

STEAM in Education: Teacher Responses and the Implementation in English Language Teaching

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Abstract

This article aims to examine the implementation of the STEAM approach in education as seen from the teacher's response and how the teacher understands and implements it in the learning process. A qualitative approach with phenomenological design was applied in this study. The targeted teacher community of alumni of the Teacher Professional Program (PPG) education in the English Language Education Study Program at a private university in Malang from 3 batches of 98 teachers, only two teachers who responded had ever implemented STEAM learning. These two teachers were then contacted to become respondents. Based on the interview results, it was found that the experience of being a teacher for over 15 years, he understands STEAM learning well. This can be seen from his understanding that STEAM learning as innovative learning can teach students to think critically and communicatively per the needs of 21st-century skills. Statements about active learning can be born from this STEAM learning.

Abstrak

Artikel ini bertujuan untuk mengkaji implementasi pendekatan STEAM dalam dunia pendidikan yang dilihat dari respon guru dan bagaimana guru memahami dan mengimplementasikannya dalam proses pembelajaran. Pendekatan kualitatif dengan desain fenomenologi digunakan dalam penelitian ini. Komunitas guru yang menjadi sasaran penelitian adalah alumni Program Profesi Guru (PPG) Program Studi Pendidikan Bahasa Inggris di salah satu perguruan tinggi swasta di Malang dari 3 angkatan yang berjumlah 98 orang, hanya dua orang guru yang memberikan respon pernah mengimplementasikan pembelajaran STEAM. Kedua guru ini kemudian dihubungi untuk menjadi responden. Berdasarkan hasil wawancara, diketahui bahwa pengalaman menjadi guru selama lebih dari 15 tahun, beliau memahami pembelajaran STEAM dengan baik. Hal ini dapat dilihat dari pemahaman beliau bahwa pembelajaran STEAM sebagai pembelajaran inovatif yang dapat mengajarkan siswa untuk berpikir kritis dan komunikatif sesuai dengan kebutuhan keterampilan abad ke-21. Pernyataan tentang pembelajaran aktif dapat lahir dari pembelajaran STEAM ini.

INTRODUCTION

STEAM stands for Science, Technology, Engineering, Art and Mathematics. STEAM is known in Indonesia as Sciences as Ilmu Pengetahuan Alam (IPA), Technology as *ilmu teknologi*, Engineering as *ilmu teknik*, Art as *ilmu seni*, such as music, painting, and crafts, and Mathematics as *ilmu matematika* (Muhtadi, 2019; Syukri et al., 2013). Natural Science (IPA) studies natural phenomena that involve observation and measurement to explain the ever-changing nature objectively. Technology is human innovations that modify nature to meet human needs through hardware and strategic means. Engineering is the application of science and technology to solve human problems. Art is everything created by man that contains elements of beauty

and can evoke feelings for himself and others. Mathematics studies the patterns and relationships that provide the language for technology, science, and engineering.

The term STEAM in education then metamorphoses into a learning approach. This stems from the challenges of the world of work in the 21st century, which requires the quality of human resources in the STEAM field (Nasrah et al., 2021). Current and future jobs require understanding and skills in STEAM, ranging from understanding medical diagnoses, evaluating lifestyle and environmental developments, to managing daily activities with various computer-based applications. In the field of art, for example, work such as making musical instruments also needs to apply STEAM in order to produce musical instruments as expected. Musical instrument makers need to master science in order to produce rhythmic instruments; need to master the technology of how to make a musical instrument; need to master the technique of arranging scales; it is necessary to master the art of musical beauty to be able to produce the correct scales; and it is necessary to master mathematics to be able to calculate the material price of a musical instrument.

STEAM learning is believed to be able to combine science, technology, engineering, art, and mathematics that match the challenges of the world of work in the 21st century. By mastering innovative STEAM learning, teachers will be able to develop the students' abilities to solve the problems they face critically, creatively, communicatively, and collaboratively according to the demands of the 21st-century world of work (Muhatadi, 2019; Nasrah et al., 2021). Thus, the quality of the learning process that teachers do can continue to be improved according to the demands of the times.

