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# STEM-INTEGRATED FLIPPED CLASSROOM IN THE TEACHER'S PERSPECTIVE: COULD ITS IMPLEMENTATION IN E-MODULE IMPROVE SYSTEM THINKING ABILITY?

**Almira Aspridanel[1], Abdurrahman[2*], Dewi Lengkana[3], Tri Jalmo[4]**
[1,2,3,4]Department Of Science Education, Postgraduate Program, Universitas Lampung, Indonesia

**Corresponding author:* abdurrahman.1968@fkip.unila.ac.id

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**ABSTRACT**

This study aims to describe the teacher's perception of flipped classroom learning strategy using STEM-integrated E-Modules in improving systems thinking ability. The research was conducted in Lampung Province, Indonesia, and was nvolving 50 junior high school science teachers. The method used in this research is mixed methods with Sequential Explanatory Design. Data was retrieved using Questionnaire, and were analyzed using descriptive analysis. The survey results show that teachers have a positive perception of the STEM approach. The results of the analysis also show that most teachers have not used the STEM approach in schools to provide an understanding of science. In addition, teachers also have not implemented STEM-integrated teaching materials.

# PERSPEKTIF GURU TERHADAP *FLIPPED CLASSROOM* TERINTEGRASI STEM: DAPATKAH PENERAPANNYA DALAM E-MODUL MENINGKATKAN KEMAMPUAN BERPIKIR SISTEM?

***Kata Kunci:***

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**ABSTRAK**

Penelitian ini bertujuan untuk mendeskripsikan persepsi guru tentang Strategi Pembelajaran *Flipped Classrom* menggunakan *E-Modul* Terintegrasi STEM dalam meningkatkan keterampilan berpikir sistem. Penelitian dilakukan di Provinsi Lampung, Indonesia. melibatkan 50 guru IPA SMP. Metode yang digunakan dalam penelitian ini adalah metode campuran dengan Sequential Explanatory Design. Data diambil menggunakan Kuesioner. Data dianalisis menggunakan analisis deskriptif. Hasil survei menunjukkan bahwa guru memiliki persepsi positif terhadap pendekatan STEM. Hasil analisis juga menunjukkan bahwa sebagian besar guru belum menggunakan pendekatan STEM di sekolah untuk memberikan pemahaman sains. Selain itu, guru juga belum menerapkan bahan ajar terintegrasi STEM.



## 1. INTRODUCTION

Along with the development of social and ecological systems around the world (globalization), it has an impact on increasing the needs of the present generation but also must be able to ensure that future generations enjoy quality sustainable resources [1] Changes in the pattern of people's lives have entered the era of society 5. 0 where all

technology become a part of human live. This 5. 0 industrial revolution emphasizes community readiness to think outside the box (think creatively) [2]. Students as the current generation are required to have sufficient knowledge and skills to decide to act in a way that supports sustainable development, namely thinking about sustainable communities, one of which is improving systems thinking skills, thus it is expected that students are ready to enter 21st century education [3]. The ability to think systems directs students to be able to think outside the mechanistic and reductionist paradigms that see a phenomenon through the analysis of its constituent parts separately or think out of the box. Systems thinking is very important to be used to understand the pattern of motion of the universe and the living things in it. In learning science, systems thinking emerged as a reaction to the difficulties of science in dealing with various problems in complex systems. For biological researchers, systems thinking is the basic conceptual framework that underlies everyday work and dynamic living systems [4]. The complexity of systems thinking does not only appear in science, but also in human life as the ability to manage that complexity, which is a way to direct changes in the world for the better Science education emphasizes environmental and environmental issues in science curriculum. Thus, each student seeks to develop environmentally responsible behavior as an introduction to the scientific understanding of the physical environment such as recycling or cleaning the schoolyard [5].

