Training on The Implementation of Mathematical Models on Basic Macrame Patterns in Producing Macrame Handcrafts

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Abstract

This training aims to introduce and implement mathematical models in the process of creating basic macrame patterns as a basis for developing aesthetically and economically valuable handicrafts. Macrame is the art of weaving knots with repetitive and structured patterns, allowing mathematical approaches such as geometric patterns, transformations, and simple algorithms to be applied in its design. Through this training, participants not only learn basic macrame techniques but also understand how knot patterns can be mathematically modeled to produce consistent, efficient, and innovative design variations. The training results demonstrate that integrating mathematical models into handicrafts can enhance creativity and accuracy, and provide an engaging alternative approach to contextual mathematics learning. This activity is expected to empower the community while introducing the STEM concepts of Science, Technology, Engineering, and Mathematics (Natural Sciences, Technology, Engineering, and Mathematics) to the world of handicrafts.

Keywords: Mathematical Models, Macrame, Basic Patterns, Handicrafts, Training

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Introduction

Aek Pancur Village, located in Tanjung Morawa District, Deli Serdang Regency, North Sumatra, is an area with significant human resource potential and community creativity. Residents in this village, particularly housewives, teenagers, and MSMEs, are interested in productive, economically valuable activities that can be done from home. Amidst the development of the creative industry and increasing market interest in unique, handmade crafts, macrame presents a promising opportunity to be developed as a superior local product. In addition to its readily available and environmentally friendly raw materials, the production process is flexible and accessible to anyone, including housewives and teenagers looking to supplement their income.

Macrame is widely known for its flexibility in producing a variety of products, such as wall hangings, plant pot hangers, accessories, and even decorative furniture. However, many people don't realize that behind these decorative knots lies a structured pattern that can be analyzed and developed through a mathematical modeling approach. Basic mathematical concepts such as patterns, symmetry, sequences, iterations, transformations, and knot combinatorics are highly relevant in designing and developing macrame patterns. Unfortunately, at the community level—especially among MSMEs, novice craftspeople, housewives, and creative youth—many still lack access to training that integrates art and science. Yet, local potential, such as readily available rope materials, high public interest in handmade decorative products, and market opportunities through social media and digital platforms, strongly support the development of macrame craft businesses.

Seeing these potentials and problems, a community service program entitled "Training on the Implementation of Mathematical Models on Basic Macrame Patterns in Producing Macrame Handicrafts in Aek Pancur Village, Tanjung Morawa District" is needed. It is hoped that this program will not only improve the skills and income of the community, but also encourage the realization of village economic independence based on sustainable local resources.

Literature Review

Macrame was discovered by Arab weavers in the 13th century which means fringe decoration. According to Asriyani (2013:8) related to the meaning of macrame, "Macrame is the oldest textile made by knotting several ropes or threads into a geometric decorative patterned shape". According to Sispayani (2012:2) macrame is a form of knotting art craft by working on the initial and final thread chains of a woven product, by making various knots on the thread chain so that various tassels and tassels are formed. This macrame craft art is a result of textile crafts, much loved by decorative art lovers because currently many people have a high interest in decorative art works to support the beauty of a residential space. This can be seen from the increasing number of macramé buyers in every decorative art store.

The art of macramé, synonymous with knotting techniques for decorative crafts, relies not only on manual skill and aesthetics but also closely links to basic mathematical concepts. In its creation, macramé patterns often exhibit consistent repetition, balanced symmetry, and measured proportions—all essential elements of mathematical models. Through this approach, macramé becomes an effective medium for introducing applied mathematical concepts in a contextual and engaging way. The use of number sequences, geometric patterns, and coordinate systems in macramé designs opens up opportunities for developing logic skills, creativity, and problem-solving abilities. Thus, the connection between macramé patterns and mathematical models not only enriches the work but also serves as an innovative educational tool for everyday life.

Many macramé artisans rely solely on intuition and practical skills, unaware that the patterns they create actually contain systematic mathematical structures, such as repetition, rows, symmetry, proportion, and basic geometry. As a result, the production process becomes

less standardized, less efficient, and difficult to optimize on a larger scale. Therefore, a training approach is needed that integrates simple mathematical models into the macramé pattern-making process, enabling participants to develop logical thinking skills while producing high-quality, high-value craft products.

