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# Teacher assistance to strengthen STEM learning based on lesson study at MTs Muhammadiyah 1 Malang

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ABSTRACT

*STEM learning aims to prepare students to prepare themselves for a career based on the skills needed in the 21st century, but this is still not a concern for teachers so assistance is needed for science and mathematics teachers. This assistance is intended to strengthen teachers' understanding, skills, and attitudes towards STEM. The steps taken in this mentoring activity include (1) initiation of contacts and reports of initiation results, (2) discussions, (3) program planning and implementation, and (4) program evaluation. The results of the implementation of the mentoring steps, namely (1) an agreement was obtained that a comprehensive understanding of STEM concepts was needed, skills were needed to develop learning tools and implement STEM learning and a strong appreciation in STEM learning was needed; (2) agreed on the need for assistance in the form of strengthening STEM understanding, training in preparing lesson plans and STEM learning practices and strengthening attitudes towards STEM as a choice of learning approach that is in line with the demands of the 21st century; (3) The results of discussions related to program plans and implementation are the formulation of STEM training plans and their implementation involving teachers in the fields of Science and Mathematics; and (4) The results of discussions related to evaluation stated that the results of mentoring were evaluated in a process through observing STEM learning practices using the open-class and reflection method, while product evaluation was through learning plan portfolios and learning videos. The conclusion of this mentoring activity is the implementation of the stages of STEM learning assistance which includes initiation, discussion, plans and implementation of actions and evaluation. The mentoring process has strengthened the understanding, skills, and appreciation of science and mathematics teachers for STEM learning.*

***Kata kunci***
Keterampilan
Lesson Study
Pembelajaran STEM
Pengetahuan
Sikap

***Pendampingan guru untuk menguatkan pembelajaran STEM berbasis lesson study di MTs Muhammadiyah 1 Malang.*** Pembelajaran STEM bertujuan mempersiapkan siswa menyiapkan dirinya untuk bisa berkarir berdasarkan skill yang dibutuhkan di abad ke-21, namun hal ini masih belum menjadi perhatian guru sehingga diperlukan pendampingan kepada guru IPA dan Matematika. Pendampingan ini ditujukan untuk menguatkan pemahaman, keterampilan, dan sikap guru terhadap STEM. Langkah yang dilakukan dalam kegiatan pendampingan ini meliputi (1) inisiasi kontak dan laporan hasil inisiasi, (2) diskusi, (3) perencanaan dan pelaksanaan program, dan (4) evaluasi program. Hasil implementasi atas langkah-langkah pendampingan, yaitu (1) diperoleh kesepakatan bahwa diperlukan pemahaman yang komprehensif terkait konsep STEM, diperlukan keterampilan menyusun perangkat pembelajaran dan implementasi pembelajaran STEM serta diperlukan apresiasi yang kuat dalam pembelajaran STEM; (2) menyepakati perlunya bantuan berupa penguatan pemahaman STEM, pelatihan penyusunan RPP dan praktek pembelajaran STEM serta penguatan sikap terhadap STEM sebagai pilihan pendekatan pembelajaran yang sesuai dengan tuntutan abad ke-21; (3) Hasil diskusi terkait rencana dan pelaksanaan program adalah tersusunnya rencana pelatihan STEM dan implementasinya yang melibatkan guru dalam bidang studi IPA dan Matematika; dan (4) Hasil diskusi terkait evaluasi menyatakan bahwa hasil pendampingan dievaluasi secara proses melalui observasi praktek pembelajaran STEM dengan metode buka kelas dan refleksi sedangkan evaluasi produk melalui portofolio learning plan dan Vidio Pembelajaran. Kesimpulan dari kegiatan pendampingan ini adalah terimplementasikannya tahapan pendampingan pembelajaran STEM yang meliputi inisiasi, diskusi, rencana dan pelaksanaan aksi serta evaluasi. Proses pendampingan tersebut telah menguatkan pemahaman, keterampilan, dan apresiasi guru IPA dan Matematika terhadap pembelajaran STEM.



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## INTRODUCTION

Education in Indonesia is encouraged to prepare for the golden generation of 2045 (Amran et al., 2020; Listyaningsih et al., 2021; Rokhman et al., 2014; Shaturaev, 2021) and achieve the Sustainable Development Goals in the education sector (Arifin et al., 2017; Malik, 2018; Sihaloho et al., 2017). The expected golden generation is currently being prepared as Pancasila Students who have the characteristics of critical thinking, creative thinking, collaborative skills, and communicative. To realize such a Pancasila Student profile, qualified teachers are needed, one of which is in implementing modern learning (Lestari et al., 2022; Rotty et al., 2022). Modern learning that is very hotly discussed at the moment is science, technology, engineering, and mathematics (STEM). STEM learning, which is believed to be able to answer the challenges of a world that is volatile, uncertainty, complexity, and ambiguity (VUCA) (Alexander & Fry, 2016; Rodrigues & Simoes, 2021).

