Designing STEM-based $AJarMat$ activities for the study from home program

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Abstract. $AJarMat$ or “$Ayo Belajar Matematika$” was a movement program that involved teachers and parents in guiding children to learn mathematics at home. Especially during a pandemic, learning is done from home so its need parental support. This study aimed to determine parents' role in assisting children to learn mathematics at home, obtain a STEM-based $AJarMat$ activities design that can be supported by parents, and know the strengths and weaknesses of the design from the parent's perspective. This research began with a survey on parental perceptions followed by a focus group discussion with two $AJarMat$ ambassador teachers who had attended STEM training and two teacher trainer who had experienced in STEM and $AJarMat$. The participants of $AJarMat$ from Jaten Public Elementary School were 26 parents of grade VI students. Data were collected using a Likert scale questionnaire 1 to 4, interview and document study then analyzed by descriptive statistics and qualitative analysis. The results showed that parents mainly act as motivators for children to learn mathematics at home. Furthermore, STEM-based $AJarMat$ activities that parents can support include a project to make necklaces from seeds for integer learning and a cake-making project for learning fractions. On the other hand, the strengths of this design are using creative activities and using real objects as counting objects so that students find it easy to understand mathematics, are enjoy and not bored. Lastly, the weaknesses of this design are the difficulty in obtaining materials and the process of making requires special skills and patience.

1. Introduction

The study from home program that was implemented during the Covid-19 pandemic need good cooperation between teachers and parents. In accordance with the guidelines for organizing study from home in the emergency period of the spread of Covid-19 [1], teachers play a role in preparing learning activities and evaluating student learning outcomes. 86.6% of learning activities from home was by working on questions from the teacher [2]. This caused difficulties for parents and students. This pandemic situation forced parents, ready or not, to help their children learn from home.

The home learning program could be conducted online or in combination with offline so technology and internet support were strongly needed. Home learning programs can be very challenging for teachers, students and parents, especially those people who live in developing countries because the accessibility, availability and using of technology are not well spread out [3]. The online learning during covid-19 also brought the negative effects such as teacher could not provide quick feedback to their student, sometimes students also did not respond to the feedback that given by teacher, lacking of
understand in learning materials, the student could not submit their assignment on time because the lacking of communication device, parents complained because the demand for internet quota has increased, parents were occupied with their children’s assignment and children saturation [4].

Parents realized that their children have difficulty in learning mathematics, but they were not able to provide support and could not explain in detail, while on the other hand the teacher needed support in making appropriate learning designs [5]. The packaging of learning and the media used by teacher affect mathematics resilience of elementary school students [6]. Teacher should design the learning that prevent student’s saturation and supported by the parent in home with the lack accessibility in learning device or in understanding mathematics materials. In learning mathematics at home, parents can play a role as motivator, resource provider, monitor, mathematics content advisor, and mathematics learning counselor [7].

*AJarMat* which stands for “*Ayo Belajar Matematika*” or let’s learn mathematics is a movement program that involves teachers to escort and help parents in accompanying their children to learn mathematics [8]. In the early stages, *AJarMat* socialized mathematics as a science that is applicable to everyday life [9]. *AJarMat* based on perspective of mathematics as human activity. Learning mathematics with children could be conducted with daily activity such as shopping to learning social arithmetic, playing water to introduce the concept of volume and so on. Parents were involved to assist children in learning mathematics through creative and fun activities.

Mathematics learning activities with parents can be carried out through activities developed based on STEM. Mathematical content in STEM activities is basic and utilitarian with activities that have didactic potential [10]. Therefore, it is possible to involve parents in it. At the other hand, the implementation of STEM on distance learning can increase students productivity more creatively [11].

STEM is an alternative to learning mathematics that is creative and fun [12]. STEM learning can be design by integrating traditional game through outdoor activity [13]. Learning with STEM approach allows student to learn mathematics in a fun way. Engineering in STEM education helped student to explore mathematics and science more independently and also helped them to develop critical thinking [14]. Although engineering skills would be the most needed in the working world, STEM education should began from primary level in order to get maximum impact for the student [15].

The current National Curriculum in Indonesia strongly supports the integration of STEM learning in order to practice it in the primary classroom [16]. The 2013 curriculum explain that learning at primary school level comes with an integrated approach. That was suitable with the definition of STEM approach as a curriculum based on the idea of educating students in four specific disciplines — science, technology, engineering and mathematics — in an interdisciplinary and applied approach. STEM learning was suitable for application in elementary school learning which was carried out thematically [17]. The integration of mathematics with science, technology and engineering (STE) is useful in providing context so that students can make a meaningful connection between mathematics and STE [18].

