STEM at Home: Provide Scientific Activities for Students during the Covid-19 Pandemic

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Abstract. The various barriers to learning science using online system during the Covid-19 pandemic, do not make us as a science educators, silent. One way to keep students able to carry out scientific activities is to provide scientific projects that students can work on in their own homes. The assignment can be delivered online and teachers’ feedback can also be given online using the learning management system. This study is the phase analysis of developing Module and Kits of STEM Project at Home that can be used in online science learning bay teachers and students. The results of this needs analysis phase serve as recommendations for the next stage of research. The final result of this development research is the availability of STEM at Home Project Modules and Kits that are valid and practical for students to use in learning science during the Covid-19 pandemic or New Normal era. A total of 340 respondents consisting of grade 1, 2, and 3 junior high school students in several schools in Riau Province, Indonesia, have participated in filling out the online questionnaires. This needs analysis shows that there is a great chance that STEM project-based science learning can be carried out online by students.

1. Introduction
This paper reports on the results our preliminary studies that have been carried out in the context of developing an online-based STEM module during a disaster situation. This research is based on the premise that learning services during disasters situation such as disease outbreaks and haze disasters due to forest fires need to be optimized. The existence of physical distancing during the Covid-19 virus outbreak that hit the world including Indonesia and the smog due to thick forest and land fires that always hit Riau Province and several other provinces in Indonesia almost every year, causing restrictions on the space for students and teachers to interact in the classroom. Zulirfan [1] suggested the need to maximize the house as a fun learning environment for students in carrying out scientific activities.

The situation of the Covid-19 pandemic disaster or the haze disaster, requires schools to close for an uncertain period of time. This situation is seriously detrimental to students and education in general. To minimize losses in the education sector, the online learning system is an alternative that must be applied in the learning process. However, to prepare for effective online learning is not an easy job. Educators must be creative in choosing a strategy and make good preparations.

Meanwhile, education is faced with the implementation of 21st century learning in the industrial era 4.0. The learning products of this century are 21st century skills including high-level thinking skills or HOTS, information technology literacy, effective communication, and collaboration skills. In the book Assessment and Teaching of 21st Century Skills [2], 21st century skills are categorized into 4 categories, namely way of thinking, way of working, tools for working, and skills for living in the world. Way of thinking includes creativity, innovation, critical thinking, problem solving, and decision
making. Way of working includes the skills to communicate, collaborate and work in teams. Tools for working include awareness as a global and local citizen, life and career development, and a sense of responsibility as a person and socially. Meanwhile, skills for living in the world are skills based on information literacy, mastery of new information and communication technology, and the ability to learn and work through digital social networks. To produce a generation that has the abilities of the 21st century, learning must undergo significant changes. Nichols stated that there are 4 important roles of 21st century learning [3]. The four roles are teaching which should be student-centered, collaborative education, learning that should be appropriate to the context, and schools that should be integrated with society.

STEM education is a learning strategy that is expected to improve critical and creative thinking skills to face the challenges of the 21st century [4]. Morisson stated several benefits of the STEM approach, including making students better able to solve problems, innovators, inventors, independent, logical thinkers, and technological literacy [4].

In the STEM approach, four disciplines, namely science, technology, engineering, and mathematics, are integrated [6]. These four disciplines are generally integrated in the form of a student's STEM project. In science teaching, the STEM project is an application of science concepts that are always adapted to real contexts in everyday life. This integration makes STEM a new discipline in a context that connects the experiences gained in school with the realities of everyday life [7]. According to Afriana [8], the implementation of project based learning STEM makes learning more interesting and can motivate students and form creative attitudes. Students feel happy working in groups so that they wish that the PjBL STEM learning can be applied again to other materials. In relation to the implementation of STEM education, Bybee [8] states that in STEM learning, at a higher level of education, students need to be challenged to perform authentic engineering tasks as a complement to science learning through project activities that integrate science, engineering, technology, and math.

The results of the study by Yennita et al [10], show that the application of STEM in schools especially in Pekanbaru is still very low. Science teachers need to be even more active in applying the STEM approach in their teaching. Although STEM has not been optimally implemented by teachers in teaching, especially science teaching, all science educators agree that STEM is a holistic approach that is needed. Bozkurt's study [11] shows that science teachers have a positive perception of the application of STEM in learning.

The Covid-19 pandemic limits teacher-student interactions in learning in classrooms or school laboratories. This is detrimental to students in particular and education in general. In order to develop online learning-based STEM project modules, researchers need to investigate the following research questions:

a. What scientific activities did students do at home during a pandemic?

b. To what extent are students willing to work on STEM projects at home?

c. What are the STEM projects that will be developed in this research?

