**Regular Course on STEM for Mathematics Learning**
**for Junior High School Mathematics Teachers**
**SEAMEO Regional Centre for QITEP in Mathematics**
**Yogyakarta, 18 – 31May 2022 (100 hours @ 45 minutes)**

**FINAL REPORT**

# ON DESIGNING STEM LESSON, PEER AND REAL TEACHING, AND REFLECTION

**Themes :**

## PATTERN AND SEQUENCES

**FOR GRADE 8**

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## FOREWORD AND ACKNOWLEDGEMENT

To God is the glory for the wonderful blessings and for giving us knowledge and wisdom for us to be able to accomplish this final report of the "Regular Course on STEM for Mathematics Learning for Junior High School Mathematics Teachers, SEAMEO Regional Centre for QITEP in Mathematics Yogyakarta, 18 – 31 May 2022".
We wish that this report be beneficial to all teachers and personnel who have commitment to improve the quality of Mathematics Education in Southeast Asia.

This final report contents are:

1. The process of Designing STEM Lesson
2. Peer Teaching
3. Real Teaching
4. Reflection

We would like to thank first the Government of Indonesia for the generosity of giving fund for the course, to the facilitators, who selflessly shared their knowledge and ideas about Joyful Learning Mathematics Education and to the Committee who were there all the way to make all things easy, simple, and smooth sailing for us, a heart-warming Thank You! It is such a wonderful experience for each one of us!

This final report may not be perfect due to our limitations and weaknesses. Therefore, we invite everyone who reads to give some comments and suggestions for the betterment and improvement of this report.

**Group Members**

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# CHAPTER 1
# INTRODUCTION

## A. Introduction

Education should be able to form a positive way of thinking and behaving for all children. We, as teachers want to develop the ability to think logically, critically, and

systematically. So, from these thinking skills we can lead everyone, especially the students to behave in a positive, purposeful, and effective way. Mathematics as a science is a means to improve the thinking ability of each person. Therefore, the awareness of knowing and understanding the math for students is expected to grow in a very early age. Forming a full understanding of children in math is required prior to the love of mathematics, so that an educator should be able to create "Fun Learning" in the classroom. Fun learning in mathematics can be created if the teacher is able to teach various math concepts using various methods and techniques. Mathematics is known widely as the foundation of science and technology. In the information and technology era today, the ability to think and to reason is very important for everyone in every place. The reason is that today's world is changing rapidly. Mathematics can help or facilitate our students to learn to think and to reason. Marquis de Condorect, for example, (Fitzgerald and James, 2007: ix) has written: "Mathematics is the best training for our abilities, as it develops both the power and the precision of our thinking." Increasingly, mathematics will play a major role in determining the strengths and the weaknesses of nation's workforce. Therefore, Cross, Woods, and Schweingruber (2009:1) state that mathematicseducation has risen to the top of the national policy agenda as part of the need to improve the technical and scientific literacy of every citizen. The new demands of international competition in the 21st century require a workforce that is competent in and comfortable with mathematics.

Many of the changes in our world today mean that proficiency in basic mathematical concepts especially for primary school students will become more and more critical. In the line with that statement, the National Research Council from USA (NRC, 1989:1) states that communication has created a world economy in which working smarter is more important than merely working harder.

In this report, our group presents the process of on designing STEM Lesson, Peer and Real Teaching, and reflection. We chose the topic of pattern and sequences and a combination of STEM as teaching methods/strategies as part of our journey in developing lesson plan.

**B. The Aims of the lesson**

After the lesson we hope students will:

1. Analyzing the concepts of waves,
2. Make generalizations from patterns in number sequences and object configuration sequences,
3. Student can know the consept of pattern and can apply the pattern and wave to solve problems related to create the high and strong tower to get the signal,

4. Students use mathematics and science to design and construct a tower using clearly formulated success criteria, measurement, and constraint.