*AJarMat* activities can be developed based on STEM by involving parents. One of the keys to involving parents is a good STEM design. Homework that is clear to students and illustrates what they are learning in class supports parents’ understanding and provides a bridge between school and home [19]. The principle in STEM design is to follow the Engineering Design Process or EDP [20]. The EDP steps are. 1 Ask: student identify the problem, determine approach and identify the constraints. 2 Imagine: student determine some solutions or brainstorming idea and choosing the best solution. 3 Plan: student draw a diagram, make a list of materials that needed. 4 Create: student execute the best plan or solution and test it out. 5 Improve: student evaluate what are works and doesn’t. Students analyse and modify the design to make it better and test it out. EDP is a cycle carried out by students in solving problems or challenges presented by the teacher. The cycle can be seen in the figure 1:
This study aimed to 1) determine parents' role in assisting children to learn mathematics at home, 2) obtain a STEM-based AjarMat activities design that can be supported by parents, 3) know the strengths and weaknesses of the design from the parent’s perspective.

2. Research method
The research method used was a survey and Focus Group Discussion (FGD). The aim of survey was to determine the perceptions of parents about their role in learning mathematics at home. The respondents of survey were all participants of AjarMat from Jaten Public School at Ngemplak, Sleman Regency. They were 26 parents of grade VI students. Perception data were collected using a questionnaire with a Likert scale of 1 to 4 then analyzed using descriptive statistics by using the formula:

$$\frac{k}{n} \times 100\%$$

$k = \text{amount of voting respondent}$
$n = \text{amount of total respondent} = 26$

FGD can be used as a method to expand the result from survey and explore ideas in designing new product [21]. The research has purpose to obtain new design in mathematics learning by using STEM approach. The implementation of FGD started with identify objectives, identify questions, identify participants and moderator, select time and place, conduct research, evaluate data, and report. The notes from FGD were analyzed qualitatively.

STEM-based AjarMat activities design then implemented for study from home program. Parents were interviewed to determine the strength and weakness of the design. The results from interview were analysed qualitatively.

3. Results and Discussion
Parents were explained about the AjarMat movement in the Introduction to School Environment activity at the beginning of the new school year. After attending the socialization then asked to fill out a questionnaire via google form.

3.1. Survey Result
The profession background of the parents shown in the figure 2.
The majority respondent from parent occupation as private employee (27%) and also as teacher (4%). Parent’s occupation profile was useful to determine STEM topic activity that parents can easily support the activity. Parents' perceptions about their role in supporting children's learning at home is presented in the table 1.

Table 1. Perception Role of Parents

| No | Statement                                                                 | Always/very capable | capable | Seldom/not able | Never/very not able |
|----|---------------------------------------------------------------------------|----------------------|---------|-----------------|--------------------|
| 1  | I help my child in learning mathematics                                   | 46.15                | 34.61   | 19.23           | 0                  |
| 2  | I provide learning facilities to learn mathematics for my child           | 50                   | 30.77   | 15.38           | 3.85               |
| 3  | I motivate my child to learn mathematics as good as possible              | 76.92                | 23.08   | 0               | 0                  |
| 4  | I provide special time to support my child in learning mathematics       | 53.85                | 38.46   | 7.69            | 0                  |

76.92% of parents always motivated their children to learn mathematics and 23.08% were often. This means that all parents of *AjarMat* participants had the perception that they could act as motivators for learning mathematics. 46.15% felt that they were very capable of helping their children learn mathematics and 19.23% realized that were not capable. 50% of parents always provided facilities to learn mathematics and there were 3.85% who never provided facilities. 53.85% always provided special time to accompany their children to study and 7.69% were seldom. The result of the survey indicates that parents realize their role as a learning motivator for their child despite of time limitation, lack of mathematics competence or facility. As a motivator, parents play their role in providing emotional support for children’s learning which means providing support indirectly [7].

Based on questionnaire result, there were various background of parent’s occupation and they could play role as a motivator. Therefore, the design of STEM-based *AjarMat* activity design should not require parents to spend a lot of time guiding their children on project, it did not require parents to master
mathematics and the most important, it did not require parent to provide learning facilities which could affects some obstacles for parents.