STEM combines four disciplines in harmony to complement and form the basis of a Project-Based Learning model (PjBL). STEM is an integrated learning approach that encourages students to think more broadly about real-world problems. The purpose of STEM-based learning is none other than to support students to prepare themselves for careers based on the skills needed in the 21st century (English, 2016; Kelley & Knowles, 2016). The approach from these four aspects is a harmonious match between problems that occur in the real world. This approach is able to create a cohesive learning system and active learning because all four aspects are needed simultaneously to solve problems. The solutions given show that students are able to unify abstract concepts from every aspect (Sulistyaningsih & Purnomo, 2021; Yakuti et al., 2021).

In STEM learning, aspects of skills and knowledge are used simultaneously by students. Differences from aspects of STEM will require a connecting line that makes all aspects can be used simultaneously in learning. Students being able to relate all aspects of STEM is a good indicator that there is a metacognitive understanding developed by the participants so that they can assemble the four interdisciplinary aspects of STEM. Each aspect of STEM has special characteristics that differentiate between the four aspects. Each of these aspects helps students solve problems much more comprehensively when integrated (Falentina et al., 2018). As for the four characteristics, namely: (1) science which represents knowledge about the laws and concepts that apply in nature; (2) technology is a skill or a system used in managing society, organization, knowledge or designing and using an artificial tool that can facilitate work; (3) Engineering is the knowledge to operate or design a procedure to solve a problem; and (4) mathematics is a science that links quantities, numbers and space which only requires logical arguments without or accompanied by empirical evidence. To apply STEAM learning, we can adopt a series of processes used by engineers in creating a product or technology. This process is also known as the engineering design process (EDP). These steps include: (1) Finding problems and solutions, (2) Designing products, (3) Developing products, (4) Making and testing products (Priyani & Nawawi, 2020).

Specifically, in the Indonesian context, community service or mentoring activities to strengthen teacher skills in implementing STEM learning have been carried out. Community service or elementary school teacher assistance has been carried out in developing STEM learning in Bandung-West Java (Sukmana & Nurhayati, 2019) and Karimunjawa-Central Java (Arifudin et al., 2022). Especially for middle school teachers, assistance in the development of STEM learning has also been carried out (Nugraheni et al., 2022; Setiawan et al., 2020). Meanwhile, assistance for the development of STEM learning specifically for early childhood education teachers to several university lecturers has also been carried out (Nasir et al., 2022). Based on the literature search, there have been no reports of STEM learning development assistance activities in the City of Malang-East Java, especially those focused on MTs Muhammadiyah 1 Malang.

MTs Muhammadiyah 1 Malang is a junior high school that provides education according to the current curriculum. This school has the right response regarding 21st century learning which includes their interest in organizing STEM literacy and learning activities. The results of communication with teachers and principals indicate that schools have a need to strengthen STEM learning so that it can support the careers of their students in the future. The need for strengthening STEM learning is expected to be fulfilled through collaboration with universities that have experience in developing STEM learning. Meeting with several lecturers who already have a reputation in STEM learning from the University of Muhammadiyah Malang (UMM) campus made the hopes of MTs Muhammadiyah 1 Malang even closer to reality. We agree that STEM-based learning assistance implementation activities can also be integrated with lesson study.

STEM can be integrated with lesson study (Aykan & Yıldırım, 2022; Kandaga et al., 2021; D. Wati et al., 2020). Lesson study has three cyclic steps, namely open plan, open lesson, and reflection. The main characteristic of lesson study is openness in conveying lesson plans, implementing and reflecting. Learning tools that have been prepared by the teacher need to get an open joint scrutiny so that all forms of deficiencies that are found can be anticipated in advance. Togetherness and openness in learning planning will certainly bring a lot of accuracy, thoroughness and completeness of insight. The same goes for the open class step or open lesson. This step is one of the steps to expose learning to an interested learning community. Learning communities are expected to autonomously act as observers or observers of learning. So, an observer is not a recorder of deficiencies that occur in teaching played by a model teacher, but learns how students learn. The third step is reflection which is an effort to review the learning process that has been carried out. This step is important to reveal the processes that occur in learning, including aspects of strengths and weaknesses in achieving learning objectives and the factors that cause them (Hindun et al., 2019, 2018; Miharja et al., 2020;

Nurwidodo et al., 2018). Reflection invites notes from the observations found by the observers. The results of reflection provide benefits for tutors and observers to reinforce good practices that occur in STEM learning. Therefore, this mentoring or service activity is aimed at strengthening teachers' understanding, skills, and attitudes towards STEM.