## C. Group Members

Our group consists of five teachers as follow:

Group Members

1. Afrizal Hasbi Indonesia
2. Annisa Nurfadhila Indonesia
3. Atika Defita Sari Indonesia
4. Churotul Mafiroh Indonesia
5. Danang Nurdiansah Indonesia

(*Youmay provide the picture of your group members*)

# CHAPTER II
## STEM FOR MATHEMATICS LEARNING FOR PRIMARY SCHOOL TEACHERS

### A. Designing STEM Lesson

STEM Lesson Plan planning begins with group discussions in stages by determining the things that will be done when giving lessons to students. During the group discussion we discussed the following:

a. Determining the Topic

Determination of the topic of the lesson plan based on the mutual agreement of the group members. Before choosing what topic to make a lesson plan on, each group member conveys their ideas about the topic that will be used as a lesson plan. Some of the topics that emerged were about the shape of the space, the area and circumference of a plane, Cartesian coordinates, then patterns and sequences of numbers. Each topic certainly has a relationship with problems that exist in everyday life. From some of the topics presented, we chose the topic of patterns and number sequences. The discussions conducted by our group were not limited to face-to-face discussions but were also continued through the Whatsapp group.

b. Determining Topics with Everyday Problems

After determining the topic, we continue by connecting the topic with everyday problems. From the experience of one member of the group that there is a problem about the difficulty of getting a telecommunications signal. To get a telecommunications signal requires a high place, namely the tower. The tower has a certain arrangement pattern in its structural design that can be connected with a number pattern.

c. Define Challenges, Success Criteria and Planning Limits

After connecting the topic with the existing problem, the next step is to plan what students will do in making the product, then also make the criteria for product success, and the limitations that exist in product design planning.

d. Making Engineering Design Process

The next step is we try to make a tower from the arrangement of playing cards. The tower was made as a guide to the success criteria in the form of the bottom of the

tower being bigger and smaller until it got to the top, each level of the tower has a different number of cards used, the height of the tower is also part of the success criteria.

e. Make Lesson Plans According to Standard Format

The next step is to write down what has been discussed previously into a standard lesson plan format consisting of titles, time allocation, guiding questions, curriculum standards, learning outcomes, engineering connections, prerequisite knowledge, tools and materials, resources, learning activities and making worksheet.

f. Creating Worksheets

To make it easier for students to make products and work in groups, it is necessary to make printed worksheets. Students plan their product designs on a worksheet and then write down ideas and practical data from the products made on the worksheet.

## A. PEER TEACHING

Peer teaching is a learning model that allows students to share their knowledge with their peers or teach their peers. Peer teaching is a learner-centered learning method. The Peer Teaching activity in the Regular Course on STEM for Mathematics Learning for Junior High School Mathematics Teachers in 2022 was held on Saturday, May 28, 2022. The implementation of Peer Teaching was divided into 3 classes, 2 face-to-face classes and 1 virtual class via the zoom application. meetings. The first class consists of groups 3 and 4, the second class groups 5 and 6 while the third class is for participants from abroad and students through the zoom meeting application, namely groups 1 and 2.

Our group is group 3, together with group 4, were in the first class in the study room of the Seaqim building. The first group to appear was group 4 with the model teacher, Mrs. Fitria Habsah. After that, after peer teaching, group 4 continued with group 3 with the model teacher, Mrs. Churotul Mafiroh.

Peer teaching is carried out based on the lesson plans that have been made. The model teacher starts peer teaching by greeting the course participants who act as students, followed by giving ice breaker first to ensure that students are ready to start

the lesson. Next, the model teacher introduces himself to his students and continues with the delivery of learning objectives. After that, the model teacher gave several questions to stimulate students' thinking, questions were asked about communicating via smartphones and about telecommunication signals (internet). Furthermore, pictures of several tower-shaped buildings are given as an initial picture of what will be discussed next.

The next stage is conveying the problem that is being faced by someone regarding the difficulty of getting a good signal to communicate. To get a good signal, you need a high place or you can also build a tower. Next, the model teacher conveys about what the students will make, namely making the tower as high as possible with some limitations, namely at the bottom of the tower making it bigger and continuing to shrink until it reaches the top. The tower is made with tools and materials in the form of playing cards, glue, clear insulation, scissors, and a tape measure used to measure the height of the tower.