STEAM issues in Indonesia are translated separately and used as a reference for their own fields of study with specific characteristics. Special lessons in Science and Mathematics have been taught to students since elementary education and adjusted to the difficulty level. Technology studies are studied specifically at universities, such as Educational Technology and Food Technology. Likewise, engineering science began to be explicitly studied in vocational secondary education. The learning practice uses a silo approach, where each STEAM discipline is taught separately to keep the knowledge domain within the boundaries of each discipline (Asmuniv, 2015). In the *silod* approach, learning relies on each subject area to allow students to gain a deep understanding and be assessed in each STEAM subject area (Juniaty, Siti, Supriyono: 2016).

Along with the times and the importance of understanding STEAM, STEAM can no longer be understood with a separate approach. In the context of innovative learning approaches, STEAM is no longer seen as just a separate subject area. The STEAM learning approach should be viewed as a conceptual framework that describes a systematic procedure. The STEAM learning approach must organize the learning experience to achieve both embedded and integrated STEAM learning goals.

The embedded approach on STEAM emphasizes maintaining the authenticity of the subject matter that is the main area, not focusing on embedded subjects, and the material on the embedded approach is not designed to be evaluated or assessed. The field of science consists of at least one or more subject areas embedded in another context (e.g., mathematics and technology). The embedded approach differs from the siloed approach in terms of assessment. If the silo approach assesses each STEAM field (because it is

considered that all fields are major) while the embedded approach, the assessment is only focused on the main area, and the field embedded in the main area is not assessed (Juniaty, Siti, Supriyono: 2016).

Meanwhile, an integrated approach allows each STEAM field to be taught as if it were integrated into one field of study. The integrated STEAM education approach aims to remove the wall between each STEAM field in a siloed and embedded approach. STEAM education that is carried out in an integrated manner is taught as if in one subject of study. An integrated approach can be taken with a minimum of two disciplines. The intersecting lines of the circle show the various choices of knowledge involved in an integrated approach in order to create multidisciplinary and interdisciplinary integration. The integrated approach is expected to increase students' interest in STEAM, especially starting from elementary school (Juniaty, Siti, & Supriyono, 2016). Learners can relate material from different areas of STEAM with critical thinking skills, problem-solving skills, and knowledge to reach conclusions.

Thus, it can be concluded that STEAM Learning is an innovative interdisciplinary learning approach where science, technology, engineering, art, and mathematics are integrated with a focus on the learning process of solving problems in real life. STEAM learning shows students how concepts and principles of science, technology, engineering, and mathematics are integrated to develop products, processes, and systems that benefit competitive human life (Sahih, 2015).

As a learning innovation that is understood to be very contextual in the 21st century, of course, this knowledge is needed by a teacher. The teacher referred to here must be delivered by all existing teachers, which is not limited to being implemented by science, technology, arts, and mathematics teachers. Teachers outside this field are also expected to be able to apply this STEAM approach. This is what underlies the author to reveal the magnitude of the response from teachers in implementing STEAM and how teachers who have implemented STEAM learning are in accordance with the concept of STEAM learning itself.

METHOD

Research Subjects

The research subjects are professional teachers who have graduated from the Teacher Professional Program (PPG) at one of the private campuses in Malang City, East Java. There are 3 (three) batches with a total of 32 or 34 batches with a total of 98 teachers. As one of the instructors from PPG, the author is still connected to the WhatsApp group (WA) so that young people can communicate and contact PPG alumni who are still connected today. In the group, it is common to share professional development after they graduate from PPG. For the purpose of this study, the author asked the group who is experienced in STEAM learning and has experience using STEAM learning. Of the number of teachers from the three groups, only two teachers stated that they had experience using STEAM learning, and the rest answered that they had never used STEAM learning. The two teachers came from 2 different batches, one from the Ministry of Education and Culture and one from the Ministry of Education and Culture. The two teachers then followed up with the author to conduct an interview by establishing communication to find the right time.