## METHOD

This activity was carried out at MTs Muhammadiyah 1 Malang for 8 months (June 2022-January 2023). The method in this service uses the Community Development Methode (CDM) which consists of 4 stages, namely Stage 1. Initiation; Stage 2. Discussion, Stage 3. Action Plan and Implementation, and Stage 4. Evaluation (Campfens, 2019). At the initiation stage, the service team conducted a Focus Group Discussion (FGD) to obtain information on the needs of science teachers and Mathematics teachers at MTs Muhammadiyah 1 Malang to strengthen STEM learning. The results of the FGD included the nature of STEM, DTEM content and processes, an assessment of the need for STEM learning, reasons why there should be STEM, the relationship between STEM and 21st century learning, how to structure STEM learning, how to implement STEM learning, and how to conduct an assessment in STEM learning. The results of the FGD will then become input (entry point) to start the program.

In the discussion stage, the service team discusses whether the requirements are needed to be able to carry out STEM learning properly and correctly, how to fulfill these requirements, when to fulfill them and how to evaluate that the fulfillment of the requirements is sufficient. Furthermore, at the planning and action implementation stages, a strategy is formulated to carry out actions to strengthen STEM learning. Based on the results of the initiation and discussion, three action plans were agreed upon, firstly strengthening understanding of STEM concepts and processes, secondly assisting in the preparation of STEM learning tools and thirdly opening classes for the implementation of STEM learning and its reflections. This action plan is the implementation of a pattern of teacher professional development known as Lesson Study. During the evaluation and reflection stages, all components and stages of the program receive an assessment in the form of responses from teachers, school management and students. Evaluation is also carried out on the products produced (learning tools and videos).

## RESULTS AND DISCUSSION

The performance results from the initiation stage which is an analysis of the need to strengthen STEM learning shows that there is an urgent need for Science and Mathematics teachers to strengthen STEM learning at MTs Muhammadiyah 1 Malang. This indication of an urgent need is reflected in the results of identifying understanding, skills and attitudes towards STEM that are still not in line with expectations.

FGDs have been carried out with science and mathematics teachers focused on 10 aspects, namely (1) understanding of STEM as content and STEM as a process; (2) The position of the problem in STEM; (3) His understanding of process design engineering (EDP); (4) The educative meaning contained in STEM; (5) The reasons for the importance of STEM learning; (6) STEM learning principles; (7) How to design STEM learning; (8) Utilization of PBL and PjBL learning models in STEM learning; (9) Obstacles encountered in STEM learning, and (10) How to overcome the obstacles encountered. FGD conclusions as presented in Table 1. Documentation of this activity as presented in Figure 1.

**Table 1.** Program Initiation Results

| No | Aspects of Initiation | Initiation Report |
|---|---|---|
| 1 | STEM content | Just an acronym: science, technology, engineering, and mathematics |
| 2 | The status of the problem in STEM | Problem is formulated after content integration |
| 3 | STEM process (engineering process design/EDP) | Not much is known and tends to be ignored |
| 4 | The educational meaning | Unknown |
| 5 | contained in STEM | Less known |
| 6 | The reasons for the importance of STEM learning | Unknown, Conventional, Lecture |
| 7 | STEM learning principles | Conventional |
| 8 | How to design STEM learning | Conventional |
| 9 | Utilization of PBL and PjBL learning models in STEM learning | Limited knowledge, skills and appreciation of STEM |
| 10 | Obstacles encountered in STEM learning, | Not yet known |

**Figure 1.** Focus group discussion activities

The FGD report shows that all science and mathematics teachers at MTs Muhammadiyah 1 Malang have never received STEM learning training. If they are familiar with STEM, this is obtained through reading independently from the news or from research journals. The teachers stated that their knowledge of STEM was still limited to the acronyms, namely science, technology, engineering and mathematics. As for the essence of the acronym, moreover, the educational benefits of each of these contents are not yet known in depth.

STEM learning has been perceived as important learning for students in schools. This opinion applies to all science and mathematics teachers at MTs Muhammadiyah Tlogomas. All teachers stated that STEM was important even though they could not state the reasons why STEM was important to be taught. The link between STEM and the need to meet the demands of 21st century skills which include STEM literacy, 4C (critical thinking, creative thinking, collaborative and communicative skills), future career development of students, responses to VUCA, have not been considered as reasons for the importance of STEM learning. Learning principles which include students active learning, discovery, inquiry, collaborative, problem-based learning and project-based learning have not been perceived as STEM learning principles. Therefore, conventional learning such as lectures or discussions or assignments for teachers has been accepted as true STEM learning, simple understanding, and this is still not correct which needs to be reviewed and redirected to the right conception. Therefore, some teachers experience difficulties when getting the task of designing this STEM learning tool. Designing STEM learning is the same as designing non-STEM learning, so there is no visible integration between content in STEM and STEM processes. The use of PBL and PjBL learning models has been known as a model that is commonly used in STEM learning. However, teachers at MTs Muhammadiyah 1 still encounter various obstacles in designing correct PBL and PjBL steps.