The next stage is that students are divided into 2 groups with each group member there are 4 people and there are 5 people. Students work in groups to build towers. The towers made by group 3 are in the form of a triangular arrangement and group 4 make towers from a rectangular arrangement. After each group finished building the tower, they presented the results of their group's work, conveying how high the tower was made, the reasons for choosing the shape of the tower and the interesting things about their respective towers.

After the presentation from the two groups, the model teacher explained that the arrangement of cards from the tower made was an example of a number pattern. Number patterns are found in everyday life, for example, the shape of a beehive and the shape of a flower petal. The teacher and students conclude the results of the work carried out and after this stage is completed, the next stage of reflection is carried out with the Seaqim Facilitator Team.

There are several things that were conveyed by the Facilitator Team as supervisors in peer teaching activities, namely:

- Improvements to the success criteria and limitations in tower planning.
- Improvements to student worksheets
- There are challenges given to students in order to make the best tower possible.

In addition to the suggestion from the Facilitator Team, Group 4 gave a suggestion to add a limit so that students make a tower with the condition that the bottom is bigger and smaller to the top.

At the end of the peer teaching activity, each student fills out an online form for reflection and evaluation as a medium for assessment and improvement for the group and also for the model teacher. Furthermore, the model teacher thanked the Advisory Team and also to all participants, then the model teacher said greetings to end the peer teaching activity.

## B. REAL TEACHING

(Please explain about your experience in doing the real teaching activity)

## C. REFLECTION AND DISCUSSION

(Please explain about the interesting things that you

## D. LESSON PLAN REFINEMENT

(Please explain about the interesting things that you

# CHAPTER III
# CLOSING

## A. CONCLUSIONS

Setelah implementasi pelajaran STEM, kami sampai pada kesimpulan dan rekomendasi berikut.

1. This STEM learning method is referred to as a method that is in accordance with the characteristics of 21st century learning. 21st century learning is learning that prepares the 21st century generation with three main subjects in learning, namely: (1) learning and innovation skills; (2) Information, media, and technology; and (3) Life and career skills. Thinking skills that must be mastered by students in education in the 21st century are creative, critical thinking, problem solving, and decision making. The way of working or the ability to work in a global and digital world is that students must be able to communicate and collaborate, both with individuals and communities and networks. Students must also be able to master the tools and technology to work.
2. STEM is an interdisciplinary learning approach that combines knowledge (science), technology (technology), engineering (engineering), and mathematics (mathematics). The four disciplines become one of the comprehensive educational approaches as a pattern of problem solving through 21st century learning experiences. In addition, some of the benefits that are important reasons for using STEM learning methods are:
   - Teach children to think critically

     This STEM learning method covers the disciplines of Science (Science), Technology Technology, Engineering (Engineering), and Mathematics (Mathematics). With this method, students are honed to think critically by learning to solve and examine problems using technological tools and creative collaborative learning strategies. Ensuring the learning process is something that is fun and relevant to everyday life. By using this method, it can help students to grow into intelligent individuals, social skills, and good communication.
   - Help eliminate barriers to creative ideas

     This STEM learning method can eliminate barriers to ideas for creativity. Students can be creative as freely as possible. There is nothing wrong with being creative using STEM principles.

- Focus on processes that help lead to innovation

  With STEM learning, students will more easily solve problems in their lives ranging from academic problems to the real world. In addition, STEM learning can also instill a mindset in students to always prioritize solutions, innovation (creators), form independence, think logically rationally and understand technology.
- Teaches the power of observing the surrounding environment

  The science component in the STEM method makes students accustomed to thinking empirically. Thinking empirically means based on the reality seen. This is obtained from the habit of observing the surrounding environment.
- According to the 21st Century Learning Concept

  The benefits of the STEM learning model can be seen from its usefulness to answer the challenges of a fast-paced era. Because if this learning is implemented, future students will be easier to adapt to the times.

  Because with the basis of science and mathematics alone, students can pursue the knowledge or skills that later they want to achieve or want.

