STEAM (SCIENCE, TECHNOLOGY, ENGINEERING, ARTS AND MATHEMATICS) LEARNING IN 21ST CENTURY INNOVATIVE LEARNING TO SUPPORT STUDENT COMPETENCIES IN SCIENCE SUBJECTS IN ELEMENTARY SCHOOLS

B. Nuraulia Rahmanita, Siti Fatonah
UIN Sunan Kalijaga Yogyakarta
bnurauliarahmanita@gmail.com, siti.fatonah1@uin-suka.ac.id

Abstract: The 21st century is also known as the age of knowledge, which is an alternative effort to meet the needs of life in a variety of more knowledge-based contexts. One of the demands of 21st century learning is the integration of technology as a learning medium to develop learning skills. Innovative learning is a learning program that directly solves problems facing the classroom based on classroom conditions. One of the advances in education in Indonesia that is proven to develop humans who are able to build a science and technology-based economy is STEAM (Science, Technology, Engineering, Arts and Mathematics) learning. This research is a descriptive qualitative research that aims to obtain information about innovative learning in science subjects carried out in Madrasah Ibtidaiyah Negeri 3 Mataram. Data collection techniques are carried out by triangulation (combined), data analysis is inductive / qualitative. The subject of the study.

Keywords: STEAM, Innovative, 21st Century, Student Competence, Science, Elementary School.

INTRODUCTION

21st century learning is learning that prepares the 21st century generation where advances in Information and Communication Technology (ICT) that are growing so quickly have an influence on aspects of life including in the teaching process. One example of advances in Information and Communication Technology has an influence on the learning process is that students are given opportunities and are required to be able to develop their skills in mastering information and communication technology - especially computers, so that

students have the ability to use technology in the learning process with the aim of achieving students' thinking and learning skills.[1]

The 21st century learning system is a learning transition where the curriculum developed today requires schools to change the educator-centered learning approach to a learner-centered learning approach. Thus the demands of the future world where learners are required to have thinking and learning skills. These skills that must be possessed include problem-solving, critical thinking, collaboration, and communication skills. All these skills are expected to be possessed by students if educators are able to develop lesson plans that contain activities that challenge students to think critically in solving problems. Activities that encourage students to work together and communicate must be reflected in every lesson plan they make. Learner-centered learning is different from learning that revolves around educators, character.[2]

English, which is the official language of the countries of the world, art, mathematics, economics, natural science, geography, history, government, and citizenship are topics of the 21st century. However, contemporary themes include knowledge of finance, economics, business, and entrepreneurship, global awareness, knowledge of health, and knowledge of the environment.[3] Regarding learning objectives, Bloom's taxonomy refers to the dimensions of knowledge and cognitive processes: factual, coceptual, procedural, and metacognitive. Cognitive processes consist of; remember, understand, apply, analyze, evaluate and create.[4] P21 (Partnership for 21st Century Learning) develops a 21st century learning framework that requires learners to have skills, knowledge and abilities in the fields of technology, media and information, learning and innovation skills, as well as life skills and homework.[5]

Innovative learning is a learning program that directly solves classroom problems based on classroom conditions. Learning programs, in turn, encourage efforts to improve the overall quality of schools (Kaharudin and Hajeniati 2020). Learning model innovation is widely discussed in the world of education because it is very necessary, especially in the creation of new learning models that can

---

[1] Iim Halimatul Mu'minah, "Studi Literatur: Pembelajaran Abad-21 Melalui Pendekatan Steam (Science, Technology, Engineering, Art, and Mathematics) Dalam Menyongsong Era Society 5.0," *Prosiding Seminar Nasional Pendidikan* 3 (2021): 584–94.

[2] Mu'minah.

[3] Hadisaputra, 2018.

[4] E P I Hifmi Baroya, "Strategi Pembelajaran Abad 21 - Lpmp Jogja," *Jurnal Lembaga Penjaminan Mutu Pendidikan Prov. DIYogyakarta* I, no. 01 (2018): 101–15.