Research Procedure

This study applies qualitative research by applying phenomenological design. Phenomenology is used to answer and extract information from respondents about their understanding of STEAM learning and their experience using STEAM in the learning process. This research will reveal the extent to which teachers understand one of these innovative learnings and how teachers implement STEAM learning.

Instruments for Collecting Data

The instrument used in this study is an interview. The author prepares questions in advance. The author contacts and makes an appointment to determine the right time. The author first submitted a list of questions to the respondent teachers to prepare them to answer the questions. There are ten questions prepared to get an idea of the teacher's understanding of STEAM learning, its principles, preparation, and experience in implementing STEAM learning according to their experience.

Data Analysis

Data in the form of transcripts from the interview results are then analyzed. Analysis is used to maintain the quality of translated transcripts, and we ask participants to provide comments and feedback for improvement. Next, we read the transcript results several times to get a comprehensive understanding of the data that has been collected (Widodo, 2014). After that, the authors interpreted similar statements from the interview data and grouped them to make three theme findings for the study, namely about the fundamental conception of STEAM learning, STEAM learning from a philosophical point of view, and how the implementation of STEAM learning is based on experiences that teachers have applied.

RESULTS

This study aims to uncover teachers' understanding of STEAM learning and their experience teaching with STEAM learning. Is then what they understand and do in line with the concept of STEAM learning explained in theories and by experts? Furthermore, in the research results section, it is explained about the data that has been collected with research instruments.

The research findings were detailed into three emerging themes obtained from the interview session: 1) basic conception of STEAM learning, 2) STEAM learning from a philosophical point of view, and 3) how the implementation of STEAM learning is based on experiences that teachers have applied.

Basic conception of STEAM learning

The first theme obtained based on the interview results was related to the understanding of the 2 teachers about STEAM learning. Based on the answers obtained, the teachers interviewed understand STEAM learning well as innovative learning that can lead students to critical thinking. This can be seen from the following interview statements written by Teacher 1 (T1) and Teacher 2 (T2).

- T1: STEAM, which I understood, is connecting knowledge and skills where elements of science, technology, engineering, art, and mathematics are in it into a unity in solving problems.
- T2: An approach that emphasizes learning in aspects of science, technology, engineering, art, and mathematics where this learning, I think, is perfect to make our students active in class.

Based on the statement above, teachers' understanding of STEAM learning is included in an integrated conception. This is seen from the statement of elements of knowledge, technology, engineering, art, and mathematics used to solve problems, not silos (separate) or embedded (embedded). This is because the teacher who is the author of the review is an English teacher who applies STEAM learning.

Second, STEAM learning is believed to be able to make students active in class. When the author followed up on the meaning of active here, the teacher replied that being active is having creative thinking, the desire to actively ask questions, and trying to find solutions to his problems.

Based on the answers above, the author tries to follow up on questions about the goals of the teacher using the STEAM learning approach. Based on the results obtained, the teacher confirms the previous statement: training students to think critically and actively. This can be seen from the following answer.

- T1: For learning purposes with this STEAM approach, I try to do the following:
- Invite students to think critically
 - Explore and optimize the potential and talents of students
 - Create products or works according to the abilities of students
 - Train independence and creativity
 - Make students feel happy
- T2: Of course, I use learning with the STEAM approach. I want students in the classroom to be active students. There is no opportunity for students to just sit quietly in class but are forced to really learn.

Philosophical view of STEAM learning

Based on the teacher's understanding of STEAM learning and the objectives to be conveyed, the author also wants to dig deeper into the principles of STEAM learning. Based on the existing answers, the authors found continuity of statements of what they understand with the principles that must be prepared when this STEAM learning will be applied. For example, creative and innovative thinking, critical, and student activeness is a very important aspect. This can be seen from the following statement.

