningful learning since the rapid changing of technology and other platforms [25]. So, it is needed to prepare a learning experience that effective for students.

Table 4. shows that the teachers' suggestion in implementation of STEM-Inquiry integrated with

disaster mitigation can be categorized in many aspects; teachers, learning materials, facilities and infrastructure, and learning strategies and methods. Teachers should increase their knowledge about STEM learning and motivate students before study. Providing initial knowledge for students can be a solution to motivate students in learning. Teachers suggest that workshop for teachers and discussion with another teacher are very important to increase knowledge. Adequate facilities and infrastructure should be fulfilled to support learning activities and choose the problem close to students' everyday lives for better learning outcomes.

Another suggestion is integrating learning material in everyday life that is useful for students. Physics learning could be done effectively if the teaching materials support the learning activities well [41]. Since teaching materials affect the realization of learning purpose, therefore teachers should prepare them well. Suitable learning materials will motivate students to participate in the learning actively, become more successful, and improve essential thinking skills such as critical thinking, problem-solving, and creativity [42]. Teaching materials make learning more enjoyable, enable better time management, and increase productivity levels in classes.

Learning materials should be contextual and environmentally appropriate for learners [43]. One of the contextual learning is disaster mitigation since most of the areas in Indonesia are prone to natural disasters. Contextual learning will enhance students' thinking skills by solving the problem based on scientific activities. That will ease students to connect in learning and get deep understanding. However, the use of teaching materials should be accustomed to strategies and learning methods [44]. Learning strategies and methods play an essential role in qualified learning; schools have to be implemented systematically and supported by teachers' and their choice of learning methods [45]. Teachers have to be able to provide learning strategies and methods that are suitable to the need of students in the 21st century.

CONCLUSION AND SUGGESTION

Based on the research, it can be concluded that most of the teachers gave positive views in STEM-Inquiry Integrated with Disaster Mitigation. Although several teachers had not implemented it in schools, they convince that there is a potential to implement this learning method in the Covid-19 Pandemic. The implementation of STEM learning can be conducted by using simple technologies in students' daily life. STEM-Inquiry integrated with disaster mitigation implementation will face many challenges: students, teachers, learning materials, learning strategies and methods, and facilities and infrastructure.

The biggest challenges are the difficulty in connecting disaster mitigation with physics material to appropriate feasible teaching materials and the lack of students' knowledge in integration of Physics on disaster mitigation that make low students' active participation during learning. Therefore, Participants also stated some suggestions for effective implementation of STEM-Inquiry integrated with disaster mitigation. The teachers' suggested that they should Increase knowledge about STEM-Inquiry learning and disaster mitigation to prepare good suitable teaching materials in Physics. Workshop for teachers and discussion with another teacher are very important to increase knowledge. Adequate facilities and infrastructure should be fulfilled to support learning activities and choose the problem close to students' everyday lives for better learning outcomes. This research can provide information on implementing more effective STEM-Inquiry integrated with disaster mitigation learning in the future.

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