

## **STEM and Critical Thinking: Alternative Learning Collaboration between Teachers and Parents in The New Normal Era**

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### **ABSTRACT**

The ability to think critically must still be a focus on learning, especially in the era of the new normal. STEM at learning that focuses on the activity and the ability to think of students who integrate science, technology, engineering, and mathematics is one of the alternative learning in the era of the New Normal. Collaboration between teachers and parents in the implementation of learning with STEM integration is needed. It is caused, distance learning that is applied in the era of the New Normal implications at the time of learning of students is a lot at home. The results of this study indicated that STEM learning with collaboration between teachers and parents is suitable to be used as an alternative for learning in the new normal era, focus on students' critical thinking skills.

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## **INTRODUCTION**

New Normal Era when these exist after the pandemic Covid-19. In this era, many paradigm changes occurred in various fields, including education. The process of learning and teaching time is changed from previously which are conducted face-to-face into distance-learning or online. Distance learning is a measure of the most secure in the avoid the spread of the virus covid-19 in carrying out the process of learning (Zapalska et al., 2020). Indonesia is also one of the implementers of distance learning through the “learning from home” policy in accordance with the circular letter of the “Mendikbud No 4 of 2020”.

The paradigm in learning during this pandemic took place suddenly and so quickly. Changes that have not been offset by the mastery of skills, cause problems in the process of learning and teaching in Indonesia. Challenges facing changes in the paradigm of this involves the parents,

teachers, institutions of education, and students (Purnama, 2020). Support the parents is very important in the learning distance away, especially for the students of the school base. It is due to the students of the school elementary greatly in need of guidance. This is following that described by Garbe et al. (2020) that parents have the responsibility in the learning distance away to ensure the participant students were able to learn independently, have the motivation to learn, the facility of learning that supports and outcomes of learning are good. Learning the draw is required in the process of learning a distance away so that the students are comfortable learning at home with the guidance of the teachers and the parents (Ardhyantama et al., 2020).

STEM integration is joyful learning. STEM integration is learning that internalizes four interdisciplinary fields that are science, technology, engineering, and mathematics (Meng et al., 2014). Learning the integration of STEM in the context of the world real-made construction material more relevant and then can improve the outcomes of learning, achievement, motivation, and persistence of students (Paramita et al., 2019). Learning STEM with the approach of cooperative learning and PBL also can increase the enthusiasm of students to learn and the ability to think critically (Mosley et al., 2016).

The ability to think critically in learning in a pandemic era should still be the focus of educators in the process of learning. It is due to thinking critically is an ability that is highly required students to afford to survive and succeed in life. The ability to think critically needed individuals in the life of society, judge, make a decision that is rational and appropriate to resolve the problem (Ennis, 2011 & Vieira et al., 2011). Someone who has the ability to think critically is able to direct himself, regulate himself, self-discipline, and can develop himself for the better (Paul & Elder, 2015). Critical thinking skills in everyday life make a person able to do work more efficiently (Ariawan, 2020). Therefore, critical thinking skills are needed by students to face challenges in their career and life success so that they are more independent and responsible (Tsui, 1999).

The development of critical skills can be developed through the learning process in the classroom. STEM is one of the learning approaches that can improve students' critical thinking skills (Rehmat, 2015; Linh et al., 2019; Davidi et al., 2021). research conducted by (Stein et al., 2007) that the project on STEM learning is based on integration with critical thinking skills components. Through the project can be developed and the ability to think critically students. Learning through STEM projects can also support the abilities of students with higher disciplines. This is a form of lifelong learning. Learning through STEM projects can make students have the ability to solve problems in everyday life, understand and apply more complex concepts of science, mathematics, and technology (Mater et al., 2020). Through STEM education students' critical thinking skills develop and students have more awareness to determine themselves (Hacioglu & Gulhan, 2021).

However, the problem that occurs in the pandemic is the focus of learning is on the content and not the ability to think. Giving the task procedural who now have much use teachers as learning in the pandemic's (Anugrahana, 2020). This is certainly not oriented to the development of HOTS thinking skills, especially students' critical thinking. Based on the things that need their studies to generate ideas related to alternative learning the days of the new normal is to develop the ability to think critically students. Studies focused on learning the integration of STEM collaboration with the parents to develop the ability to think critically for students.