  With the knowledge or skills they can achieve, it will be much easier to get a job or produce something. Of course, there must also be other skills that need to be honed in this day and age, such as critical thinking, communication, collaboration, problem solving and digital literacy.
- Involve the role of parents

  The STEM method is actually closely related to how parents are taught to make activities with their children. In carrying out school activities during this pandemic, parents are asked to be actively involved in encouraging children to ask questions, be actively involved in children's activities, direct children to think creatively, encourage children to solve problems, and encourage children to explore, test solutions, and find new ways.
- Effective for learning during the pandemic

  This STEM learning method is very suitable for learning during a pandemic that relies on technological sophistication. With the STEM learning method, the learning process at home becomes more effective and fun.

## B. RECOMMENDATIONS

This context maybe not appropriate in certain place. It depends on the culture on their place. So as a teacher we must consider the culture where the student lives. So, for the next implementation, the consideration of the place and culture is important. There are several things that we can recommend based on experience in implementing STEM in learning, which are as follows:

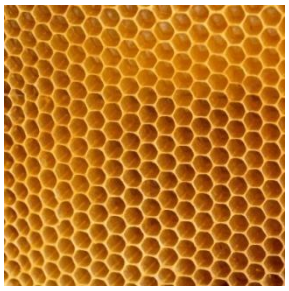
1. There needs to be support from various parties, especially from the government in an effort to improve teacher knowledge and skills in implementing STEM-based learning processes.
2. To carry out learning with the STEM method, the teacher must prepare learning tools and be equipped with STEM-based worksheets.
3. Need support from the school in terms of providing tools and materials in the implementation of STEM in learning.

**LESSON PLAN GROUP 3**

| | | | |
|---|---|---|---|
| **Title** | ***Where is my signal?*** | **Grade** | $8^{th}$ |
| **Time Allocation** | 2×40' | | |
| **Guiding question** | How to get the strong signal? | | |

| | |
|---|---|
| **Curriculum standards** | **Mathematics**:<br>3.1 Make generalizations from patterns in number sequences and object configuration sequences.<br>**Science:**<br>**3.11.** Analyzing the concepts of waves |
| **Learning outcomes** | By the end of this lesson, student can know the consept of pattern and can apply the pattern and wave to solve problems related to create the high and strong tower to get the signal |
| **Engineering Connection** | Students use mathematics and science to design and construct a tower using clearly formulated success criteria, measurement, and constraint. |
| **Prerequisite Knowledge** | Mention the examples of 2D objects you know, and shape of tower |
| **Tools and material** | 5 packs of playing cards,<br>5 insulating pieces,<br>5 scissors,<br>5 pieces of meter clothes or ruller. |
| **Resources** | *Phone signal*<br>*https://youtu.be/kIaU2e8Hcag*<br>*What is pattern in Math?*<br>*https://tinyurl.com/2p9pyrj8* |
| **Teacher preparation** | Teacher and student will be work together in their group, prepare the tools and materials will be used |

| | |
|---|---|
| **Learning Activity** | **Introduction (15 minutes)**<br>Teacher do ”ice breaking” with the student.<br>The student are given question about their knowledge about waves and signal, such as :(1) Do you often use smartphone? How often? (2) What does a cellphone need to be used for the internet ?(3) What do we need for using “data package”? (4) If we using internet, sometime we say the internet very slow. Exactly what makes this slow? Do you ever hear about ”Signal”?<br>Signals are emitted through the Tower, have you ever seen signal tower or the others? these are examples of pictures of the Tower.<br>**Main Activity (50 minutes)**<br>At the beginning the teacher gives an overview of the various forms of the Tower.<br><br>**Picture 1. The example of Tower**<br>The teacher will divide the group into 6 groups with each group of 5 students with 30 minutes of work and 30 minutes of presentation.<br>**Problem :**Atika lives in a secluded place. There the operator signal is difficult to receive. To get a signal, Atika plans to build a tower. the minimum tower height to get a signal is 7 m. Can you help tika to make the tower?<br>**Criteria** :Make the tower as high and attractive as possible, with a minimum height of 40 cm, make a simillar as possible like cellphone tower or signal tower (triangular tower). |