The obstacles in STEM learning according to the teachers lie in the difficulties in designing STEM learning tools, implementing STEM material integration, and compiling the STEM learning process according to EDP. This obstacle stems from his limited knowledge of STEM, skills in developing STEM learning designs and his very minimal experience in STEM learning. According to teachers, how to overcome the problems encountered in STEM learning is the need to increase understanding of STEM, increase skills in designing STEM learning and increase appreciation of STEM learning. Increasing understanding, skills and appreciation of STEM should be done through education or training or courses about STEM so that all things related to STEM can be understood holistically, experienced practically and optimally appreciated.

To increase teachers' perceptions of the STEM approach and its implementation, it is hoped that there will be more intensive training and outreach so that teachers understand the STEM approach (Romadlon, 2020). STEM training for teachers in preparing and managing the learning process in class to educate students needs to be done. Through STEM training, teachers can understand, integrate, and apply the STEM approach in integrative thematic learning and the ability to prepare lesson plans is also better and of better quality (Wicaksono et al., 2022).

The results of the implementation of the 2nd stage activities, namely the discussion of how to meet the requirements to be able to carry out STEM learning properly and correctly show several teacher statements (Figure 2). The teacher states the need for deepening steps towards STEM concept material and processes, preparing STEM learning tools by implementing the Project Based Learning (PjBL) model, carrying out STEM learning openly (open lesson), followed by reflection, and implementing evaluation of STEM learning, both in relation to assessment as learning, assessment for learning and assessment of learning.

**Figure 2.** Documentation of discussion activities regarding STEM

Professional teachers, both the opinion of education experts and according to the government can be characterized that a professional teacher must at least fulfill his/her co-professional competence as a teacher. One of them is competence in planning, implementing, and evaluating the learning process. Teacher Competency Standards are a statement regarding the required criteria, set out in the form of mastery of a set of abilities which include knowledge, attitudes, values and skills for an educational staff so that they deserve to be called competent. STEM involves four components of content knowledge, process, context and attitude as three dimensions of competence, so STEM also involves cross cutting concepts, core ideas of four disciplines, scientific and engineering practice as contexts to support competence in STEM (Romadlon, 2020). Teachers play an important role in drafting ideas for teacher professionalism development programs, especially STEM. The program meets teachers' needs in terms of content and pedagogical knowledge to implement STEM-based learning in the classroom (I. K. Wati et al., 2021).

The results of the implementation of the 3rd stage activities, namely the preparation of an action plan and the implementation (implementation) of the action, the lecturer and teacher agreed on material deepening activities which were carried out through socialization and equalization of perceptions. This is related to the basic STEM concept material, STEM processes, the preparation of STEM learning tools, the PjBL model in STEM, the preparation of STEM teaching materials, the preparation of STEM-based student worksheets, the preparation of STEM Media, and the preparation of evaluation tools in STEM learning. After the material deepening activities, it was agreed that next the teachers need to follow up by compiling STEM learning tools and carrying out STEM learning practices in an open (open class) followed by reflection and making learning videos.

The teacher's understanding must really be implemented in the form of STEM practice. The application of learning is a process or method carried out by educators to students who are aware of making changes in behavior that are carried out by practice and the application of scientific concepts which are carried out repeatedly to bring out the expected skills. The application of learning is a process or method that is carried out by educators to students who are aware in order to make changes in behavior carried out by practice and the application of scientific concepts which are carried out repeatedly to bring out the expected skills (Anjarsari, 2019).

The results of the deepening of the material show that science and mathematics teachers experience changes in their understanding of the basic concepts of STEM, STEM processes and other things compared to before the deepening. This is as shown in Table 2.

Table 2. Results of Deepening STEM Materials

| No | Aspects of Initiation | After STEM depart |
|---|---|---|
| 1 | STEM content | Each component has a deep educative meaning |
| 2 | The status of the problem in STEM | formation of children's personality (KAP) |
| 3 | STEM process (engineering process design/EDP) | Problems can be exported before integration |
| 4 | The educational meaning | Content, the role of problems is very important as an entry point in STEM learning |
| 5 | contained in STEM | Understood as an engineering process and a major part of STEM |
| 6 | The reasons for the importance of STEM learning | Recognized and appreciated |
| 7 | STEM learning principles | Reasons for the demand for 21st century life skills, 21st century literacy |
| 8 | How to design STEM learning | SAL, Inquiry-Decovery, Problem-Based, Project-Based, Collaborative |
| 9 | Utilization of PBL and PjBL learning models in STEM learning | Instructional Analysis, Crosscutting, designs using the recommended model for STEM |
| 10 | Obstacles encountered in STEM learning, | The PBL, PjBL and 5E Cycle models are used as steps in STEM learning |