- T1: My philosophical principles or views that I understood in the STEAM approach that I did at that time were:
- Critical thinking in the problems presented.
 - Creativity
 - Active in group work
 - Multiple potentials
 - Reflection
 - Reinforcement
- T2: The principle to consider is student activity in the classroom

The philosophical viewpoint presented by T1 shows more consistency and understanding. In detail, T1 emphasized that STEAM learning must be carried out by presenting activities that can inspire students to think critically, creatively, and actively in groups, plural potential, and the ability to reflect and encourage students to strengthen their understanding. Furthermore, T2 always focuses on the students' condition when STEAM learning is carried out, namely student activity in the classroom. This means that there must be such conditioning that teachers must do so that their students are always active before STEAM learning is carried out, or ensure that students must be involved when STEAM learning is carried out.

How to Implement STEAM learning based on the experience that teachers have applied

Related to this problem, the author focuses on the challenges in implementing STEAM learning in the classroom and also on the solutions made by teachers when facing problems in implementing STEAM learning.

In general, the challenge is the preparation of learning materials, which need to be solidified about the use of technology. This can be seen from the following statements: T1 and T2.

- T1: The challenge faced so far in STEAM learning is
- Limited learning time
 - Our ability as an educator is limited, especially regarding technology.
 - Lack of consistency in implementation
- T2: The challenge lies in the preparation of learning materials, which must be mature so that learning can be carried out in accordance with aspects of science, technology, engineering, art, and mathematics. Also, the challenge is in how we motivate students to be active directly in class.

Based on the statement above, T1 emphasizes the limited learning time. This is because the number of hours of English is only 4 hours a week. So that learning time becomes a challenge in itself. In addition, teachers' abilities in terms of technology also need to be improved. This is in line with T2, which states that preparations must be made carefully so that shortcomings in terms of technology can be anticipated. Interestingly, T1 is well aware of its shortcomings, namely consistency in implementation. At the same time, T2 is consistent with the motivation to activate students when implementing STEAM learning. Meanwhile, for the challenges faced, what about the solutions offered? It is interesting to note that teachers have their own creativity and innovation when applying STEAM learning. This can be seen from the following statement.

- T1: The solutions I did were:
- Using time outside of learning hours if the learning model is PjBL
 - Collaborating with more tech-savvy peers
 - Trying to search the Internet for things that are poorly understood
- T2: As long as we can carry out learning according to the plan that has been prepared, problems will not arise, and even though there is only motivating students, they are active because sometimes there are still students who are embarrassed to present themselves

It is clear from the T1 statement above that every challenge has a creative solution that is carried out. Because STEAM learning is innovative learning, the solutions it takes seem solutive and creative. This can be seen from the statement of T1, which tries to apply PjBL learning outside learning hours as a form of solution. As well as involving other teachers (collaborating) with teachers who are more tech-savvy. Coaching in educational practice is desirable. Also interesting is his desire to be open and out of the box and continue to improve what T1 does not understand by surfing the Internet.

While T2 is consistent with the statement of how important it is to activate students in this STEAM learning, T2 also saw how important it was that learning preparation was made. The emphatic statement "As long as we can carry out learning according to the plan that has been prepared, problems will not arise" shows that learning preparation is very important. If the preparation is good, the learning process will also be good.

DISCUSSION

This study is designed to explore educators' conceptions of STEAM learning and how their learning practices contribute to the development of STEAM learning from the perspective of challenges and solutions. This research uncovers the important issues discussed in the following sections.

To what extent is the teacher's conception of STEAM learning?

STEAM learning is defined as a conceptual framework that describes systematic procedures. The STEAM learning approach must organize learning experiences to achieve STEAM learning goals in an embedded or integrated manner (Muhtadi, 2019). This statement implies that STEAM is not just a separate science, technology, engineering, art, and mathematics element of building unity to bring students to think critically and actively (see statements T1 and T2). This finding validates previous research that discusses STEAM learning activities by integrating the competencies of each of these elements (Nasrah et al., 2021; Starzinski, 2017; Syukri et al., 2013).