[5] Estetika Yuni Wijaya, Dwi Agus Sudjimat, and Amat Nyoto, "Transformasi Pendidikan Abad 21 Sebagai Tuntutan Pengembangan Sumber Daya Manusia Di Era Global," *Prosiding Seminar Nasional Pendidikan Matematika* 1 (2016): 263–78.

provide better learning outcomes and increase the effectiveness and efficiency of learning to renewal.[6]

Every curriculum change implemented by the government follows the development of students' abilities in technology education to capture the nation's generation who are ready, reliable and able to face the era of globalization. One of the advances in Indonesian education that is proven to produce humans who are able to build a science and technology-based economy is STEAM (Science, Technology, Engineering, Arts and Mathematics) learning.[7]

Students are expected to be able to master 21st century skills, so that they can face all complex challenges, efforts to achieve that by applying STEAM-based learning. Learning using STEAM is a combination of STEM (Science, Technology, Engineering and Mathematics) by adding elements of art which includes design, creativity and innovation. STEAM is very suitable to be applied in learning the 2013 curriculum with a thematic that integrates several subjects.[8] Integrating STEAM elements into learning can encourage students to seek connections with each other. The STEAM approach moves students in a range of skills such as: B. Problem-solving, critical thinking and collaborative skills.[9]

By engaging students in STEAM learning, the aim is to stimulate children's interest and love of science and art. STEAM is a creative process, and no one uses only one method of discovery and exploration. Proper learning to prepare students to become innovators in an ever-evolving world is essential not only for students but also for the future of the nation.[10] These 21st-century skills include critical thinking and problem-solving, creativity and innovation, communication, and collaboration.

---

[6] Restu Rahayu, Sofyan Iskandar, and Yunus Abidin, "Inovasi Pembelajaran Abad 21 Dan Penerapannya Di Indonesia," *Jurnal Basicedu* 6, no. 2 (2022): 2099–2104, https://doi.org/10.31004/basicedu.v6i2.2082.

[7] Sevi Lestari, "Pengembangan Model Pembelajaran Berbasis STEAM Sebagai Solusi Dari Tantangan IPTEK Dalam Dunia Pendidikan," *Jurnal Pendidikan Dan Konseling* 4 (2022): 1349–58.

[8] I Priantari et al., "Improving Student Critical Thinking Trough STEAM-PjBL Learning," *Bioeducation Journal* 4, no. 2 (2020): 95–103.

[9] I R W Atmojo, "Implementasi Pembelajaran Berbasis Science, Technology, Engenering, Art And Mathematich (STEAM) Untuk Meningkatkan Kompetensi Paedagogik Dan ...," *Jurnal Pendidikan Dasar*, 2020, 119–23.

[10] Siti Zubaidah, "STEAM (Science, Technology, Engineering, Arts, and Mathematics): Pembelajaran Untuk Memberdayakan Keterampilan Abad Ke-21," *Seminar Nasional Matematika Dan Sains*, no. September (2019): 1–18.

The development of these 21st century skills can be done in all disciplines. Science lesson content is perfect for developing 21st century skills. The competencies and survival skills needed by students in facing life, the world of work, and citizenship in the 21st century are emphasized in seven, namely the ability to think critically and solve problems, collaboration and leadership, agility and adaptability, initiative and entrepreneurial spirit, able to communicate effectively both orally and in writing, able to access and analyze information, and have curiosity and imagination skills. Based on the results of research conducted by the OECD obtained a description of the three dimensions of learning in the 21st century information, communication and ethics and social influence.[11]

Teachers are expected to innovate and create a learning atmosphere that is in accordance with the needs of the 21st century, where students not only receive information from teachers but are also encouraged to actively participate in learning activities including in the Science Lesson itself. STEAM is an innovative learning model that allows students to master five areas in addition to one, namely: Science, Technology, Engineering, Arts and Mathematics.

RESEARCH METHODS

This research is a qualitative research of focused interviews that aims to obtain information about innovative learning in science lessons conducted at Madrasah Ibtidiiyah 3 mataram in Lombok, West Nusa Tenggara. Qualitative research methods are used to examine the condition of natural objects, data collection techniques are carried out through structured interviews, triangulation (combined) data analysis is inductive / qualitative and qualitative research results emphasize the meaning of generalization.[12]

This research was conducted in one of the State Madrasah Ibtidaiyah in Mataram. The subject of this study was a grade IV teacher of Madrasah Ibtidaiyah Negeri 3 in Mataram for the 2022/2023 academic year. Data collection was conducted through open interviews with grade IV teachers of Madrasah Ibtidaiyah Negeri 3 Mataram.

21st Century Innovative Learning

The development of the human era is asked to create new innovations, as well as in the world of education. Teachers are required to be able to create

[11] Nanik Rahmawati, "Analisis Kebutuhan Media Dan Bahan Ajar Berbasis Augmented Reality Dalam Pembelajaran Ipa Pendekatan STEAM Keterampilan Abad 21 Guru Sekolah Dasar" 3, no. 4 (2016): 1–23.