From Table 2 it can be seen that there have been positive changes towards increasing understanding of STEM learning. STEM content consisting of Science, Technology, Engineering and Mathematics has been understood as "having an educational meaning in the formation of a child's personality". The position of the problem in STEM is understood as a start so that it can be explored at the beginning before integrating content, the role of the problem is very important as an entry point in STEM learning. Teachers already understand how to design STEM learning, namely by conducting instructional analysis, cross cutting between content and implementing recommended learning models for STEM, such as PjBL.

Based on the results of the deepening of the material shown by the teacher's understanding of STEM in Table 2, it can be continued with the next activity, namely the preparation of STEM learning tools and the implementation of STEM learning. A review of STEM learning tools compiled by science teachers found several facts. The facts found include, (a) The content of the learning plan consists of basic competencies, objectives, learning steps, tools and materials, and student worksheets; (b) The chosen learning model is PjBL-STEM; (c) Syntax: Reflection, Research, Discover, Applicationn, Communication; (d) Student worksheets consist of Reflection, tools and materials, instructions for designing purification equipment, and communicating (presentation), and (e) Not equipped with teaching and evaluation materials. A review of STEM learning tools compiled by Mathematics teachers found several facts. The facts found include: (a) The content of the learning plan consists of basic competencies, objectives, learning steps, tools and materials, and student worksheets, (b). The learning model chosen by PjBL-STEM, (c). Syntax: Reflection, Research, Discover, Application, and Communication, (d). The student worksheet consists of Reflection, tools and materials, instructions for designing purification equipment, communicated (presented), and (e) Not equipped with teaching and evaluation materials.

The suggestions made based on these findings are: (a) The content of the STEM quartet is not yet apparent, (b) This water purification is an engineering (solution to the problem of clean water needs), then what are the aspects of science, technology, and mathematics? (c). Are teaching materials not needed (quartet integration, or separation/stay alone)? (d). Is there no need for evaluation information, at least in the form of a grid? (e) How is the Research and Discover mechanism planned for water purification and biopore production? (f). Student worksheets only guide student work at the Reflection stage, then are asked to carry out activities to design equipment and communicate results. What about the research and discovery steps? Just skip it? Is it not necessary to prepare a student worksheet? If needed, what is the student worksheet like? (g) The characteristics of STEM apart from the quartet content and the EDP process are the learning that implements a collaborative model, how is this collaborative learning designed? (h) Does learning in a group setting (physically) represent collaborative? What if there is no learning process in the group, meaning that the group does not interact and learn from each other, and (i). Is it not necessary to work in a group setting so that work productivity and responsibility for group work are formed?

Based on the results of observations in STEM learning, follow-up is needed to prepare them to become innovative teachers in implementing STEM. These recommendations relate to efforts to increase understanding, skills, and attitudes towards STEM learning. The service team has taken the right policy in managing the learning program by integrating STEM learning. The step of setting a period for compiling a 3rd learning tool that is fully STEM-based is a strategic step that deserves appreciation. This step begins with socialization and STEM learning workshops which are attended by all science and mathematics teachers at MTs Muhammadiyah 1 Malang. Specifically, lecturers and teachers receive STEM learning enrichment at a later time with the aim of being able to provide complete guidance to students, starting from the

preparation of STEM learning plans, learning designs (using issues as STEM entry points), teaching materials, media, learning models, up to the evaluation.

In developing STEM literacy, the role of the teacher is very important. Teacher behavior that is influenced by individual, social, environmental, and policies has an impact on teacher decisions about the pedagogical approach to be adopted in learning. The teacher's perception of a lesson is an important component of content and pedagogical knowledge. Teachers who have negative perceptions and attitudes towards STEM tend to avoid STEM-oriented learning. To develop STEM literacy there are four aspects that must be considered by the curriculum and teachers. First, the STEM field cannot be viewed as a separate field of study. STEM must be seen as a meta-discipline which is the integration of fields of study into one unified whole. Second, content and pedagogy must be mixed. Attitudes, views, self-confidence and motivation of students must be considered. Fourth, students must be fully involved in STEM-oriented learning effectively and efficiently (Afifah & Qomaria, 2018).