STEAM learning is closely related to acquiring higher-order thinking skills (HOTS). Therefore, STEAM learning with HOTS as part of innovative learning is closely related. In line with this, the STEAM model can help develop knowledge, help answer questions based on investigation, and help students create new knowledge (Nasrah et al., 2021). Thus, the statements of T1 and T2 in previous findings confirm that STEAM learning is closely related to active learning. Integrating STEAM elements as part of student competency needs in the 21st century or this Industrial Revolution era supports learning to activate students in every learning process. Thus, the application of STEAM learning, as conveyed by T1, can lead students to think critically about the problems presented, creativity, activity in group work, explore multiple potentials, reflect on the problems faced, and provide reinforcements.

STEAM learning aims to hone the level of STEAM literacy in students. STEAM literacy is a goal that students and educators can achieve. For students, STEAM literacy will be helpful in the development of their lives. For educators, STEAM literacy is useful for supporting the performance of educating a competitive and collaborative generation (Muhtadi, 2019). STEAM literacy is a reference for developing problem-solving skills and conducting scientific behavior. A distinctive feature of scientific behavior is finding problems to

be given solutions in people's lives to scientific standards. For our society to have the capacity for STEAM literacy, nowadays, education needs to apply the STEAM learning approach (Muhtadi, 2019). STEAM literacy can be seen in Table 1 below.

Tabel 2. Definition of STEAM literacy

STEAM Field	Literacy
Science	Science Literacy: The ability to identify scientific information, formulate and analyze problems, conduct experiments with the scientific method, collect data and analyze it to a conclusion, and then apply it in the real world, which also has a role in finding solutions.
Technology	Technology Literacy: Skills in using various technologies, learning to develop technology, and analyzing technology can influence the thinking of students and society.
Engineering	Engineering Literacy: Ability to develop technology with more creative and innovative designs through combining various scientific fields.
Art	Art Literacy: Skills in writing, communication, poetry, video presentation, making models.
Mathematics	Mathematics Literacy: Ability to analyze and convey ideas, formulations, and solve problems mathematically in their application.

Source: Taken from PPG Module by Muhtadi, 2019

STEAM literacy refers to an individual's ability to apply an understanding of how fierce competition works in the real world, which requires four interrelated areas of STEAM (Asmuniv, 2015). The American National Governors Association Center for Best Practices (in Asmuniv, 2015) defines STEAM literacy according to each of the five STEAM areas. The findings of this study reveal that T1 is very confident in preparing students to face the challenges of the 21st century by equipping them with the skills needed, such as inviting students to think critically, explore and optimize the potential and talents of students, make products or works according to the abilities of students, train independence and creativity, and make students feel happy. In line with T1, T2 also views that the era of the 21st century requires active people. The results of innovation and creativity characterize active people. Therefore, STEAM makes students active, there is no opportunity for students to sit quietly in class but are forced to really learn, and learning is active because learning is a verb (T2).

What is the teacher’s philosophical view, implementation, and solution of the problem faced?

STEAM learning is positioned as a learning approach that can be implemented in an integrated or integrated manner, along with how STEAM can be integrated. As a constructive element to prepare for 21st-century competence, this philosophical view and how it is implemented can be a reference in its implementation.

Muhtadi (2019) explained how STEAM is implemented with an integration pattern in the classroom. It can be seen in Figure 1 below.