The potential for macrame handicraft production at the Aisyah Green House Foundation, Community Learning Center (PKBM) in Aek Pancur Village, Tanjung Morawa District, Deli Serdang Regency, is as follows:

1. Creative and Aesthetic Potential
   - Macramé can be made into various products: wall hangings, pot hangers, curtains, bags, key chains, and even fashion accessories.
   - Patterns and designs can be created according to taste and market trends.
   - Uses techniques that are relatively easy to learn and develop.
2. Economic and MSME Potential
   - Relatively small initial capital required (thread, wood, metal rings, etc.).
   - Can be done at home and is flexible (suitable for housewives, students, teenagers, and the elderly).
   - Potential to become a superior local product and regional souvenir.
   - Can increase community income based on handicrafts.
3. Local and International Market Potential
   - Macramé products are in demand in domestic and international markets, especially the crafts and interior design markets.
   - Can be sold through various channels: exhibitions, souvenir shops, and marketplaces (Tokopedia, Shopee, Etsy, etc.).
   - The natural and handmade lifestyle trend among young people and home decor enthusiasts expands market opportunities.
4. Potential for Education and Empowerment
   - Suitable as a medium for productive skills training in community development centers (PKBM), women's communities, Islamic boarding schools, or schools.
   - Opens opportunities for collaboration with other subjects such as mathematics (patterns, geometry), art, and entrepreneurship.
   - Serves as a means to cultivate precision, patience, and creativity.
5. Environmentally Friendly Potential
   - Can use natural materials (cotton, leaf fiber, wood, bamboo).
   - Supports the sustainable craft movement and the circular economy.
   - Macramé products do not produce chemical waste and are recyclable.
6. Potential for Collaboration between Art and Science
   - Can be used for experimentation with less commonly used mathematical patterns, such as the Fibonacci pattern for knot size and the logarithmic spiral pattern for unique shapes.
   - Uses color and shape combinations that follow the principle of symmetry or the golden ratio in knot size.

Based on the situation analysis above and the existence of several problems in Aek Pancur Village, Tanjung Morawa District, the community service team offers solutions to overcome these problems, namely:

1. Basic Macrame Pattern Technique Training
   - Introduction to macrame materials and tools.
   - Explanation and practice of basic knots (such as square knots, lark's head knots, spiral knots, etc.).
   - Simple pattern construction.
2. Use of Linear Models to calculate material requirements

   Rope Length = Number of Knots x Average Length per Knot

- Macrame patterns are created as a measurable system (matrix or scale), so the craftsperson knows exactly how many knots and materials are needed for each product.
- Use of proportional measurements (height-to-width ratio, length-to-knot ratio) to create efficiency and consistency in product results.
- Application of mathematical patterns in design:
  - Arithmetic sequences to form triangular patterns (for example: number of knots per row = 1, 3, 5, ...)
  - Simple fractals for branching patterns (resembling leaves, flowers, or tree branches)
  - Radial or translational (sliding) symmetry in circular or rectangular designs.

3. Project-Based Learning
   - Each participant is asked to create a simple product (e.g., a key chain or hanging planter).
   - The technique used must incorporate the knots learned.

Research Methodology

The community service method used is Participatory Action Research (PAR) through specific stages (Wahyuni et al., 2023). The stages of community service implementation include: 1) Focus Group Discussion (FGD). The FGD is conducted at the beginning of the activity between the community service team. This is done to provide a more detailed explanation of the activities to be implemented and to establish a time contract for the activity. 2) Socialization of the community service activity to community groups. During this socialization, the team provides explanations to community groups regarding the technical aspects and schedule of activities to be carried out in the community service implementation. The media used in this socialization activity are PowerPoint (PPT) and demonstration aids. 3) Education and practice on community empowerment (Lubis et al., 2023) through training on the implementation of mathematical models in basic macrame patterns to produce macrame handicrafts and motivation. The work procedures carried out include:

1. Preparation Stage
   The team coordinates the community service implementation plan, including the schedule and location of the activity. The activity is planned for July 2025 at the Aisyah Green House Foundation, the Green House Community Learning Center (PKBM) in Aek Pancur Village, Tanjung Morawa District.
   a. Work Procedures
      1. Preparation Phase
         The team will coordinate the planned community service implementation, including the schedule and location of the activity.
      2. Implementation Phase
         The activity will be implemented in the following stages:
         a. Preparation of training modules/materials for implementing mathematical models in basic macrame patterns to produce macrame handicrafts.
         b. Lecture and discussion
         c. Hands-on practice in making macrame handicrafts.
         d. Lecture materials (presentations) will be provided to participants in the form of training modules, followed by discussions (Q&A sessions) and hands-on practice in the field.
2. Activity Schedule
   The activity was carried out with a partner, the Aisyah Green House Foundation, Community Learning Activity Center (PKBM) in Aek Pancur Village, Tanjung Morawa District, on June 25, 2025.

3. Description of Partner Participation
   The partner participated in providing the necessary materials and equipment and providing participants from the Aisyah Green House Foundation, Community Learning Activity Center (PKBM) in Aek Pancur Village, Tanjung Morawa District.