[12] Sugiyono, *Metode Penelitian Kualitatif, Kuantitatif Dan R&D* (Alfabeta, 2019).

learning innovations where students are asked to be active in learning activities and not only obtain material through teachers. Students are also expected to think critically. As expressed by Mr. "I" as follows:

> "Innovative learning is learning that is oriented towards the application of strategies, methods and learning models in the implementation of learning that aims to help solve a problem that occurs in the implementation of learning in the classroom. As well as striving to improve skills, innovation and creativity in students"

Everett M. Rogers argued that innovation is ideas, ideas, objects, and practices that are based on a particular person or group and accepted as something new, applied, and adopted by them.[13] Innovative learning is teacher-designed learning that is new than usual and aims to facilitate students to build their own knowledge in the process of changing behavior for the better according to the abilities and differences students have.[14]

Innovative learning also includes learning compiled by teachers or other instructors which are new ideas or techniques to facilitate students to gain progress in learning processes and outcomes. Innovative learning can be adapted from fun learning models. "Learning is fun" is key to innovative learning.[15]

The objectives of innovative learning are as follows:

a. Provide facilities for students to be able to think for themselves in order to change for the better.
b. Help find, test, and compile data necessary for scientific purposes.
c. Support the teaching and learning process so that the learning implementation process is carried out as well as possible.
d. The learning process can be done in a fun and motivated way, so that the learning material is easier for students to understand.

Encourage the learning process with good results so that learning objectives are achieved. In innovative learning in the 21st century, students are asked to be active in learning activities. 21st Century Skills is usually used as a reference in the competencies that students must achieve in learning activities such as critical thinking skills, the use of technology, problem solving and

[13] Andi Kaharudin and Nining Hajeniati, *Pembelajaran Inovatif Dan Variatif*, 2020.

[14] Yose Indarta et al., "21st Century Skills : TVET Dan Tantangan Abad 21," *Edukatif : Jurnal Ilmu Pendidikan* 3, no. 6 (2021): 4340–48, https://doi.org/10.31004/edukatif.v3i6.1458.

[15] Mifullah Shofiul, "Konsep Teori Media Pembelajaran Inovatif," *Universitas Muhammadiyah Sidoarjo, 2018.* 1, no. 1 (2018): 10–17.

communication and collaboration which at this time must be carried out in schools in classroom learning activities [16]. 21st century skills are considered a necessity in the digital era like today so that the skills needed to be possessed in this digital era include the ability to think critically, use technology, problem solving, and communication and collaboration are mentioned as competencies of 21st century students.[17]

From some existing opinions, we can know that in innovative learning in the 21st century students are asked to be active in learning activities so that later students have skills such as being able to think critically, being able to use and utilize existing technology, being able to solve problems and being able to communicate and collaborate during learning activities.

STEAM Approach in Supporting 21st Century Student Competencies in Science Subjects

Learning using STEAM in 21st Century Learning, especially in science lessons, directly provides students with experience about:

a) Science

Science learning in schools for students focuses on learning about themselves, the environment and natural phenomena. Benefits of science learning in students to:

1) Learn to explore and investigate, which is an activity to observe and investigate natural objects and phenomena.
2) Learn to develop basic science process skills, such as making observations, measuring, communicating observational results, and so on.
3) Learn to develop curiosity, pleasure and willingness to do inquiry or discovery.
4) Learn to understand knowledge about various objects both their characteristics, structures and functions. Some games or science experiments conducted in schools include: volcano erupting experiments, weathering kapok experiments, cola fountain experiments, foam experiments, floating egg experiments, floating camphor experiments without meniuo, floating camphor experiments and dancing corn experiments.

b) Technology

[16] Harlinda Syofyan and Ismail Ismail, "Pembelajaran Inovatif Dan Interaktif Dalam Pembelajaran Ipa," *Qardhul Hasan: Media Pengabdian Kepada Masyarakat* 4, no. 1 (2018): 65, https://doi.org/10.30997/qh.v4i1.1189.

[17] Budiana Dwi Kosasih and Anton Jaelani, "Desain Pembelajaran Matematika Berbasis Steam Dalam Menunjang Kompetensi Siswa Abad 21," *Semadik*, 2021.