Better familiarization with environmental issues alone is not enough for students to develop decision-making abilities in good systems thinking about environmental issues. Observations on science education in schools reveal that junior high school students may have little experience of thinking about simple new systems [6]. Thus, previous research revealed that teachers need to consider the types of activities such as facilitating students' systems thinking that arise in real-world contexts. In addition, the teacher demonstrates environmental care behavior by learning specific and holistic knowledge that guides learning about the environment. Teachers need to prepare students for the future by involving them in the process of constructing concepts in their minds [7]. Therefore, the main aim of science education in schools should be to equip students with the systems thinking skills needed to understand environmental problems, such as environmental pollution in a more coherent way [8].

The results of the preliminary study observation analysis of the E-Module needs questionnaire conducted on 50 science teachers in Lampung Province showed that 58% of teachers had not implemented learning oriented towards improving systems thinking skills, because 24 out of 50 teachers did not know how to think continuously and had not received strategies, approaches and appropriate teaching materials to be applied. The ability to think systematically in science learning is characterized by the ability to relate one concept to another, but learning in schools has not facilitated the training of this ability. Learning in schools mostly only focuses on handbooks. Less effective teaching materials make teachers deliver learning using methods that tend to be conventional.

According to Alimuddin, Director of HAFECS (Highly Functioning Education Consulting Services), in this era of industrial revolution 5. 0 (society 5. 0) teachers are required to provide more innovative and dynamic learning in the classroom teaching [9]. One example of an innovative technology-based learning product to answer student needs is the e-module. E-Module is a teaching material that is used as a guide for teachers and students in the learning process that is packaged in electronic form. E-Modules are made to facilitate students to learn independently without a teacher [10]. By implementing e-module, teachers do not need to directly teach students face-to-face, because e-modules contain lessons, methods, limitations, and evaluations thatare designed systematically and

attractively to achieve the expected competencies [11]. If the concept is abstract (like most concepts in physics), then the module is able to help students describe something abstract by using pictures, photos, charts, schematics, simulations, etc.

One of the lessons that teachers can do to improve students' higher order thinking skill is by applying STEM-based learning (Science, Technology, Engineering and Mathematics). STEM is a learning approach that involves the application of science, technology, engineering and mathematics to thinking ability [12]. The linkage of the STEM approach provides an opportunity to students to improve systems thinking skills.

STEM education engages science, technology, engineering, and mathematics as well as other fields of study through project-based learning experiences that require the application of knowledge to solve authentic real-world problems in a collaborative environment for the needs of students. Through STEM learning, students learn about scientific and technological literacy that arises from reading, writing, observing, and doing science in the environment [13]. Based on a preliminary study of teacher needs questionnaire analysis as many as 66% of teachers have not used STEM integrated teaching materials and the modules used by teachers do not use learning strategies and there is no science integration. Besides, during the Covid-19 pandemic, students study form home. This of course makes students experience a lack of understanding of environmental concepts and environmental problems in everyday life, thus providing a great opportunity for misconceptions. Therefore, researchers develop a STEM-oriented e-module with the topic of environmental pollution, to improve systems thinking skills. STEM learning, students learn about scientific and technological literacy that arises from reading, writing, observing, and doing science in the environment.

This E-Module will provide the learning that students and teachers need that can be used anywhere and anytime. In addition, e-modules provide assistance in understanding concepts through videos, pictures, and virtual lab practicum activities. This is in line with the results of the analysis of student needs where they need e-modules for independent study. The e-modules they need must contain explanations of concepts, videos, pictures, virtual labs and provide ways to solve problems in questions [14].

In line with previous research by Ben, O, Assara, Z, and Orion, N, students who understand the mindset of sustainable systems towards the environment and the processes that occur within it may have better tools to evaluate the changes taking place within them and may know how to live in peace with environmental awareness. The cause of the problem is that a better introduction to environmental problems is not enough for students to develop decision-making abilities in good systems thinking about environmental problems [15][16] Thus, he argues that teachers need to consider the types of activities such as facilitating students' systems thinking that arise in real-world contexts. In addition, teachers demonstrate environmental awareness behavior by learning specific and holistic knowledge that guides learning about the environment.