<table>
<tr><td></td><td></td></tr>
<tr><td></td><td>Announce the criteria, measurement, and constraint.<br>Write or show this in front of the class, below the challenge.<br><br><table><tr><th>Constraints</th><th>Criteria of successful solution</th><th>How to measure<br>How can you kno<br>your books fulfi<br>criteria?</th></tr><tr><td>1. Use one pack of playing cards.<br>2. The tower must be like triangle.</td><td>1. The tower can stand firm<br>2. Make the tower as high as possible, with a minimum height of 40 cm.</td><td>Reach minimum he</td></tr></table><br>Engineering Design Process( 40 minutes)<br>Students can make a signal tower from cards as high as possible with a minimum height of 40 cm and have order in the tower.<br><br>Group presentation and discussion (20 minutes)<br>Students present the results of the Tower they have made, and tell the difference (something that are unique in their tower).<br>The student and teacher see one of the unique tower (that using ”pattern”), and conclude with student what is pattern?Andwhat is the function of “pattern” in our tower? The next teacher given noun using pattern in real life<br><br> </td></tr>
<tr><td>Assessment</td><td>Mathematics Assessment:Get the arithmatics sequence.</td></tr>
<tr><td></td><td>Science Assessment: The taller the tower, the stronger and the farther the signal range gets.</td></tr>
<tr><td>Worksheet</td><td></td></tr>
<tr><td>Special Vocabulary</td><td>Pattern and wave</td></tr>
</table>

**Grup : ……..**
**Name : ……**
**Class : …….**

## PROBLEM

Atika lives in a secluded place. There the operator signal is difficult to receive. To get a signal, Atika plans to build a tower. the minimum tower height to get a signal is 7 m. Can you help tika to make the tower?

| SUCCESS CRITERIA | CONSTRAINTS |
|---|---|
| ▪ The tower can stand firm<br>▪ Make a tower as high as possible, with minimum height of 10 cm. | ▪ Made with playing cards (1 pack playing card) |

## TOOLS AND MATERIAL

- 5 packs of playing cards,
- 5 insulating pieces,
- 5 scissors,
- 5 pieces of meter clothes or ruller.

## LET'S DISCUSS

Try to discuss what you think about the shape of the telecommunication signal transmitting tower that you usually see everyday?

## LET'S PLAN

Make a picture of a telecommunications signal transmitting tower according to your respective constellations!

## LET'S CREATE AND TEST

- Make a tower with materials that have been prepared according to your design
- Please test whether the tower can stand, a good tower is one that can stand strong
- Write down the results of your activities in the table provided
- Please re-read the data in the table!
- Based on the results of your experiments, try to conclude about the criteria for a good tower!

## LET'S IMPROVE

Answer the following question! You will present it in front of your friends.

- Can your tower stand strong? Did you succeed in building a tower?

- Is there anything unique about your tower?

- Is there a relationship between the height of the tower and the signal obtained?

- If you could fix it a tower it better, how you improve it?

## DATA TABLE ACTIVITY 1

**Tower Height(H)= …….**

| SECTION LEVEL<br>Section 1 begin from bottom | AMOUNT OF CARD |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| **Total** | |