2. Method

In this preliminary study, we have investigated the need for developing student STEM project modules for online learning during the Covid-19 pandemic. The analysis was carried out on students and the curriculum of junior high school science subjects. For this purpose, we surveyed 340 junior high school students in several schools in Riau Province, Indonesia, as respondents. The instrument is in the form of a questionnaire to identify student scientific activities during the Covid-19 pandemic and opportunities for students to implement STEM projects in their respective homes. The instruments are delivered online to respondents and they have responded quickly. The analysis of the science subject curriculum was carried out by examining the content of science lessons in several junior high school science textbooks. Both quantitative and qualitative data analyzes were carried out to describe the basis for developing an online-based STEM project. However, the results of this study cannot be generalized to a wider area. This is due to the limited number of samples and the sampling that has not been representative of various regions in Indonesia. However, for the purposes of our research, these needs assessment are considered sufficient.
3. Result and Discussion
The descriptive analysis carried out on the research data provides an overview of the possibility of implementing online-based STEM project for students’ science learning. The results of the analysis are as follows.

3.1. Scientific activities of students at home
We have identified four activities students might undertake in learning science online during the Covid-19 pandemic. These activities include: answering science questions, reading material in science textbooks, carrying out science project work, and observing natural phenomena around students’ homes. The response descriptions for the four activities are shown in Figure 1.

![Figure 1. Students’ activities for science learning at home in Covid-19 pandemic](image)

Figure 1 shows that the activity most often carried out in teaching science at home was solving science questions assigned to them by the teacher online. In addition, the task of reading science textbooks and summarizing the contents of the reading also got a large enough portion of the assignment for students. In contrast to the two activities above, more than half of the students stated that in science learning, they were rarely given assignments to do science works. In fact, almost some respondents stated that they had never done a science assignment at all in the form of a project. In line with that, respondents also stated that in science learning they were rarely given the task of observing scientific phenomena in their environment.

The results above indicate that online-based science learning generally still prioritizes the transfer of science knowledge and skills in solving problems. Many of the problems that occur in this online learning as reported by several researchers such as Luh Devi [13] and Rizqon [14]. However, this phenomenon is understandable considering that educators have not familiarized themselves with online learning, even blended learning has almost never been implemented so far, in the period before the Covid-19 pandemic. As if without warning, science educators suddenly have to prepare and implement online learning. In addition, giving assignments to read and summarize subject matter and work on science questions is relatively easy to prepare and easy to give to students online. Both of these activities can be applied quickly and do not require specific equipment and materials. Over time, science educators are believed to have had good experiences with online learning. Therefore, the quality of the science learning process needs to be improved.

Although online learning limits direct teacher-student interactions, we, as a science educators need to be more creative in finding relatively better strategies for our science learning. Online learning that was carried out for more than one semester presumably provides experience and skills for educators in managing online learning. Thus, in the future, the quality of online learning, especially science
learning can be improved. Science learning oriented to scientific activities at home should be implemented. In line with this, [12] emphasized that education is very important to embrace curriculum, teaching, and assessment that empowers students while paying attention to scientific thinking skills. To support carrying out scientific activities at home, we will try to develop an online-based student STEM project module and kits for our next phase of research.

3.2. Opportunities to implement STEM via online learning

The study also investigated students' perceptions of the STEM project and their willingness to implement it. Respondents' perceptions of the benefits of project-based science learning and their willingness to carry out project tasks are shown in Figure 2.

![Figure 2](image)

**Figure 2.** Students' perceptions of science projects at home and their willingness to do

Figure 2 shows that almost all respondents have positive perceptions (agree and strongly agree) on the benefits of project activities in science learning for them. By working on a project (STEM), students get the opportunity to apply their science concepts in technology products directly or solve contextual problems. In addition, students practice to integrate other disciplines (technology, engineering, and mathematics) in completing projects. Integration of STEM elements is necessary because no discipline can stand alone. Meanwhile, Figure 2 also shows the respondent's willingness to carry out STEM project activities. Most of the respondents are willing to carry out the STEM project assigned to them in their respective homes. This result is in line with research [15] which found that students show a positive attitude towards the implementation of STEM projects. Meanwhile, study [16,17] shows that students feel comfortable in learning with the STEM approach.

Because the STEM project module will be delivered through online learning, online learning facility support for students is needed. Android or smartphone is an ICT facility that is fast and flexible to use. In this regard, we have also surveyed the students' android ownership levels, as shown in Figure 3.
Figure 3. Availability of android of students for online learning purposes

Figure 3 shows that 75.3% of respondents claimed to have their own android, 15.3% used the android of their parents who were married to their other siblings, while around 9.4% of respondents admitted that they did not have an android at all. This data shows that the STEM project at home can be delivered via android because there are around 90.6 percent of respondents who can use their own android or share. Meanwhile, for students who do not have Android or do not have internet package fees, a module will be provided in hard copy form which is delivered manually.