The teacher prepares students for the future challenge by involving them in the process of constructing a concept in their mind in school learning. The main goal of school science education should be to equip technology-based learning with e-modules during the Covid-19 pandemic. In addition, students must understand the concept of environmental pollution that impacts the ecosystem well and eliminate the tendency to memorize in solving a problem but provide ways to overcome environmental pollution.

Therefore, this study aims to describe the teacher's perception of the role of the STEM-integrated flipped classroom in the E-Module on the development of students' systems thinking skills. This is due to the provision of videos, images using the E-Module

to make it easier for students to study independently and make it easier for them to understand concepts in learning during the Covid-19 pandemic.

## 2. METHOD

This study uses mixed methods, and the strategy used is Sequential Explanatory Design by combining qualitative and quantitative data collection and data analysis. The research was conducted in SMP/MTs (junior high school) in Lampung Indonesia. The research subjects were 50 science teachers. Data were collected using a questionnaire created through google form and distributed online to find out the teacher's perception of STEM with the teaching materials used during the learning process. The questionnaire made has three aspects including aspects of systems thinking skills, STEM integrated teaching materials and flipped classroom learning strategies. In the preliminary study used instruments in the form of a teacher's needs questionnaire and to find out information about the learning approach used and the results of the analysis of the modules used by the teacher during learning.

The questionnaire made has three aspects including systems thinking skills, STEM integrated teaching materials and flipped classroom learning strategies. Furthermore, an analysis of the results of the questionnaire analysis of the needs of teachers and students was carried out which was described in the form of a percentage, then interpreted qualitatively. The questionnaire uses the Guttman scale which has answer choices according to the content of the question, namely: “Yes” and “No” with scores of “1” and “0”. The results of the questionnaire were analyzed using the percentage of responses from each item and the results of the interpretation of the presentation of respondents’ answers in descriptive narrative form were categorized as very good, good, quite good, and not good. The results of the questionnaire were analyzed using the percentage of responses from each item submitted. Both studies have the same priority with triangulation and integration The schematic research design can be seen in the following figure.

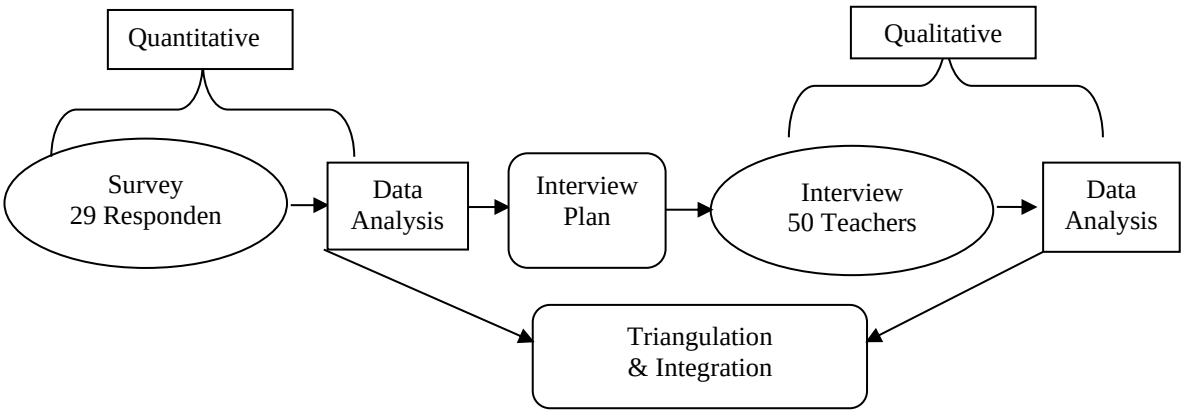


**Figure 1**. The Schematic Research Design

Figure 1 is a schematic research design in sequential research stages, starting with qualitative research and continuing with quantitative research that follows the sequential explanatory design stage [17]. The collection and analysis of qualitative data was carried out at an early stage. Building on the results of the exploratory analysis in the first stage. Then proceed to the next stage with quantitative methods (a survey of 29 respondents) to test or make generalizations based on the initial findings and interpret how the results of qualitative research are built with initial findings (interviews with 50 teachers). Build an instrument based on findings at an early stage to obtain overall prevalence in a larger

sample. Data analysis in quantitative and qualitative analysis was carried out in an integrated and triangulated.