Several efforts can be made to become a solution so that the STEM-based learning process can run. one of the related studies revealed that efforts that could be made include the authorities in the field of education need to build awareness for teachers about the importance of STEM, provide training so that teachers have the expertise to teach STEM-based learning and also provide adequate facilities so that the learning process takes place as expected. Teachers must also be assisted by preparing training to develop professionalism, pedagogical abilities and the ability to understand the curriculum so that they are really ready to implement STEM) because so far teachers have also been seen doubting whether they are able or not to apply STEM in learning. Furthermore, to overcome problems related to facilities and costs, teachers are expected to be able to modify STEM learning so that it can be applied according to existing conditions. The enthusiasm of teachers to develop STEM-based learning can also be seen from the development of learning media that has been running to date, including STEM-based student books, STEM-based student worksheets, and STEM-based modules (Diana & Turmudi, 2021).

This community service activity in the form of teacher assistance related to STEM learning supports efforts to achieve the SDGs in the field of education. The development of scientific literacy is related to the application of STEM (Aswirna et al., 2022). Implementation of STEM in the classroom by teachers can encourage students to learn and gain knowledge on their own through self-study. They can share information, experiences with friends in groups and others. Then they can help and solve problems for learning together. In addition, students can create their innovations for the SDGs until they gain full competition. They get motivation and inspiration to learn with STEM Project. They will be able to see the value in themselves and in others (Kanjanapan et al., 2021).

## CONCLUSION

Strengthening teachers in STEM learning shows significant changes, between before and after the service program. Exciting changes have occurred in various important aspects of STEM learning, and in various domains (cognitive, affective and psychomotor). There are at least 10 aspects that have experienced positive changes as a sign of strengthening Science and Mathematics teachers in welcoming and developing STEM learning. The ten aspects are: (1) Understanding of STEM as content and STEM as a process, (2) Position of problems in STEM, (3) They understanding of process design engineering (EDP), (4) The educational meaning contained in STEM, (5) The reasons for the importance of STEM learning, (6) The principles of STEM learning, (7) How to design STEM learning, (8) Utilization of the PjBL learning model in STEM learning, (9) Obstacles encountered in STEM learning, and (10) How to overcome the obstacles encountered. On the basis of the good experience gained in overseeing STEM learning for PPG students, it is recommended that the policy of making STEM an integral part in preparing professional teachers can be expanded, not only in Science and Mathematics, but also in other fields of study. This is necessary so that the spread of STEM can be immediately expanded to all schools at various levels.

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## REFERENCES

Afifah, A., & Qomaria, N. (2018). Persepsi calon guru IPA dan Matematika terhadap pembelajaran berorientasi STEM. *Science Education National Coenference*, 266–275. https://journal.trunojoyo.ac.id/nser/article/view/4840

Alexander, R., & Fry, A. (2016). Practicing What We Teach : Iterative Design Methods for Innovation Education. *Fifth 21st CAF Conference in Harvard, Boston, USA*, *11*(1), 1–15.

Amran, A., Jasin, I., Perkasa, M., Satriawan, M., Irwansyah, M., & Erwanto, D. (2020). Implementation of education for sustainable development to enhance Indonesian golden generation character. *Journal of Physics: Conference Series*, *1521*(4), 1–5. https://doi.org/10.1088/1742-6596/1521/4/042102

Anjarsari, N. (2019). *Kesiapan guru terhadap penerapan pembelajaran STEM (science, technology, engineering, mathematics) (Survei pada guru TK se Kecamatan Gunungpati Kota Semarang)*. Universitas Negeri Semarang.

Arifin, B., Listiana, A., Dwi Arumsari, A., Alimudin, A., & Wiwoho Widjanarko, S. (2017). Introduction of Sustainable Development toward Early Childhood Education in Indonesia. *Advances in Social Science, Education and Humanities Research (ASSEHR)*, *58*, 112–116. https://doi.org/10.2991/icece-16.2017.18

Arifudin, R., Setiawan, A., Abidin, Z., & Efrilianda, D. A. (2022). Pembelajaran STEM Berbasis Robotika Sederhana bagi Guru Sekolah Dasar di Karimunjawa. *Abdimasku*, *5*(3), 570–578.

Aswirna, P., Kiswanda, V., Nurhasnah, & Fahmi, R. (2022). Implementation of STEM E-Module with SDGs Principle to Improve Science Literacy and Environment-friendly Attitudes in Terms of Gender. *JTK: Jurnal Tadris Kimiya*, *7*(1), 64–77. http://journal.uinsgd.ac.id/index.php/tadris-kimiya/article/view/16599

Aykan, A., & Yıldırım, B. (2022). The Integration of a Lesson Study Model into Distance STEM Education during the COVID-19 Pandemic: Teachers' Views and Practice. *Technology, Knowledge and Learning*, *27*(2), 609–637. https://doi.org/10.1007/s10758-021-09564-9

Campfens, H. (2019). *Community Development Around the World: Practice, Theory, Research, Training* (H. Campfens (ed.)). University of Toronto Press.