3.2. Focus Group Discussion Result

The purpose of FGD was to design STEM-based *AjarMat* activities that could support by parents. The FGD was carried out in two phases involving participants based on their expertise. The first phase of the FGD aimed to produce a STEM project theme and activity design. For this reason, the first FGD involved two *AjarMat* ambassador teachers who had attended STEM training at The Regional Centre for Education in Science and Mathematics (RECSAM) Malaysia. *AjarMat* ambassador teachers or *guru kader* are teachers who have attended *AjarMat* coaching organized by PPPPTK Matematics, Ministry of Culture and Education of Indonesia. The second FGD aimed to produce validated STEM-based *AjarMat* activity designs. For this reason, the second phase involved two teacher trainers or *widyaiswara* from PPPPTK Mathematics who were experts in STEM and *AjarMat* learning. The FGD questions were compiled based on parents’ occupation's profile, the results of questionnaire and the curriculum that was applicable during the pandemic.

The questions for the first FGD are as follows: 1) what was the key point of STEM-based *AjarMat* activity? 2) What was the theme of the project in accordance with the mathematics topic that will be taught this semester? 3) What was project activity that will be provided to students regarding to the various conditions of students and parents? Student condition that needs to be considered was device availability, parents working hours, and parent capability to assist mathematics learning? 4) what materials that need to be prepared by teacher?

The First FGD conducted virtually through zoom meeting involved two participant and researcher as moderator. The result of first FGD were: 1) STEM-based *AjarMat* was implementation from STEM education in project or creative process to determine result or solution from problem which is including in this process EDP. 2) The material that had been given to students was the introduction of negative positive integers and the operation of calculating the addition of subtraction with a number line. Therefore, the theme of STEM project based according to pocketbook *AjarMat* was “Meronce” activity for integers and baking activity for fractions. The STEM design is presented in the table 2.

| Name of Project            | Mathematics                                                                 | Science                                                                 | Technology                                                                 | Engineering                                                                 |
|----------------------------|------------------------------------------------------------------------------|-------------------------------------------------------------------------|----------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Meronce                    | Apply an integer count operation to determine the value of a necklace         | Recognizing various seeds as a way of breeding plants                   | Use technology to find information about types of seeds that can be made into necklaces and how to make necklaces from these seeds | Apply the technique of making necklaces from seeds                        |
| (Making of Necklace or Bracelet) |                                                                                 |                                                                         |                                                                            |                                                                            |
| Making of Cake            | Applying fraction in making cakes and distributing them to all family members | Know the types of plants that can be made into cakes                    | Using technology to find information about various cake recipes and using tools to make cakes | Applying how to make a cake                                                |

3) Students' activity in the “meronce” project was to make necklaces or bracelets from seeds and then determine the value of the necklace or bracelet as a result of the integer operation. The activity in the cake making project was students together with their parents made recipes containing ingredients and their measurements by using fraction number, cooked with their parents and designed the distribution...
of cakes for all family members. 4) Learning materials that need to be prepared by the teacher were student worksheets and questions as drill preparation for examination. The worksheet would be given to the student during home visiting as well as providing material explanation. Furthermore, the student would complete the project with parent’s support at home. The duration of the project was one determined based on discussion between students, teachers and parents. Student’s project and worksheet then submitted to the school. After that, the teacher provided feedback to students and parents.

The questions for second phase FGD were: 1) Was the design and learning activity in this project in the same line with the implementation of national curriculum during pandemic? 2) Was the activity in the project design suitable with STEM education? 3) Was the activity in the project suitable with AJarMat concept? 4) Was the activity in the design could be accomplish by student with parent’s support? The second phase FGD conducted in person with two teacher trainers and researcher as moderator. The results from second FGD were: 1) Project design and activity were in the same purpose with national curriculum during pandemic. Advice and suggestion for workshee shown in the following table 3:

| No | Worksheet                  | Suggestion and improvement                                                                 |
|----|----------------------------|------------------------------------------------------------------------------------------|
| 1  | Meronce Activity           | The illustration of the necklace on the worksheet should use a bracelet with bigger seeds. This is because student still at the conceptual understanding stage with small number value. |
| 2  | Making Cake Activity a.    | Adding activity instructions so that students pay attention to problems first (ask and imagine) before planning     |
|    |                            | It is necessary to add "determining the tools used to bake the cake" as a point in the technology component            |
|    |                            | It is necessary to add fraction conversion table from regular fraction to decimal with example                            |