## **METHODS**

This study uses a literature review research method. The literature review in the article was carried out by analyzing to explore alternative solutions for distance learning strategies through STEM integration, the application of STEM integration learning with students' critical thinking skills. In addition, it also examines the importance of the role of collaboration between parents and teachers in distance learning. The data collected from the literature were analyzed based on the object being studied. The stages of analysis carried out are analyzing problems and needs, determining the object of study, reviewing the literature, clarifying and eliminating data that were not relevant to the object of the study, synthesizing findings, and describing the results. Based on the research stages, it is described that STEM integration learning with collaboration between teachers and parents can be used as an alternative to developing distance learning or not.

## **RESULTS AND DISCUSSION**

### **Learning in the New Normal Era and Its Problems**

The Covid-19 pandemic that has hit the whole world, including Indonesia, has changed the order in all sectors, including the world of education. To minimize the spread of the Covid-19 virus, the government has made policies related to social distancing. Social distancing is the practice of providing distance in interactions between individuals to reduce the transmission of the Covid-19 virus (Sen-Crowe et al., 2020). Social distancing is enforced in all sectors including the education sector. Schools make an important contribution to social distancing because schools involve individual interactions, be it teachers, students, parents, and the community (Faherty et al., 2019). Therefore, a policy related to social distancing in schools was made through distance learning which was held online. This is following the circular letter of the "Mendikbud No. 4 of 2020" which explains that learning is carried out online through meaningful learning without burdening students with curriculum achievements.

Based on the explanation above, learning in this pandemic era changes the paradigm that was originally implemented face-to-face, but now it is carried out indirectly (online). However, because the paradigm shift was so sudden, it created challenges and obstacles in the field. According to research conducted by Purnama (2020), the challenges and problems related to distance learning practices in the current pandemic era involve parents, teachers, educational institutions, and students. The challenge for teachers is in mastering technology skills to create innovative learning. Innovative learning is needed considering the limitations that exist so that learning objectives can be achieved. Jamilah (2020) also explained that the challenges of educators in distance learning include the ability to master technology, human resources, and support for infrastructure.

The condition of the people of Indonesia is so diverse also makes the emergence of the problems that arise from the students. Students who live in areas remote experiencing difficulties because of the limitations of the network internet. Facilities for learning a distance far too many that are not owned by the students, for example, handphone. It's like that delivered coconut Disdikpora Yogyakarta and contained within the compass that in the area of Gunung Kidul approximately 70% of students do not have the devices or facilities that support for learning online so it was

difficult to access the internet. Problems that occur also emerge from the support of the parents. The role of parents is very important in the learning distance away in an era of the pandemic because policies related to learning distance away are carried out at home or learn from home. However, explained that in addition to facilities that do not support such devices are also to be owned by the parents there is the difficulty of the elderly-related knowledge that he has in assisting students. The incompetence of the parents affects the success of the students in carrying out learning distances away (Nuraini et al., 2020). There are some people of old who also has a flurry of such work so as the accompaniment of learning is also not maximal. Problems that arise too often the task of the school were given by teachers instead of students who do but the elderly. So that control of both external and internal to the student in the learning distance away in the era of a pandemic is very less.

The same thing was also explained by Primasari & Zulela (2021) hat the obstacles experienced in distance learning in this pandemic era include: (1) poor mastery of technology for students, teachers, and parents, especially in remote areas, (2) parents have to pay additional fees, especially for internet fees, (3) not all parents can accompany their children because they collide with working hours for working parents, (4) some parents are not used to accompanying children to study, are more emotional and easy to stress, (5) the constraints of working hours that are not limited by the teacher due to always having to establish intense communication with students, parents, and stakeholders in the school.

### **The Importance of Teacher and Parent Collaboration in the New Normal Era**

Distance learning at the time of the pandemic is still a concern for researchers and practitioners in developing the techniques of learning are effective. There is four Part the nucleus that should be developed in learning distance away to develop learning that is effective that was developed by the Commonwealth of Learning, Burnaby, British Columbia (Zapalska et al., 2020). Four components include learning resources, pedagogy, learner support, and management.

Components	Description
<i>Learning resources</i>	Material of learning should be designed to be easily accessible and understandable students are independent both are presented in print, audio-visual equipment with assisted media electronics such as gadgets, TV, and radio. The purpose of delivering the material must also be clear following the competencies that are expected to be mastered by students.
<i>Pedagogy</i>	Guidance of teachers through the medium of communication is very necessary for the learning distance away. Teachers must set up a process of communication and guidance that remains intertwined even though no meeting is direct. In addition to communication between teachers and students in the process of learning the communication between students was also to be facilitated to still establish the process of learning. Teachers should guide students to have independent learning skills.
<i>Learner Support</i>	Support emotional and psychological clenched around a role important in the success of learning self-students. Create the environment to learn the fun, without pressure and involves the activity of students in the learning distance away need to be managed as efficiently. Management which efficiently can

	be done through planning, organizing through the development of curriculum to assessment needs to be managed with either.
<i>Management</i>	Planning, curriculum, the process of learning, as well as evaluation need to be managed either through the administration of the well by the school. Through the management of the well can make the process of learning to teach distance away run effectively.