In 21st century learning, especially in science lessons, the term technology refers to the use of equipment and developing gross motor and fine motor skills. Equipment or tools can help students to develop hand-eye coordination, as well as train and strengthen hand and finger muscles for writing, typing and drawing.

c) Engineering

Engineering is the knowledge to operate or design a problem. Or it can be said that engineering is a skill that someone has to operate or assemble something. Engineering skills for students include the ability to assemble or build a shape using various media.

d) Art

Art skills in students include recognizing and showing Various works and art activities, such as drawing, painting, with fingers, stamping, folding, playing music, expression of motion according to rhythm, designing a work, performing arts such as mini drama, singing, storytelling, and exploration with objects that can be used to produce works of art.

e) Mathematics

Math games that can be played by students include:

1) Play size and color
2) shape sorting game
3) Pattern recognition game
4) Calorie calculation of the human body.[18]

The implementation of STEAM in 21st century learning is very useful and useful, it can be known that not only cognitive aspects are developed, STEAM learning can also develop students' skill abilities to face the challenges of the globalization era in the future.

In the 21st century competence, students are expected to be able to think critically so that later they can have creativity and broad thinking. Teachers can create a supportive learning atmosphere for example using innovative models, methods, strategies or learning media. One of the learning models that can be used to encourage student creativity is the STEAM (Sciences, Technology, Engineering, Art and Mathematics) learning model. As stated by Mr. "I" as the resource person as follows:

[18] Iim Halimatul Mu'minah and Yeni Suryaningsih, "IMPLEMENTASI STEAM (SCIENCE, TECHNOLOGY, ENGINEERING, ARTS AND MATHEMATICS) DALAM PEMBELAJARAN ABAD 21," *Jurnal Bio Educatio* Vol 5, no. April (2020): 65–73.

> "STEAM (Science, Technology, Engineering, Arts, and Mathematics) is a learning approach that collaborates a set of science, technology, engineering, arts, and mathematics to help students develop their skills and abilities. The STEAM approach is also an integrated learning approach that encourages students to think more broadly about problems that occur in the real world and to help students to solve problems in science subjects."

STEAM stands for Science, Technology, Engineering, Arts and Mathematics. This method combines several disciplines that can be interpreted with each other and creates a learning method that can train students to think critically and comprehensively.[19] In addition, STEAM also includes a combination of all aspects of learning. Because the STEAM approach does not only focus on intellectual (cognitive) aspects, but also includes all aspects of attitudes (affective) and emotional (psychomotor) developed simultaneously.[20]

STEAM (Science, Technology, Engineering, Art and Mathematics) is an evolution of STEM education by adding elements of art to learning activities [21]. Learning with the help of the STEAM approach is learning related to problems that exist or commonly occur in everyday life, so it is expected that creativity, thinking skills and high curiosity from students later.[22] The STEAM approach also encourages students to be able to think and do learning in accordance with their respective abilities. Therefore, in the STEAM learning approach, students will produce a result or product that is different from their friends. Then in terms of cooperation in the form of group work, later students will carry out a collaboration and communication in one group. Such a STEAM approach aims to develop.

The 21st century learning model that develops students' soft skills is the STEAM (Science, Technology, Engineering, Arts and Mathematics) learning model, which combines Science, Technology, Engineering, Arts and Mathematics. In order for students to gain a complete understanding of the relationship between domains of expertise through learning experiences with 21st century skills, the

---

[19] Salsabilla Naura, Dita Nurdianti, and Surya Maulana, "Telaah Pengintegrasian STEAM Pada Model Problem Based Learning Terhadap Adversity Quotient Siswa Dalam Pembelajaran Matematika," *PRISMA, Prosiding Seminar …* 5 (2022): 598–605.

[20] Neni Mariana et al., "Desain Pembelajaran STEAM Dengan Media Selasi Untuk Peserta Didik Kelas II SD," *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini* 7, no. 1 (2023): 240–50, https://doi.org/10.31004/obsesi.v7i1.2809.

[21] Berliany Nuragnia, Nadiroh, and Herlina Usman, "Pembelajaran Steam Di Sekolah Dasar : Implementasi Dan Tantangan," *Jurnal Pendidikan Dan Kebudayaan* 6, no. 2 (2021): 187–97, https://doi.org/10.24832/jpnk.v6i2.2388.