2) The activities in the design were suitable with STEM Education, strongly recommended to add learning activity “communicate the result” through zoom meeting if it’s possible. This suggestion could not be conducted because lack of facility. 3) The activities in the design were in the same line with AJarMat concept through displaying mathematics in daily activity and learning mathematics by involving parents. 4) Meronce and baking cake plan were possible to be done with parent’s support. They could assist their children in searching information from the internet or books, help in designing a necklace or bracelet model and making a cake plan. The activity did not require much computer and internet access. Parents could give advice to children about the shape of a beautiful necklace or bracelet, the ingredients in making cakes, or provided materials and tools that were found in the home environment.

The design activity AJarMat “Meronce” and baking cake has fulfilled the element of EDP [20]. The activity “meronce” implemented as following step: 1) student identified the various seed as materials for necklace (ask), 2) student did brainstorming with parents in choosing type of seeds (imagine), 3) student designed a necklace or bracelet model (plan), 4) student created necklace and bracelet (create) 5) student evaluated their work with the parent. Then they work on worksheet and math evaluation (improve)

The activity of baking cake was carried out through the following steps: 1) the student decided the type of cake after discussion with parent (ask and imagine), 2) student made plan and material list (plan), 3) student made the cake with parent (create) 4) student evaluated cooking result, divided cake into equal portions for the whole family and got feedback about the cake that they have made (improve). Then student filled out worksheet to strengthen their mathematics skill related to fractions.
3.3. Constraints in Implementation and Parental Responses

The STEM-based AJarMat activity design that was implemented in home learning was “meronce” activity. Student use peanuts, maize, lamtoro, peanuts, jail corn, and guide beans to make necklaces or bracelets. Examples of student work are presented in figure 3 and 4 below:

![Figure 3. The addition of the integers with the small number](image)

The student work (figure 3) used 12 corns and 5 lamtoro seeds. The value of one corn seed was -1 and the value of one lamtoro seed was 1, then the value of the necklace was $-12 + 5 = -7$.

![Figure 4. The addition of the integers with the large number](image)

In figure 4, student used 25 peanut seeds and 30 corns. The value of one peanut seed was 1 and the value of one corn seed was -1, so the value of the necklace was $25 + (-30) = -5$.

The various kinds of necklaces and bracelets made by students can be seen from the variety of seed materials used. The varied design of necklaces and bracelets allows student to obtain different count result because the number of seeds used is different. Therefore, STEM-based AJarMat activities allowed
students to be creative and solve open problems. They could solve the problem in various ways or solutions.

However, the teacher encountered several problems in implementing the project of "meronce" at the study from home program. Some students still had difficulties to understand what they had to do. Although the worksheet and instructions had been prepared, students did not read the entire instructions from the project. Therefore, an explanation from the teacher was still needed. Some students had difficulties finding seeds and materials to make the projects. Parents' involvement in this activity of "meronce" was indirect, but there were still students who did not make their own work or had it made by their parents. The agreed duration for completion project was one week. For the purpose of monitoring project implementation, the teacher asked students to send documentation of the manufacturing process, but some students did not document it properly.

According to the parent's perspective, the weaknesses of "meronce" project were the difficulties in finding the material and the process of "meronce" project was not easy. It required patience on "meronce" process. The strengths of this project were their children were happy to be able to produce works and easy to understand mathematics because they used real objects as counting objects. The students did not get bored because they learnt mathematics through activities and not only doing assignment. STEM-based AJarMat activity was believed by parents to be able to retreat intelligence in calculating mathematics and enabled the student to learn mathematics in a fun way.

Due to the pandemic situation, fractional activity cannot yet be carried out and will be implemented at second semester. Considering at the response of parents toward STEM-based AJarMat activity, we need to develop the activity for different mathematics topic. Furthermore, we need research on students to determine their mathematics abilities after participating STEM-based AJarMat activity and know their opinion about learning mathematics activities at home with parent.

4. Conclusion

- Parents mainly act as motivators of children in learning mathematics.
- STEM-based AJarMat activities that can be supported by parents are in the form of creative activities to make necklaces from seeds for learning integers and baking activities for learning fractions.
- The strengths of this design are using creative activities and using real objects as counting objects so that students find it easy to understand mathematics, the student are enjoy and not bored. The weaknesses of this design are the difficulty in obtaining materials and the process of making requires special skills and patience.

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