Tabel 1: Components of distance learning (Zapalska et al., 2020)

Based on the table above, it is known that learning support from the environment plays an important role. On learning distance away in the era of a pandemic is the support of the elderly is most needed by the participant students. People older have a responsibility in learning distance away to ensure the participant students were able to learn independently, have the motivation to learn, the facility of learning that supports and outcomes of learning are good (Garbe et al., 2020). It is due to part-time participant students in the study carried out at home. The role previously performed by the teachers at the school when it should be taken over by the parents at home. People older should assist the participant students in learning independently. Of course, the parents do not walk alone. People older must remain to collaborate with teachers in implementing the learning that is effective during a pandemic. It is following the research that is done by some experts that the collaboration method or consultation the parents with the teacher effectively used in learning distance away (Smith et al., 2020; Mansyur, 2020; Hadi et al., 2021).






Furthermore, it is described in more detail by Smith et al. (2020) that the involvement of the parents and teachers can do to the based framework of the work as follows: (1) the parents and teachers mutually interact and collaborate to guide the children in the learning environment of each is directly related to the development of the participant students, (2) teacher collaborated with the parents are not directly are related to the interests of the school, (3) teachers and parents to interact and collaborate related to the structure of social child, for example, related to the policy of the school related to the interaction of the social child with the environment, as well as with schools, (4) teachers and parents interact and collaborate related policy of the general government, for example, related to culture that can affect the development of the students.

Based on the explanation above, the collaboration of parents in distance learning is very important. Collaboration that can be done by parents and teachers is also important in the direct student learning process. Methods of learning that involve collaboration and parents are needed. Parents are supporters of student success in e-learning in this pandemic era (Panaoura, 2021). Parents will not experience confusion if the teacher prepares a detailed method that can be carried out easily by parents in guiding children along with the material that students must master. Project-based learning is an effective alternative to distance learning (Ardhyantama et al., 2020). Based on the research of Ivana & Hutasoit (2021) there is mathematical learning in this pandemic era, the Project Base Learning model is proven to be able to help students in: (1) building a broader and more flexible understanding of knowledge; (2) can selectively develop problem-solving abilities; (3) develop the ability to learn lifelong or self-directed; (4) be a good initiator and collaborator; (5) have good self-motivation in learning. Based on the consideration of the principle aspects of project learning, thematic, learning stages, the project-based learning model can be used as a collaborative learning model with parents. Projects can be designed by involving parental guidance.

### Learning with STEM Integration

STEM integration learning is learning that internalizes four interdisciplinary sciences, namely science, technology, engineering, and mathematics (Meng et al., 2014). There are many ways to implement STEM integration learning, including problem-based, inquiry, project-based, and implementation of engineering in real-life problems (Mosley et al., 2016; Shahali et al., 2017; Park et al., 2018). STEM implementation involves work processes that are also integrated into disciplines such as data processing, computational thinking, scientific inquiry, critical thinking, and process engineering (Hacioglu & Gulhan, 2021). The implementation of STEM in mathematics learning is the implementation of mathematical skills to solve problems in daily life by producing innovative products that are integrated with science and technology (Milaturrahmah et al., 2017).

Teacher collaboration in STEM integration learning can be done by understanding STEM as follows (Larkin & Jorgensen, 2017):

<p><b>Each discipline of science STEM is taught separately.</b>                      In grade science focus the most on the development representative for the development of the concept. In grade math can be used by teachers to present the problems of the complex as an effort to train the ability to solve problem students.</p>	
<p><b>All disciplines STEM integrated but are preferably one or two disciplines of science</b>                      Teachers integrate science and math through the challenge-based project work and students build ideas to complete them</p>	
<p><b>Integrating one to three more but are taught in separate</b>                      The processes of teamwork in engineering, identifying, and understanding problems, building solutions, applying, and evaluating them are integrated with themes in science and mathematics and relate to a limited extent.</p>	
<p><b>All disciplines of science are integrated as a whole</b>                      The science teacher integrates T, E, and M in a full science lesson that focuses on designing new innovative solutions to solve real problems</p>	
<p><b>Dividing the curriculum STEM into a mutually separate subject</b>                      Each teacher of science, engineering, and mathematics collaborate to design a theme that can be integrated, and each teacher has contributed to the theme of which is taught to clear.</p>	