[22] Kosasih and Jaelani, "Desain Pembelajaran Matematika Berbasis Steam Dalam Menunjang Kompetensi Siswa Abad 21."

learning model that uses the STEAM approach is contextual learning.[23] The purpose of STEM learning is to help students understand the concepts taught, apply them in everyday life, and explore their potential. The next development is the addition of "Art" to the STEAM program to explore students' creativity and art.[24]

Berdasarkan keterangan di atas kita mengetahui bahwa dalam pembelajaran inovatif abad 21 terdapat model pembelajaran yang dapat mendukung pengembangan *soft skill* siswa yaitu STEAM (*Science, Technology, Engineering, Arts and Mathematic*). Tujuannya agar siswa lebih muda sehingga mereka memahami konsep pembelajaran yang dapat ditindaklanjuti.

Advantages and disadvantages of STEAM learning

In the implementation of learning activities, each learning model certainly has advantages and disadvantages in learning activities, just like the STEAM learning model. As the interviewer "I" said:

> "The advantages of STEAM Learning: it can make students more able to rely on the way of thinking, students' insights become broad, students are easier to solve various problems, students are able to think critically which is the basis and provision to face the 21st century, Collaboration or cooperation can make students more effective. Disadvantages of using the STEAM approach lack of teacher understanding of STEAM learning. Students tend to have less respect for other subjects. The obstacles experienced by teachers when applying the STEAM approach are as follows: it takes a long time to solve problems, students who are weak in experimentation and information collection will have difficulties and there is a possibility of learners who are less active in group work."

Benefits of STEAM include:

a. The STEAM approach shows positive results in students' science literacy.
b. The STEAM approach teaches students to use technology to solve problems actively, creatively and innovatively. With the help of technology, students can implement their ideas in the latest technology.

[23] Sri Lestari, "Pengembangan Orientasi Keterampilan Abad 21 Pada Pembelajaran Fisika Melalui Pembelajaran PjBL-STEAM Berbantuan Spectra-Plus," *Ideguru: Jurnal Karya Ilmiah Guru* 6, no. 3 (2021): 272–79, https://doi.org/10.51169/ideguru.v6i3.243.

[24] Noni Dwi Sari and Jan Setiawan, "Papan Gekola Sebagai Media Pembelajaran Matematika Yang Inovatif Dengan Pendekatan Steam," *Jurnal Saintika Unpam : Jurnal Sains Dan Matematika Unpam* 3, no. 1 (2020): 31, https://doi.org/10.32493/jsmu.v3i1.4728.

c. The STEAM approach can blend abstract mathematical concepts with science, technology, research and art, and integrating art into STEAM encourages student creativity in developing fun learning tools.
d. The STEAM approach allows students to apply learning outcomes in everyday life.[25]

Despite the growing popularity of the STEAM approach, previous research has found several factors that hinder the use of the STEAM approach, including:

a. Teacher readiness means, as teachers often know, that lessons that integrate the STEAM approach require more knowledge.
b. Some teachers feel they don't have time to incorporate the STEAM approach into lesson plans.
c. A common misconception that integrating the STEAM approach requires expensive and high-tech materials.[26]

From the information above, we can see that each learning model has advantages and disadvantages in its implementation and in the STEAM learning model. The STEAM learning model can teach students to think actively, but some teachers feel that the STEAM learning model takes a long time. Therefore, future learning activities must be organized as well as possible in accordance with the STEAM learning model.

In the application of each learning model, it certainly has benefits that will be felt by both teachers and students as well as the benefits felt from the application of the steam learning model. As felt by Mr. "I" as the resource person:

> "In the application of the STEAM approach, there is a perceived influence on and students in the application of this approach, this is evidenced when the implementation of mathematics learning flat material is built. Where the flat material is associated with examples of objects that exist in everyday life that correspond to the flat shapes of triangles, squares, rectangles and circles".

The benefits of the STEAM approach include students understanding how to work in teams on real projects, paying attention to:

a. Students can use the knowledge and skills of different subjects to support project work. You begin to recognize the content used in real life and why it is important to know this.

[25] Emma Suganda, "Studi Meta Analisis Pendekatan Science, Technology, Engineering, Art And Mathematics (STEAM)," 2021, 79.