A. Results

The Community Service entitled Training on the Implementation of Mathematical Models on Basic Macrame Patterns in Producing Macrame Handicrafts in Aek Pancur Village, Tanjung Morawa District aims to provide skills to the community through the application of mathematical concepts to basic macrame patterns so that they can produce handicraft products that have aesthetic value and have economic potential. Participants consisting of young village youth were able to understand the basic concepts of mathematics applied in macrame knot patterns. Through practical guidance, they succeeded in making various macrame handicraft products such as pot hangers, wall hangings, and other simple accessories. In addition to improving skills, this activity also fosters creativity and opens the community's insight into handicraft-based business opportunities. The following is a more detailed report of the results:

1. Participants
   - Twenty young people from Aek Pancur Village, Tanjung Morawa District, participated in this training during their school holidays.
   - Attendance and participation were high, demonstrated by their enthusiasm throughout the training session.
2. Materials Delivered
   - Basic mathematical concepts relevant to macrame pattern formation.
   - Basic macrame knotting techniques and their application in various designs.
   - Developing creativity in producing marketable craft products.
3. Participant Achievements
   - Participants were able to understand the application of mathematical concepts to macrame knotting patterns.
   - Participants successfully produced handicraft products such as pot hangers, wall hangings, and simple accessories.
   - Participants demonstrated improved skills and neatness in creating macrame patterns.
4. Impacts and Benefits
   - Improving community skills in macrame-based handicrafts.
   - Fostering creativity and awareness of the economic potential of craft products.
   - Providing opportunities for the development of craft-based micro-enterprises for the Aek Pancur Village community**.**

The community service activity began with an introduction to the community service program for members of the Indonesian Muslim Student Association (IKBI) of PTPN II, followed by an explanation of the mathematical number patterns associated with macramé knots and a hands-on experience in macramé crafting.

The presentation and hands-on experience in macramé crafting were as follows:

- First, the UNPAB community service team explained the origins of macramé. The word macramé comes from the Arabic word "mucharam," which in Turkish comes from the word "makrama," meaning tassel. Macramé is believed to have first appeared around the 13th century among Arab weavers. Traders, especially sailors, carried and distributed macramé from one place to another. Sailors knotted knots as a leisure activity and brought them home as souvenirs.
- Second, the community service team explained the relationship between mathematics and macramé craftsmanship. The explanations were as follows:
  a. Geometry

- Macrame knot patterns form plane shapes (triangles, squares, parallelograms, rhombuses).
- Macrame ornaments often utilize the concepts of line symmetry and rotational symmetry.

Example: Repeating knot patterns form a rhombus motif that is symmetrical on the left and right.

b. Pattern and Repetition (Pattern & Sequence)
   - Macrame knots are created by repeating certain steps.
   - This aligns with the concept of sequences and series in mathematics.

   Example: A spiral knot is formed by repeating a single knot in the same direction consistently.

c. Proportion and Size (Measurement & Ratio)
   - The length of the rope used must match the size of the product you want to create.
   - Calculations are made using ratios, for example: rope length = 4–5 times the length of the macrame product.

   Example: If you want to make a 50 cm long pot hanger, prepare approximately 250 cm of rope.

d. Geometric Transformations (Rotation, Translation, Reflection)
   - Macrame often features patterns that are repeated through rotation (rotation), translation (shifting), or reflection (mirroring).

   Example: Macrame wall hanging patterns are usually mirror images (reflections), thus creating symmetry.

e. Symmetry and Mathematical Aesthetics
   - The neatness of macrame relies heavily on pattern balance (symmetry).
   - This principle aligns with the concept of symmetry in mathematics, which creates visual beauty.

   Example: A circular macrame accessory with a balanced pattern of 8 knots, similar to the symmetry of a circle.

- Third: Then, we will explain the knots used in macrame: Macrame has only two basic knotting techniques: the flat knot and the cordon. These two knots can be developed into various types of knots, such as the anchor knot, double flat knot, horizontal cordon knot, double flat knot, plait, pearl knot, Chinese crown knot, and many others.
- Fourth: Practice making macramé products, namely macramé flower hangers (macrame flower hangers), step by step.
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Figure 1. Macramé handicraft making practice

- Fifth: Promote the creative economy, namely opening up business opportunities in the creative industry where each product to be marketed is the result of the entrepreneur's own creation/processing.

Conclusion

Based on the series of training activities that have been carried out, it can be concluded that the implementation of mathematical models in basic macrame patterns has been proven to be able to: 1) improve participants' understanding of the application of mathematical concepts, especially patterns, repetition (iteration), and symmetry in making macrame handicrafts, 2) connect mathematical theory with direct practice through the application of basic macrame patterns, so that the resulting crafts are neater, structured, and varied, 3) provide added value, both in terms of artistic skills and from the aspect of mathematical thinking logic, which is useful for developing creativity and the potential for independent business in the field of handicrafts. Overall, this training has succeeded in achieving its goal of improving participants' ability to apply mathematical concepts to the practice of making macrame products, thereby supporting the productivity and quality of craft results.

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