## 3. RESULTS AND DISCUSSION

The results and discussion of the data obtained in the form of a questionnaire. The results of the teacher's perception of the flipped classroom learning strategy using the integrated STEM E-Module in Improving Systems Thinking Skills are in Table 1.

**Table 1**. Results of Interpretation of Teacher's Perception Questionnaire

| No | Question | Percentage (%) | |
|---|---|---|---|
| | | Yes | No |
| 1 | Teachers' understanding of sustainable community thinking | 34 | 66 |
| 2 | Teacher's understanding of systems thinking skills | 56 | 44,2 |
| 3 | The teacher's way of applying systems thinking skills during learning | 42 | 58 |
| 4 | Use of teaching materials that improve systems thinking skills | 94 | 6 |
| 5 | Teaching materials used by teachers during classroom learning | 42 | 58 |
| 6 | How teachers obtain teaching materials | 34 | 44 |
| 7 | The need for teaching materials that can be accessed with mobile learning | 98 | 2 |
| 8 | The need for teaching materials with the STEM Integrated Flipped Classroom strategy | 93 | 7 |
| 9 | Teacher's understanding of Flipped Classroom strategy | 46 | 54 |
| 10 | Flipped Classroom strategy implementation | 24 | 76 |
| 11 | Giving Assignments Before Starting Classroom Learning | 96 | 4 |

The results showed that as many as 34% of teachers did not know about sustainable community thinking so that in implementing learning oriented towards improving systems thinking skills there were difficulties because only 56 % of teachers already knew the indicators of system thinking. The ability to think systems in science learning is done by associating a concept with another concept, but the learning that is carried out only focuses on one concept and is not associated with other concepts [18]. Less effective teaching materials make teachers deliver learning using methods that tend to be conventional. This is supported by the results of the study, namely as many as 66% of teachers have not used STEM integrated teaching materials and 52% of teachers have used teaching materials such as printed modules, as many as 42% of teachers obtained modules by downloading from the internet and only 16% of teachers obtained modules by means of make your own. The modules used by teachers do not use learning strategies and there is no integration of science so that as many as 94% of teachers need teaching materials that can improve systems thinking skills. In the current era of digital technology, *E-Learning is* experiencing rapid development. *E-Learning* leads to learning through electronic resources, and supports distance interactive learning. The available information can be accessed using a web system without having to be bound by space and time, therefore as many as 98% of teachers need electronic-based teaching materials that can be accessed online. A teacher can prepare students for a better learning process and improve learning performance, encourage students to actively participate in sharing knowledge through the flipped classroom strategy, but as many as 46% of teachers do not understand the flipped classroom strategy, and 24% of teachers have not implemented the flipped strategy. classroom. The results of the teacher's questions and responses are in Table 2.