Tabel 2: STEM Integration (Larkin & Jorgensen, 2017)

Based on the table above, teachers can apply the STEM perspective model to classroom learning both individually and collaboratively. The selection of the STEM model can be adapted to the learning objectives developed by the teacher. Teachers in collaboration or individually can develop classroom learning designs that are by the culture in their schools (Larkin & Jorgensen, 2017). The application of the STEM model does not focus on STEM design or the resulting product, but understands the relationship between science and technology, applies engineering processes and scientific skills (Guzey et al., 2019) to solve problems and career development (Hacioglu & Gulhan, 2021). Some researchers agree that the teaching of STEM build context world real inter-disciplinary science in addition to building an understanding of the conceptual

also more to train the abilities, skills, and character to resolve the complex problem (Meng et al., 2014; Erdogan et al., 2016; Peterman et al., 2016; Leonard et al., 2016; Rochman et al., 2020).

Learning with STEM integration according to Meng et al. (2014) can develop the ability of students to have:

- (1) The knowledge, skills, and attitudes that are used to understand the problems in life every day, analyzed the phenomenon, making planning settlement of the problem, and make conclusions that can be solved with the integration of STEM.
- (2) An understanding of the characteristics of STEM disciplines as a form of knowledge, design, and innovation which are ideas from humans.
- (3) Awareness that STEM will become an intellectual culture that will always develop in society.
- (4) Ability to contribute to the benefit of the nation related to engineering SCIENCE, technology and science of mathematics that can be used to create the idea of innovative that are useful settlement of the issue of the country such as the efficiency of energy, the issue of the environment, the source of the power of nature.

### STEM and Critical Thinking

The process of learning is certainly not just simply equip students to know. However, through the learning process, students must also be able to develop thinking skills, especially the HOTS (Higher Order Thinking Skill) ability (Kusuma et al., 2017). HOTS Brazilians activities involve the ability to analyzing, evaluating, and creating (Elder & Richard, 2020). HOTS includes the ability to settlement of problems, think critically, and the ability to think creatively (Davidi et al., 2021).

Critical thinking is the ability to think through reflectively and rationally regarding whether decisions can be believed and what beliefs occur after the decisions are taken (Ennis, 2011). Someone who has the ability to think critically will first analyze the information he gets whether it can be trusted and used for decision making (Asari et al., 2019). Critical thinking skills require decision-making by analyzing situations that support the problems that occur. So, with the ability to think critically decision-making can be taken appropriately. Critical thinking skills are related to positions/attitudes, knowledge, abilities, and standards or criteria for scientific literacy (Vieira et al., 2011). The explanation can be seen in the following table:

Component	Description
Disposition	Openness, impartiality, integrity, sensitivity to evidence, perseverance, consideration of science
Knowledge	About the material of teaching and learning, problem or issue that will be resolved, the hypothesis, the relationship correlation or cause a result, associated with a condition that is necessary to resolve the problem
Ability	Ability to identify and analyze information, look for evidence and make arguments, prove hypotheses, and make conjectures, communicate and make conclusions or problem solutions
Standard or criteria	Precision, accuracy, clarity, validity, consistency, control of variables

Tabel 3: Student's critical thinking in science classroom (Vieira et al., 2011)

Disposition, knowledge, ability, and standards or criteria are components of scientific literacy. This component involves critical thinking skills. This shows that critical thinking skills are fundamental in literacy. The integration of critical thinking skills in science concepts through classroom learning is very important to equip students in life in society (Vieira et al. 2011). Knowledge as a basic concept is meaningful if it is supported by the use of technology and scientific literacy as a form of developing computational thinking in elementary schools (Dicke & Farris, 2019).

The ability to think critically can be developed through a process of learning. For this reason of learning needs to be designed for the development of the ability to think critically. Design learning to think critically can be supported with the selection methods, strategies, or models of learning the right. STEM is one of an approach to learning that can improve the ability to think critically students (Rehmat, 2015; Davidi et al., 2021). Furthermore, Rehmat (2015) explained that learning with a STEM-based Problem Base Learning (PBL) approach can support students' ability to understand the material, students' attitudes in developing STEM skills, and critical thinking. Learning STEM with the approach of cooperative learning and PBL also can increase the enthusiasm of students to learn and the ability to think critically (Mosley et al., 2016).