Diana, N., & Turmudi, T. (2021). Kesiapan Guru dalam Mengembangkan Modul Berbasis STEM untuk Mendukung Pembelajaran di Abad 21. *Edumatica: Jurnal Pendidikan Matematika*, *11*(2), 1–8. https://doi.org/10.22437/edumatica.v11i02.11720

English, L. D. (2016). STEM education K-12: perspectives on integration. *International Journal of STEM Education*, *3*(1), 1–8. https://doi.org/10.1186/s40594-016-0036-1

Falentina, C. T., Lidinillah, D. A. M., & Mulyana, E. H. (2018). Mobil Bertenaga Angin : Media Berbasis STEM untuk Siswa Kelas IV Sekolah Dasar. *Pedadidaktika: Jurnal Ilmiah Pendidikan Guru Sekolah Dasar*, *5*(3), 152–162. http://ejournal.upi.edu/index.php/pedadidaktika/index

Hindun, I., Nurwidodo, N., Wahyono, P., Miharja, F. J., & Rais, A. (2019). Implementation of lesson study for learning community (LSLC): Impact on piloting school teachers in Batu City. *9th International Conference on Lesson Study*, 204–211.

Hindun, I., Nurwidodo, Wahyono, P., Miharja, F. J., & Rais, A. (2018). Implementation of lesson study for learning community (LSLC) impact on piloting school teachers in Batu City. *International Conference on Lesson Study*, 204–211. https://onesearch.id/Record/IOS4109.44395

Kandaga, T., Dahlan, T., Gardenia, N., Darta, & Saputra, J. (2021). A lesson study to foster prospective teachers' disposition in STEM education. *Journal of Physics: Conference Series*, *1806*(1), 1–7. https://doi.org/10.1088/1742-6596/1806/1/012107

Kanjanapan, T., Hemman, A., Rattanaburee, N., Nauldum, N., Kongkanon, S., & Ruamcharoen, J. (2021). STEM Project Approach to the Topic of Sustainable Development Goals Through Online Meeting on Students' Self-regulation. *2021 2nd SEA-STEM International Conference (SEA-STEM)*, 119–123. https://doi.org/10.1109/SEA-STEM53614.2021.9668099

Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education*, *3*(1). https://doi.org/10.1186/s40594-016-0046-z

Lestari, E. T., Bahri, S., & Rivasintha, E. (2022). International Journal of Social Science And Human Research Teaching Campus Project Batch 3 in Strengthening the Profile of Pancasila Students (Case Study at State Elementary School 14 Pontianak Kota). *International Journal of Social Science And Human Research*, *5*(12), 5817–5825. https://doi.org/10.47191/ijsshr/v5-i12-65

Listyaningsih, L., Alrianingrum, S., & Sumarno, S. (2021). Preparing Independent Golden Millennial Generation Through Character Education. *Proceedings of the 2nd Annual Conference on Education and Social Science (ACCESS 2020)*, *556*(Access 2020), 162–167. https://doi.org/10.2991/assehr.k.210525.066

Malik, R. S. (2018). Educational challenges in 21St century and sustainable development. *Journal of Sustainable Development Education and Research*, *2*(1), 10–20. https://doi.org/10.17509/jsder.v2i1.12266

Miharja, F. J., Nurwidodo, N., Wahyuningrum, L., Iffah, A. H., & Eskasasnanda, I. D. P. (2020). Tokkatsu: Initiating students' collaborative activities in lesson study piloting school. *Jurnal Pendidikan Progresif*, *10*(1), 63–72. https://doi.org/10.23960/jpp.v10.i1.202008

Nasir, R., Ucok Manigor Jokkas Siahaan, Manto Lumban Gaol, Ni Made Intan Kertiani, & Churun Lu'lu'il Maknun. (2022). Pengabdian Kepada Masyarakat Melalui Workshop Peningkatan Pemahaman Guru Mengenai Pembelajaran Berbasis STEAM. *Rengganis Jurnal Pengabdian Masyarakat*, *2*(1), 55–68. https://doi.org/10.29303/rengganis.v2i1.161

Nugraheni, F. S. A., Wati, I. K., Sari, M. W., Suciati, S., Widyastuti, A., & Kamaliah, K. (2022). Pelatihan Pembuatan Perangkat Pembelajaran Berbasis Etno-STEM pada Mata Pelajaran IPA di Sekolah Menengah Pertama. *Jurnal Pengabdian Masyarakat Indonesia*, *2*(4), 357–365. https://doi.org/10.52436/1.jpmi.440

Nurwidodo, N., Hendayana, S., Hindun, I., & Sarimanah, E. (2018). Strategies for establishing networking with partner schools for implementing lesson study in Indonesia. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *4*(1), 11–22.