**Table 2**. Teacher's Questions and Responses

| No | Question | Teacher's Response |
|---|---|---|
| **1** | What are the thinking skills of a sustainable community? | • To a better direction for society in the future<br>• Critical thinking<br>• mindset related to custom and science and technology<br>• Efforts to develop community empowerment through the development of human resources, technology, environmental conservation, legal awareness and others that can |
| **2** | What is systems thinking ability? | • Systems thinking is a person's ability to think in a structured and global way<br>• Ability to look at the problem as a whole<br>• Understanding things in a different way (not just from one side only) |
| **3** | How do you improve systems thinking skills in science learning? | • Not yet, because I don't really understand how to apply systems thinking<br>• Haven't found the right approach<br>• Discovery learning models, scientific approaches, and methods of discussion, question and answer and recitation. |
| **4** | What teaching materials have you used so far? | • LKPD<br>• Module<br>• Props and information resources |
| **5** | How did you get the module in science learning? | • Downloading from internet<br>• Teacher's book<br>• Buy at publisher |
| **6** | Can the module that you have used so far improve students' system thinking ability? | • Lack of understanding of making modules that can improve students' systems thinking skills<br>• More to improve mastery of concepts |
| **7** | According to you, do you need a module that integrates STEM and constructs the way students think to work in groups through *Flipped Classroom* ? | • I think it is necessary, because as part of the variation in teaching so that students are not too bored to take part in learning<br>• So that students in particular and educators are ready to face the challenges of 21st century learning |

Based on the explanation above, it is believed that the use of technology in learning is in the form of an electronic module with an integrated STEM -based *flipped classroom* strategy on science material that is close to the context in everyday life, namely environmental pollution. The following is the STEM integration design in teaching materials according to the results of observations and interviews:

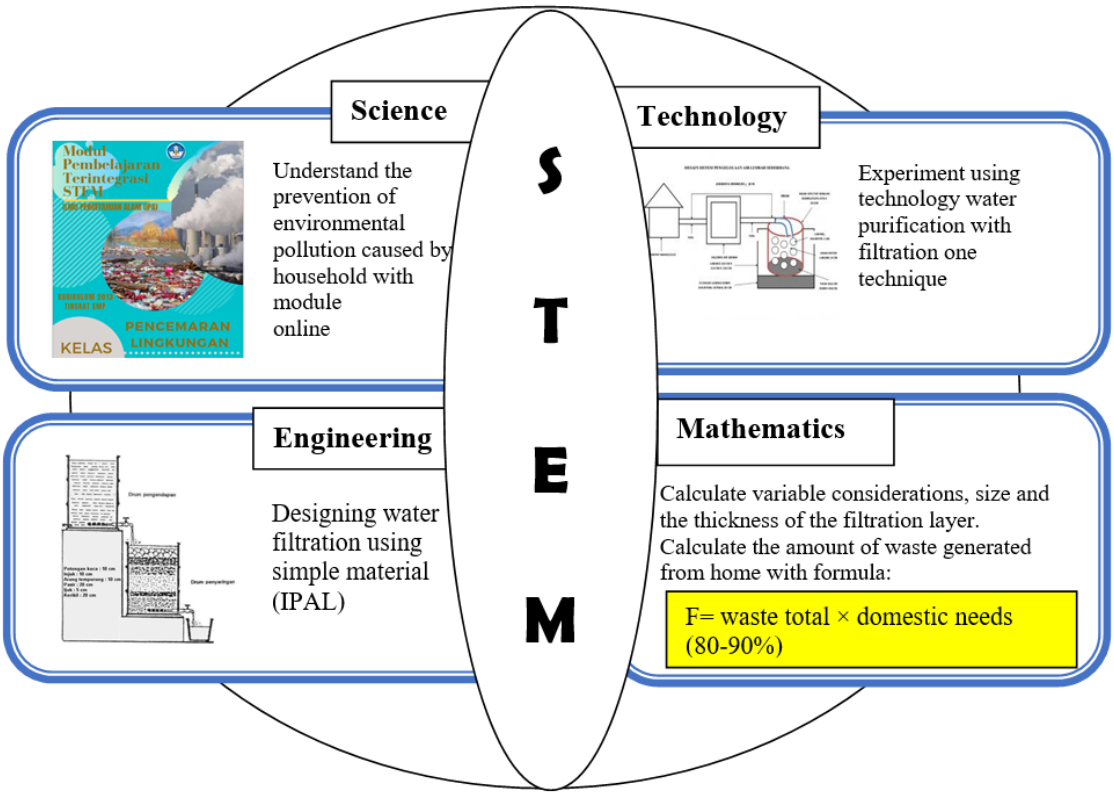


**Figure 2**. STEM Integration Design in Teaching Materials

One way to implement *E-learning* learning strategies and models is by developing electronic module teaching materials. Learning in the form of electronic modules or ( *E-Modules* ) is teaching materials designed in a structured manner based on the curriculum and arranged in a certain time unit, which packaged using electronic devices such as computers or androids, which makes the learning process more effective, practical and can increase knowledge to additional skills for teachers and students [19]. packaged using electronic devices such as computers or androids which makes the learning process more effective, practical and can increase knowledge to additional skills for teachers and students [20]. Thus, this approach involves fully automated e-learning and team collaborative learning by implementing the Flipped Classroom [21]. STEM integration teaching material, Through the tool information in a simple IPAL video, students can conclude the use of household by correct. students can arrange experimental procedures for household IPAL (Waste water treatment installation) systematically. students can describe the design of a simple IPAL for household waste stairs according to literature, measuring in the manufacture of simple IPAL tools for waste household properly. making simple IPAL products for household waste according to the correct procedure[22]. This is in accordance with the multimedia cognitive theory [23] which explains that students have two channels of information processing, namely visual and verbal. This means that every human being has separate and different communication channels freely so that different information must be presented in the right media to maximize the learning process.

Thus, this approach involves fully automated e-learning and team collaborative learning by implementing the Flipped Classroom strategy [24]. This is also in accordance with multimedia learning, it is expected that students can have control over the speed of their own learning according to their respective abilities. In addition, multimedia learning makes students more independent in understanding the subject matter. Multimedia cognitive theory explains that students have two channels of information processing,

namely visual and verbal[25][26]. This means that every human being has a separate communication channel freely so that different information must be presented in appropriate media to maximize the learning process.

Therefore, teaching materials in the form of *E-Modules* will make it easier for students to understand learning materials, this is in line with previous research, namely the Development of *E-Modules for* Natural Science Subjects for the Interaction of Living Things with their Environment. Teachers make learning materials as homework for students [27]. During the learning process in the classroom, students must pay attention to the teacher. Learning significantly related to the concept of *E-Learning* can be through modules science based projects , combined with the approach of STEM. So that students have the opportunity to learn Science, Mathematics, and Engineering by overcoming problems that have applications in the real world. Learning in the exact fields of Science, Technology, Engineering and Mathematics can occur through STEM, namely learning between sciences to learn academic concepts that are combined with the real world as the application of these fields [28]. In STEM learning, students are required to solve problems, make updates, find/design new things, understand themselves, do logical thinking and master. STEM in learning is expected to produce meaningful learning for students through the integration of knowledge, concepts and skills systematically [29].

This is supported by research that STEM is to produce students who later when they enter the community, they will be able to develop the competencies they already have to apply them to various situations and problems they face in their daily lives. In addition, STEM can develop when it is associated with the environment, so that learning is realized that presents the real world experienced by students in everyday life [30] According to Gagne, the learning objectives are abilities, namely Learning outcomes in the form of behavior that can be analyzed [31]. The learning objectives proposed by Gagne are the same as instructional goals or goals whose formulation shows behavior The science module is designed with an attractive appearance and selection of illustrations that can make it easier for students to understand the material, so that it will attract students' attention to learn.

## 4. CONCLUSION

The survey results show that teachers have a positive perception of the STEM integrated E-Module to improve students' systematic thinking skills. Based on the results of the analysis of the use of the STEM approach in schools, most of the teachers have not used the STEM approach. The STEM approach not only trains students to explore understanding of science but also mathematical skills and conceptual understanding in science so that STEM learning with the Flipped Classroom strategy can support 2013 curriculum learning. Science learning with the STEM approach has the potential for developing learning oriented to equipping systems thinking skills, so as to be able to involve students actively in the learning process.

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