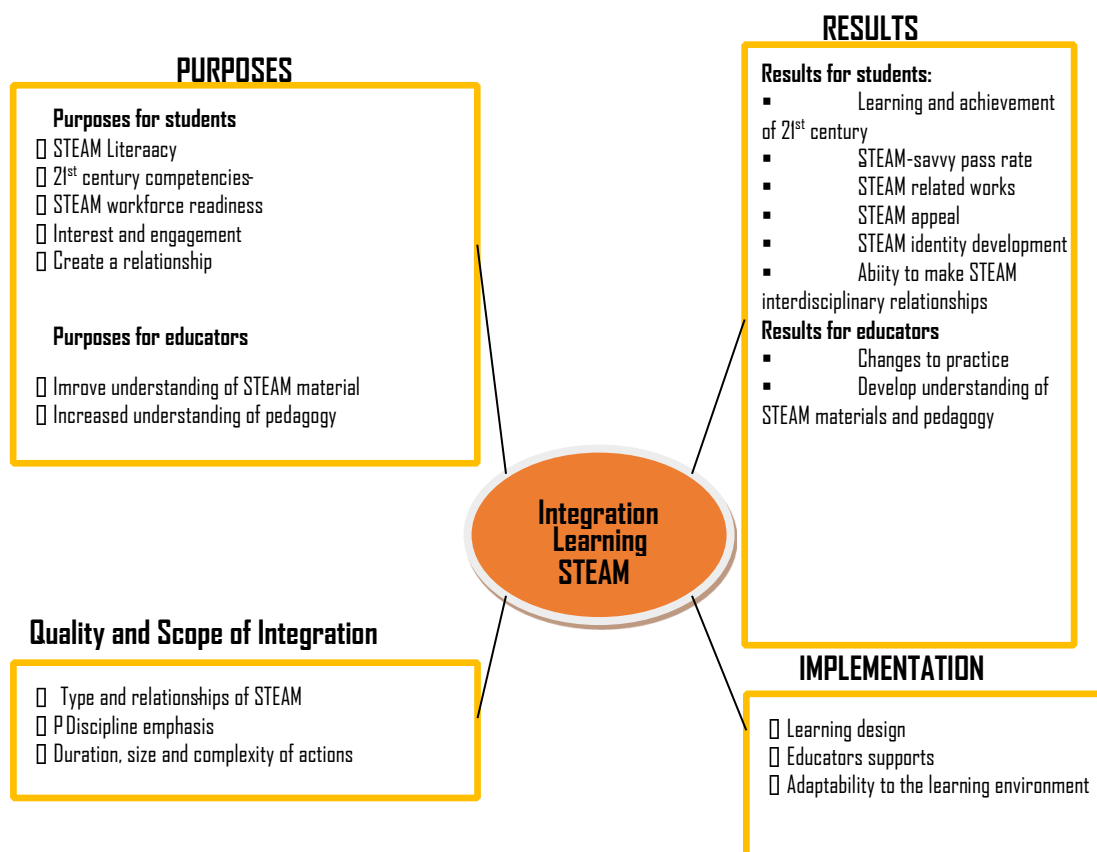


Figure 1. The Interdisciplinary education framework of STEAM (National Academy, 2014 Cited rom Module 3 PPG by Muhtadi (2019))

Based on Figure 1 above, it is clear that STEAM learning is a challenge to prepare the current generation to be able to master 21st-century competencies. The study's findings revealed that T1 also shared the same belief in this philosophical foundation. According to T1, current learning must be able to drive students to think critically and involve students to be active (T2)

Therefore, the learning process in the classroom requires teachers to be able to upgrade themselves with good educational technology adaptation that can deliver students to have 21st-century skills. The results indicate that teachers who apply innovative learning show themselves to be innovative and able to find

solutions to the problems they face as well. For example, T1 said that utilizing the project-based learning (PjBL) learning model for insufficient time in STEAM learning can be used as a solution, including collaborating with teachers who have more abilities in the field of technology and enriching material from the Internet, which has provided many learning resources (T1). Meanwhile, STEAM learning will be good if you have good planning, so teachers are obliged to make plans as mandated by the law. This is based on the findings conveyed that "As long as we can carry out learning according to the plan that has been prepared, problems will not arise and although there is only in motivating students to be active because sometimes there are still students who are embarrassed to present themselves" (T2).

CONCLUSION

Based on the exposure results in the previous section, it can be concluded that STEAM learning needs to get more massive socialization to teachers. As part of innovative learning that can deliver students to have 21st-century competencies, it needs to be introduced and practiced in learning. STEAM as a learning approach must be understood in the form of elements that build STEAM itself by understanding good STEAM literacy. Teachers who are respondents to this study have conveyed well their understanding of STEAM learning which is revealed in 3 essential aspects, namely from 1) the fundamental conception of STEAM learning, 2) STEAM learning from a philosophical point of view, and 3) how the implementation of STEAM learning is based on the experience that teachers have applied.

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