https://doi.org/10.22219/jpbi.v4i1.5489 11

Priyani, N. E., & Nawawi, N. (2020). Pembelajaran Ipa Berbasis Ethno-Stem Berbantu Mikroskop Digital Untuk Meningkatkan Keterampilan Proses Sains Di Sekolah Perbatasan. *WASIS : Jurnal Ilmiah Pendidikan*, *1*(2), 99–104. https://doi.org/10.24176/wasis.v1i2.5435

Rodrigues, M. F., & Simoes, F. (2021). Student representation promoting transversal competencies and a dynamic academia. *The 4th International Conference of the Portuguese Society for Engineering Education*, *June*, 21–23.

Rokhman, F., Hum, M., Syaifudin, A., & Yuliati. (2014). Character Education for Golden Generation 2045 (National Character Building for Indonesian Golden Years). *Procedia - Social and Behavioral Sciences*, *141*, 1161–1165. https://doi.org/10.1016/j.sbspro.2014.05.197

Romadlon, R. (2020). Meningkatkan Kemampuan Guru dalam Menerapkan Model Pembelajaran Stem Melalui Workshop di Sekolah Dasar Negeri 86/X Harapan Makmur Tahun 2019/2020. *Jurnal Ilmiah Dikdaya*, *10*(1), 102–106. https://doi.org/10.33087/dikdaya.v10i1.164

Rotty, V. N. J., Kainde, Q., Pitoy, J. I., Grace, L., & Punuh, L. (2022). "Sekolah Penggerak" and Centers of Excellence. *International Journal of Information Technology and Education (IJITE)*, *1*(4), 111–138.

Setiawan, N. C. E., Sutrisno, S., Munzil, M., & Danar, D. (2020). Pengenalan STEM (Science, Technology, Engineering, and Mathematics) dan Pengembangan Rancangan Pembelajarannya untuk Merintis Pembelajaran Kimia dengan Sistem SKS di Kota Madiun. *Lumbung Inovasi: Jurnal Pengabdian Kepada Masyarakat*, *5*(2), 56. https://doi.org/10.36312/linov.v5i2.465

Shaturaev, J. (2021). 2045 : Path to nation's golden age (Indonesia Policies and Management of Education). *Science and Education*, *2*(12), 866–875.

Sihaloho, L., Arianti, J., & Siahaan, R. L. M. (2017). The Development of Good Quality Education and Evenly Spread Learning Opportunities as One of The Sustainable Development Goals (SDGs) in Indonesia. *International Conference on Education, Research and Innovation May*, *May 2017*, 189–194.

Sukmana, R. W., & Nurhayati, Y. (2019). Pengabdian kepada Masyarakat Pembelajaran Berbasis STEM Bagi Guru - Guru Sekolah Dasar di Kabupaten Bandung. *Jurnal Pengabdian Tri Bhakti*, *1*(1), 1–4. https://doi.org/10.36555/tribhakti.v1i1.1345

Sulistyaningsih, D., & Purnomo, E. A. (2021). *Model pembelajaran blended learning berbasis STEM* (D. Sulistyaningsih (ed.)). Penerbit Unimus Press.

Wati, D., Oktavia, B., & Yerimadesi. (2020). The Effect of STEM-Based Learning in Lesson Study to Improve Students Learning Outcomes under Chemical Equipment Material. *International Journal of Progressive Sciences and Technologies (IJPSAT)*, *20*(1), 273–276. http://ijpsat.ijsht-journals.org

Wati, I. K., Suciati, S., Sari, M. W., & Nugraheni, F. S. A. (2021). Persepsi Guru IPA Terhadap Pembelajaran STEM. *SPEKTRA: Jurnal Kajian Pendidikan Sains*, *7*(2), 92–102. https://doi.org/10.32699/spektra.v7i2.203

Wicaksono, A. G., Jumanto, J., & Hanafi, M. F. (2022). Pelatihan Penerapan Pendekatan Stem Dalam Pembelajaran Tematik Integratif Bagi Guru Sekolah Dasar Islam Di Surakarta. *Diseminasi: Jurnal Pengabdian Kepada Masyarakat*, *4*(1), 105–112. https://doi.org/10.33830/diseminasiabdimas.v4i1.1961

Yakuti, N., Makmuri, M., & Sumiharsono, M. R. (2021). Perbedaan Antara Metode Stem Dan Metode Discovery Learning Terhadap Hasil Uji Kompetensi Keahlian Siswa Pada Perawatan Berkala Mobil Di Smk Negeri 3 Bondowoso. *Journal of Education Technology and Inovation*, *4*(1), 65–75. https://doi.org/10.31537/jeti.v3i1.592