[26] Budi Sadarman et al., "Pelatihan Keterampilan Kreatif Ecoprint Steam Pimpinan Cabang Muhammadiyah Gedebage" 1, no. 1 (2022): 1–5.

b. Students are encouraged to recognize and appreciate their own abilities and those of others. They learn to adapt well to groups based on the roles they perform well in a collaborative environment.
c. STEAM learning can also strengthen students' cognitive abilities through meaningful learning, increase student creativity and encourage the development of students' soft skills, such as collaboration and cooperation in working groups and criticism of environmental phenomena.[27]

Based on the information above, the benefits of applying the STEAM learning model can be felt because the knowledge and skills obtained by students can be used in any subject, students are expected to evaluate their skills and improve students' cognitive abilities can increase. The STEAM learning model can improve performance in learning activities. Students can think critically and comprehensively, the learning activities carried out are not passive because students actively participate in activities.

CONCLUSION

In 21st century learning, innovative learners are challenged to actively participate in learning activities. 21st Century Skills is usually used as a reference for competencies that students must have in learning activities such as: B. Critical thinking skills, technology utilization, problem solving, and communication and collaboration which are currently mandatory to be practiced in schools in the learning process. Class The 21st century learning model that develops students' soft skills is the STEAM (Science, Technology, Engineering, Arts and Mathematics) learning model, which combines Science, Technology, Engineering, Arts and Mathematics. To enable students to truly understand the relationship between disciplines and knowledge through experiential learning with 21st century skills.

Like the STEAM learning model, the learning model also has advantages and disadvantages for its implementation. Although the STEAM learning model can teach students to think actively, some educators find the STEAM learning model too slow. Therefore, in the future it is necessary to optimally design learning activities that utilize the STEAM learning model. The benefits of applying the STEAM learning model are that the knowledge and skills obtained by students can be used in all subjects, especially science subjects, students are expected to be able to assess their skills, and their cognitive abilities can be improved.

[27] Suganda, "Studi Meta Analisis Pendekatan Science, Technology, Engineering, Art And Mathematics (STEAM)."

References:

Atmojo, I. R. W. 2020. "Implementasi Pembelajaran Berbasis Science, Technology, Engenering, Art And Mathematich (STEAM) Untuk Meningkatkan Kompetensi Paedagogik Dan ...." *Jurnal Pendidikan Dasar* 119–23.

Baroya, E. P. I. Hifmi. 2018. "Strategi Pembelajaran Abad 21 - Lpmp Jogja." *Jurnal Lembaga Penjaminan Mutu Pendidikan Prov. DIYogyakarta* I(01):101–15.

Dwi Sari, Noni, and Jan Setiawan. 2020. "Papan Gekola Sebagai Media Pembelajaran Matematika Yang Inovatif Dengan Pendekatan Steam." *Jurnal Saintika Unpam : Jurnal Sains Dan Matematika Unpam* 3(1):31. doi: 10.32493/jsmu.v3i1.4728.

Hadisaputra, Saprizal, Aliefman Hakim, Muntari, Hadiprayitno. Gito, and Muhlis. 2018. "Pelatihan Peningkatan Keterampilan Guru IPA Sebagai Role Model Abad 21 Dalam Pembelajaran IPA." *Jurnal Pendidikan Dan Pengabdian Masyarakat* 1(2):274–77.

Indarta, Yose, Nizwardi Jalinus, Rijal Abdullah, and Agariadne Dwinggo Samala. 2021. "21st Century Skills : TVET Dan Tantangan Abad 21." *Edukatif : Jurnal Ilmu Pendidikan* 3(6):4340–48. doi: 10.31004/edukatif.v3i6.1458.

Kaharudin, Andi, and Nining Hajeniati. 2020. *Pembelajaran Inovatif Dan Variatif*.

Kosasih, Budiana Dwi, and Anton Jaelani. 2021. "Desain Pembelajaran Matematika Berbasis Steam Dalam Menunjang Kompetensi Siswa Abad 21." *Semadik*.

Lestari, Sevi. 2022. "Pengembangan Model Pembelajaran Berbasis STEAM Sebagai Solusi Dari Tantangan IPTEK Dalam Dunia Pendidikan." *Jurnal Pendidikan Dan Konseling* 4:1349–58.

Lestari, Sri. 2021. "Pengembangan Orientasi Keterampilan Abad 21 Pada Pembelajaran Fisika Melalui Pembelajaran PjBL-STEAM Berbantuan Spectra-Plus." *Ideguru: Jurnal Karya Ilmiah Guru* 6(3):272–79. doi: 10.51169/ideguru.v6i3.243.