3.3. Students’ STEM projects to be developed in our next stage of research

Analysis of the content and process standards of science subjects in the 2013 Curriculum and students’ science textbooks, obtained a list of STEM projects that are likely to be carried out by students at home, as shown by Table 1.

| No | STEM Project                              | For Students Grade | Embedded in science concepts                                      |
|----|-------------------------------------------|--------------------|------------------------------------------------------------------|
| 1  | Making a simple bimetal switch            | 7                  | Application of the concepts of temperature, expansion and heat in technology |
| 2  | Simple manufacture of local plant perfume | 7                  | Application of the concept of evaporation and condensation in the perfume refining process |
| 3  | Simple windlass                           | 8                  | Application of the concept of simple machine in technology        |
| 4  | Simple periscope                          | 8                  | Application of the concept of light reflection in technology      |
| 5  | Paper airplane                            | 8                  | Application of the concept of force and air pressure in technology |
| 6  | Simple ship dockyard model               | 8                  | Application of the concept of buoyancy in technology products     |
| 7  | Electrical energy of local fruits         | 9                  | Application of the concept of electrical energy and renewable sources of electrical energy |
| 8  | Simple flood alarm                        | 9                  | Application of the concept of electric circuits and buoyancy      |
Table 1 lists simple STEM projects that might be able to by students at home. For this purpose, a STEM project module will be prepared. Because some projects require components that are not available in students' homes, besides the module as a student guide in working on the project, the researcher also provides a STEM kit.

4. Conclusion

Although using online modes, science learning must prioritize scientific activities. In addition to observations, or experiments, working on a STEM project is an activity that is very important for students in improving their critical and creative thinking skills. With this ability, students will have the ability to solve contextual problems and the ability to innovate. STEM project assignments can be assigned online. Implementing a STEM project requires a STEM module and kit. The STEM kit is especially needed for projects with tools and materials that are not available in the home or the environment. The results of the investigation show that STEM project-based science learning is very likely to be implemented in times of the Covid-19 pandemic or other natural disasters that have caused schools to close.

References

[1] Zulirfan, Iksan Z H, Osman K and Salehudin S N M 2018 Take-home-experiment: Enhancing students' scientific attitude Journal of Baltic Science Education 17(5) 828 – 837
[2] Griffin P, McGaw B and Care E (eds) 2012 Assessment and Teaching of 21st Century Skills Dordrecht NL Springer
[3] Nichols J 2013 Four essential rules of 21st century learning [online] http://www.teachthought.com/learning/4-essential-rules-of-21stcentury-learning/ Acessed on 3 Agustus 2020
[4] Nugroho O F, Permanasari A and Firman H  2019 The movement of stem education in Indonesia: Science teachers’ perspectives Jurnal Pendidikan IPA Indonesia 8(3) 417–425
[5] Stohlmann M, Moore T J and Roehrig G H 2012 Considerations for teaching integrated STEM education Journal of Pre-College Engineering Education Research 2(2) 1–28
[6] Gonzalez H B and Kuenzi J 2012 What is STEM Education and why is it important? Congressional Research Service 1–15
[7] Baharin N, Kamarudin N and Manaf U K A 2018 Integrating STEM Education approach in enhancing higher order thinking skills International Journal of Academic Research in Business and Social Sciences 8(7) 810–821
[8] Afriana, A Permanasari and A Fitriani 2012. Penerapan Project Based Learning Terintegrasi STEM untuk Meningkatkan Literasi Sains Siswa Ditinjau dari Gender. Jurnal Inovasi Pendidikan IPA 2(2) 202–212
[9] Bybee R W 2013 The case for STEM education: Challenges and opportunity. Arlington, VI: National Science Teachers Association (NSTA) Press
[10] Yennita, Afni N, Kazmi T, Azizahwati and Fakhruddin 2019 The need analysis developing STEM embedded project Proceeding of the SS9 & 3 URICES
[11] Bozkurt A E and Ercan S 2016 STEM education program for science teachers: Perceptions and competencies Journal of Turkish Science Education 13 (specialissue) 103–117
[12] Erduran S 2020 Science education in the era of a pandemic: How can history, philosophy and sociology of science contribute to education for understanding and solving the Covid-19 crisis? Science and Education 29 233–235
[13] Herliandry L D, Nurhasanah, Suban M E and Kuswanto H 2020 Pembelajaran pada masa
pandemi Covid-19 Jurnal Teknologi Pendidikan 22(1) 65–70
[14] Aji R H S 2020 Dampak Covid-19 pada pendidikan di Indonesia: Sekolah, keterampilan, dan proses pembelajaran SALAM; Jurnal Sosial & Budaya Syar-I 7(5) 395–402
[15] Afriana J, Permanasari A and Fitriani A 2016 Project based learning integrated to stem to enhance Elementary School’s students scientific literacy Jurnal Pendidikan IPA Indonesia 5(2) 261–267
[16] Zulirfan Z, Rahmad M, Yennita Y, Kurnia N and Hadi M S 2018 Science Process Skills and Attitudes toward Science of Lower Secondary Students of Merbau Island: A Preliminary Study on the Development of Maritime-Based Contextual Science Learning Media Journal of Educational Sciences 2 (2), 90-99
[17] Parno, Supriana E, Yuliati L, Widarti A N, Ali M and Azizah U 2019 The influence of STEM-based 7E learning cycle on students critical and creative thinking skills in physics International Journal of Recent Technology and Engineering (IJRTE) 8(Issue-2S9) 761–769