#### **STEM Learning Collaboration with Parents in the New Normal Era**

E-Learning still is a solution to the learning distance away in a normal new era. For some areas that have been allowed to carry out learning directly limited, of course, will still apply learning-based blended learning. So that e-learning was not going to be left so alone with learning face-to-face. Because it needed a strategy or approach to learning that is capable of supporting the success of e-learning. STEM integration is very dynamic and suitable to be applied to the study of e-learning and that the quality of learning increases can be done through simulation (Van Nuland et al., 2020). Simulation This can be supported by the guidance of the parents at home. Teachers need to collaborate in teaching children through e-learning and collaborate with the parents. Especially at the level of school basis, because children's elementary school is still very dependent on the guidance of the adult.

The integration of STEM collaboration with parents in learning can be applied to mathematics subjects in particular. Based on the study of STEM learning on mathematics material in collaboration with parents, it can be done as follows (Larkin & Jorgensen, 2017); (Nurhikmayati, 2019):

- (1) In the number material in the early grades of elementary school, students are asked to make a project with their parents by making a bridge out of straws. Then calculate the strength of the bridge that has been designed and made by asking students to count how many coins can accommodate the strength of the bridge. To develop students' critical thinking skills, students are asked to compare the strength of the bridge made with their parents' bridge and at the same time, students can understand which number is larger.
- (2) In the matter of area and volume, students and parents are asked to analyze the availability of water in their home tank enough to be used for any purpose, how long it takes to fill the tank and how efficient is the water in the tank if there is the notification from the electricity department if on a certain day.



- (3) Comparison and fraction materials can be designed by making a project together with parents to make cake preparations with a comparison of certain ingredients. It is also possible to develop a critical question of what will happen if the ratio of a certain material is changed. So that students can conduct trials as well as develop critical thinking skills.
- (4) In the corner material, students are asked to make a simple clock project by calculating the ratio of the angle to the circumference of the circle. As a form of collaboration, teachers need to present worksheets for students as well as for instructions for parents to help students construct material. Collaboration can also be done through media such as WhatsApp.

STEM with Project Base Learning on learning elementary grade V on the theme of 8 sub-theme " Efforts Wildlife Environment " also can be done by considering the case following this (Davidi et al., 2021):

- (1) Environmental problems can be explored by discussing issues that develop in the community related to water, air, and soil pollution.
- (2) Make a literature review both from articles and the internet related to the above problems. Of course, students can collaborate with the parents to discuss the issue environment.
- (3) Students are asked to identify a problem, make an alternative solution to the problem. Projects made posters related issues and an invitation to keep the environment along with the elderly also can be done. Then the poster can be contested through social media. Learning designs like this can be done to motivate and develop students' independent learning initiatives during the New Normal Era.
- (4) In the matter of mathematics students may be asked to analyze the efficiency of electrical energy that can be used at home as an effort of preserving the source power of nature and overcoming pollution of the environment. Students are asked to create a schedule pattern of life-saving electricity in a day when they learned at home. Then the students were asked to calculate the expenditure of electrical energy based on a schedule that has been created and calculates how much the cost of which could be saved with the schedule savings electrical energy that has been made.

Some of the learning alternatives described above can be adopted or adapted to be developed into learning designs in the classroom on e-learning. The learning alternative focuses on students' critical thinking skills based on STEM projects. The integration of STEM-based e-learning can facilitate face-to-face learning and the learning presented is more innovative (Van Nuland et al., 2020). The learning design developed is carried out in collaboration between teachers and parents.

## **CONCLUSION**

Learning STEM which focuses on the activity of the students to integrate science, technology, engineering, and mathematics highly associated with the development of the ability to think critically students. STEM integration can develop the knowledge, skills, ability to think which is oriented on the settlement issue is very appropriately applied to develop the ability to think critically students. Learning STEM to involve the parents in the process of learning to assist students working on projects STEM certainly very appropriate applied in the implementation of learning in the New Normal Era time is that they apply the learning distance learning. Collaboration teachers and parents through learning the integration of STEM in which teachers

prepare learning materials, plan learning and pieces of work, as well as a source of learning and the parents who accompany the students in carrying out the project STEM at home, will contribute to the success of learning to develop the ability to think critically. It is caused by things that can support the successful implementation of learning e-learning which involves components of learning resources, pedagogy, learner support, and management can be fulfilled. Alternative learning STEM in collaboration with the parents is of course still need to study more about later in the day because the study is a review of the literature that is still limited.

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