Mariana, Neni, Julianto Julianto, Heru Subrata, Khansa Iftina Balqis, Clariza Dyah Rachmadina, Veronica Herlida Kharisma Anindya, and Silvi Amaliatus Sholihah. 2023. "Desain Pembelajaran STEAM Dengan Media Selasi Untuk Peserta Didik Kelas II SD." *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini* 7(1):240–50. doi: 10.31004/obsesi.v7i1.2809.

Mu'minah, Iim Halimatul. 2021. "Studi Literatur: Pembelajaran Abad-21 Melalui Pendekatan Steam (Science, Technology, Engineering, Art, and Mathematics) Dalam Menyongsong Era Society 5.0." *Prosiding Seminar Nasional Pendidikan* 3:584–94.

Mu'minah, Iim Halimatul, and Yeni- Suryaningsih. 2020. "Implementasi Steam (Science, Technology, Engineering, Art and Mathematics) Dalam Pembelajaran Abad 21." *BIO EDUCATIO : (The Journal of Science and Biology Education)* 5(1):65–73. doi: 10.31949/be.v5i1.2105.

Mu'minah, Iim Halimatul, and Yeni Suryaningsih. 2020. "IMPLEMENTASI STEAM (SCIENCE, TECHNOLOGY, ENGINEERING, ARTS AND MATHEMATICS) DALAM PEMBELAJARAN ABAD 21." *Jurnal Bio Educatio* Vol 5(April):65–73.

Naura, Salsabilla, Dita Nurdianti, and Surya Maulana. 2022. "Telaah

Pengintegrasian STEAM Pada Model Problem Based Learning Terhadap Adversity Quotient Siswa Dalam Pembelajaran Matematika." *PRISMA, Prosiding Seminar …* 5:598–605.

Nuragnia, Berliany, Nadiroh, and Herlina Usman. 2021. "Pembelajaran Steam Di Sekolah Dasar : Implementasi Dan Tantangan." *Jurnal Pendidikan Dan Kebudayaan* 6(2):187–97. doi: 10.24832/jpnk.v6i2.2388.

Priantari, I., A. N. Prafitasari, D. R. Kusumawardhani, and S. Susanti. 2020. "Improving Student Critical Thinking Trough STEAM-PjBL Learning." *Bioeducation Journal* 4(2):95–103.

Rahayu, Restu, Sofyan Iskandar, and Yunus Abidin. 2022. "Inovasi Pembelajaran Abad 21 Dan Penerapannya Di Indonesia." *Jurnal Basicedu* 6(2):2099–2104. doi: 10.31004/basicedu.v6i2.2082.

Rahmawati, Nanik. 2016. "Analisis Kebutuhan Media Dan Bahan Ajar Berbasis Augmented Reality Dalam Pembelajaran Ipa Pendekatan STEAM Keterampilan Abad 21 Guru Sekolah Dasar." 3(4):1–23.

Sadarman, Budi, Asep Rudiyana, Tris Sudarto, and Rifqi Ali Mubarok. 2022. "Pelatihan Keterampilan Kreatif Ecoprint Steam Pimpinan Cabang Muhammadiyah Gedebage." 1(1):1–5.

Shofiul, Mifullah. 2018. "Konsep Teori Media Pembelajaran Inovatif." *Universitas Muhammadiyah Sidoarjo, 2018*. 1(1):10–17.

Suganda, Emma. 2021. "Studi Meta Analisis Pendekatan Science, Technology, Engineering, Art And Mathematics (STEAM)." 79.

Sugiyono. 2019. *Metode Penelitian Kualitatif, Kuantitatif Dan R&D*. Alfabeta.

Syofyan, Harlinda, and Ismail Ismail. 2018. "Pembelajaran Inovatif Dan Interaktif Dalam Pembelajaran Ipa." *Qardhul Hasan: Media Pengabdian Kepada Masyarakat* 4(1):65. doi: 10.30997/qh.v4i1.1189.

Wijaya, Estetika Yuni, Dwi Agus Sudjimat, and Amat Nyoto. 2016. "Transformasi Pendidikan Abad 21 Sebagai Tuntutan Pengembangan Sumber Daya Manusia Di Era Global." *Prosiding Seminar Nasional Pendidikan Matematika* 1:263–78.

Zubaidah, Siti. 2019. "STEAM (Science, Technology, Engineering, Arts, and Mathematics): Pembelajaran Untuk Memberdayakan Keterampilan Abad Ke-21." *Seminar Nasional Matematika Dan Sains* (September):1–18.