1. How many the different playing card for each level ?

2. There is the same different playing card for each level ?

3. How many card you use for your tower ?

4. If we have two package of playing card, how tall is your tower now? Explain your answer !

# SUPPORTING MATERIALS

## RUBRIC 1: ENGINEERING DESIGN PROCESS (*example*)

| No. | In Learning Process Students can … | Need Guidance (Novice) | Apprentice | Proficient | Distinguished |
|---|---|---|---|---|---|
| 1. | Design a product | Students cannot design a product | With teacher's guidance, students able to design a product | Students able to design a product | Students not only able to design a product, but also complete it with more information needed (for example scale) |
| 2. | Use mathematical concept, technology, and science to solve the problem | Students cannot relate knowledge, mathematics, and science that they have with the problem given by the teachers, and also cannot identify the technology needed | With teacher's guidance, students able to relate knowledge, mathematics, and science that they have with the problem given by the teachers, and also able to identify the technology | Students able to relate knowledge, mathematics, and science that they have with the problem given by the teachers, and also able to identify the technology | Students not only able to relate knowledge, mathematics, and science that they have with the problem given by the teachers, but also able to identify the technology, they also can identify other objects that relate to their product |
| 3. | Construct the product effectively and skillfully with correct tools | Students cannot able to construct the product and they use tools incorrectly | With teacher's guidance Students able to construct the product and they use tools incorrectly | Students able to construct the product and they use tools incorrectly | Students not only able to construct the product and use tools incorrectly, but also promote additional tools and better procedures |
| 4. | Identify strength and weakness of their design | Students cannot identify the strength or | With teacher's guidance, students able identify the | Students able to identify the strength or weakness of their design | Students not only able to identify the strength or weakness of their |

| | | | | | |
|---|---|---|---|---|---|
| | | weakness of their design | strength or weakness of their design | | design, but also able to promote other idea to improve it |
| 5. | Improve the product based on the strength and weakness found | Students cannot improve their product/ they do not test the product | With teacher's guidance students able to identify procedures to improve their product's design and give the reason why it will work | Students able to identify procedures to improve their product and give the reason why it will work | Students not only able to identify procedures to improve their product and give the reason why it will work, but also give scientific reason |

## Assessment Sheet

| No. | Name | In Learning Process Students can … | | | | | | Notes |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | Total Score | |
| 1. | | | | | | | | |
| 2. | | | | | | | | |
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## Hypotechtical Learning Trajectory

| Activity | Prediction of students' responses | Teacher responses |
|---|---|---|
| With guide from the teacher, students identify and discuss context<br>● do you often use your handphone?<br>● what does the handphone need to be used for the internet?<br>● How can we get a signal? | ● yes<br>● data/quota | For example, if we are using the internet and it feels very long, what do we really need ? |
| Discussion the building of the tower that the child might form and the criteria that have been determined | ● triangle<br>● Square<br>● Pentagon<br>● Hexagon<br>● Heptagon<br>● Octagonal | Try to test, what this tower can stand?<br>Can this design achieve a minimum height?<br>Is the number of bridge cards available enough to make this tower? |
| Discussion about what the unique things can be find from the towers<br>that have been made. | What is pattern ?<br>What function of pattern ? | Point to the pattern. |

## OBSERVATION SHEET (*example*)

**OBSERVATION SHEET FOR STUDENTS' ATTITUDE**

| No. | Name | Active | Collaborative |
|---|---|---|---|
| 1. | | | |
| 2. | | | |
| 3. | | | |
| 4. | | | |
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| 34. | | | |
| 35. | | | |

**Note:**
4 = very good
3 = good
2 = sufficient
1 = need guidance

**Rubrik for Students' Activity**

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Student doesn't take part in lesson and doesn't care for their work group | Students shows his/her effort to take part in the lesson and work group | Students shows take part in the lesson and work group consistently | Students not only, shows take part in the lesson and work group, but also give idea to improve their work group |

**Rubrik for Students' Collaboration**

| 1 | 2 | 3 | 4 |
|---|---|---|---|
| Student doesn't take part in to his/her work group | Students shows his/her effort to take part his/her work group | Students shows take part in the his/her work group consistently | Students not only, shows take part in the work group, but also give idea to improve their work group and test |

# SELF EVALUTION SHEET

**Name :** _____

| No. | Statement | Always | Sometimes | Rarely | Never |
|---|---|---|---|---|---|
| 1. | I pray before the lesson | | | | |
| 2. | I finish the task on time | | | | |
| 3. | I dare to take a risk of trying | | | | |
| 4. | I make effort by my self | | | | |
| 5. | I take part in the lesson | | | | |
| 6. | I take part in group discussion | | | | |
| 7. | I take part in designing product | | | | |
| 8. | I take part in construct the product | | | | |
| 9. | I respect other's opinion | | | | |
| 10. | I support group's opinion | | | | |

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