SOCIETY: Jurnal Pengabdian Masyarakat,
Vol. 5, No. 1 (2026): Januari, pp. 90-98
E-ISSN:2827-878X (Online -Elektronik)

Empowering Orphaned and Underprivileged Youth through Quilted Fabric Craft Based on Three-Dimensional Geometry and Realistic Mathematics Education

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ARTICLE INFO

Article history:
Received : 10-12-2025
Revised : 29-1-2026
Accepted : 29-1-2026

Keywords

community empowerment, realistic mathematics education, quilted fabric, youth entrepreneurship, digital literacy

ABSTRACT

This community service program aimed to empower orphaned and underprivileged youth at Rumah Yatim Medan through an integrated approach combining mathematics education, creative skill development, and digital literacy. A total of 18 children from elementary to high school levels participated in two sessions of quilted fabric product-making and one session of digital marketing training. Using the Realistic Mathematics Education (RME) approach, participants learned three-dimensional geometry concepts—such as area, perimeter, and volume—through hands-on activities involving fabric measurement, pattern design, and product construction. In addition, participants were introduced to basic entrepreneurship through practical exercises in social media-based promotion. Evaluation was conducted using pre- and post-tests, which showed substantial improvement across three learning domains. The average score for mathematical understanding increased from 55 to 80, product-making skills from 50 to 82, and digital marketing awareness from 40 to 78. The instruments used demonstrated high internal reliability with a Cronbach's Alpha of 0.906. The program also enhanced participants' confidence, collaboration, and initiative. A shared digital gallery was created via social media as a platform for showcasing their products and continuing promotional practice. Shelter staff expressed strong support and commitment to sustaining the activity. This program demonstrates the potential of contextual, interdisciplinary education to foster academic, vocational, and digital competencies in marginalized youth, while supporting the achievement of SDG 4, SDG 8, and SDG 12

A. INTRODUCTION

Orphaned and underprivileged children are among the most vulnerable populations, often facing compounded disadvantages including limited access to quality education, psychological insecurity, and lack of economic opportunity (Sihombing et al., 2021; Aditama & Kurniawan, 2022). Without adequate intervention, many of them internalize beliefs of inferiority and dependency, perpetuating a cycle of poverty (Prasetyo & Lestari, 2022).

Community empowerment programs that incorporate contextual education, vocational skills, and character development have been shown to produce measurable impacts in building independence and self-worth among marginalized youth (Maulida & Nugroho, 2021; Yusuf & Amalia, 2023). According to UNESCO (2016), technical and vocational education and training (TVET) should not only equip learners with job skills but also foster creativity, sustainability, and adaptability.

One such educational strategy is Realistic Mathematics Education (RME), which encourages learning through real-world situations and modeling (Freudenthal, 1991; Gravemeijer, 1994). In Indonesia, RME has been widely adopted to support students' understanding of abstract mathematical concepts by connecting them to local and contextual knowledge (Wijaya, 2012; Rahayu & Widodo, 2020; Zulkardi et al., 2021). Recent studies also emphasize the effectiveness of combining RME with project-based learning and ethnomathematics in community settings (Syahputra & Mayasari, 2020; Hamid & Nugraheni, 2022).

Meanwhile, the creative economy—particularly the textile-based craft sector—offers a low-cost and high-impact platform for social entrepreneurship, especially when using recycled materials (Adimaja, 2023; Suherman & Kartika, 2023). Quilting and patchwork production not only engage spatial and geometric reasoning but also develop motoric skills, problem-solving, and design thinking (Rahman & Nurhaliza, 2021; Kurniasih & Ramadhan, 2020). These elements are essential for fostering 21st-century competencies such as creativity, communication, and collaboration (Trilling & Fadel, 2009).

Equally important is the introduction of digital marketing literacy. Today's youth need to be equipped with digital tools to communicate value, present products, and access broader markets (Permana & Indriani, 2022; Fauziyah & Rosyidah, 2023). Low-income communities, in particular, benefit from training that includes branding, content creation, and social media promotion (Wahyuni & Pramana, 2023).

This program was implemented at Rumah Yatim, a shelter located in Medan, North Sumatra, housing 18 children from elementary to senior high school levels. The community service aimed to:

(1) Develop children's creative and entrepreneurial skills through quilted fabric craft,
(2) Reinforce mathematical concepts of three-dimensional geometry via the RME approach, and
(3) Introduce digital marketing as a basic entrepreneurial literacy.

This initiative is grounded in the national guidelines for non-formal education empowerment (Kemendikbudristek, 2021) and aligned with Sustainable Development Goals (SDGs) 4 (Quality Education), 8 (Decent Work and Economic Growth), and 12 (Responsible Consumption and Production) (Suryani & Abdullah, 2021).

The novelty of this program lies in its interdisciplinary integration of mathematics, craft-based vocational skills, and digital entrepreneurship, embedded in a participatory learning environment designed for underprivileged youth. This model affirms that transformative education must go beyond the classroom to address socio-emotional needs, economic sustainability, and community participation (ILO, 2020; Nugroho & Wibowo, 2020).

B. METHODS

This community service program was conducted at Rumah Yatim, a social shelter located in Jalan Karya Kasih, Johor, Medan, which houses 18 orphaned and underprivileged children, both boys and girls, aged 8 to 17 years. The method used was participatory educational empowerment, combining hands-on skill-building with contextual learning in

mathematics and entrepreneurship.

The program was implemented in five stages:

a) Socialization and Initial Assessment
   The project began with a needs assessment phase involving informal interviews with the shelter's caregivers and children to identify existing perceptions, prior experiences, and training gaps. This participatory diagnosis process ensured that the training materials and strategies were relevant to the beneficiaries' context (Fauziyah & Rosyidah, 2023; Yusuf & Amalia, 2023).
   The team also presented the goals, expected outcomes, and timeline of the activity to the shelter, fostering mutual commitment and co-ownership of the process (Sihombing et al., 2021).
b) Product-Making Training (Two Sessions)
   Participants received two sessions of training on how to create basic products from recycled fabric (patchwork quilting). They were introduced to cutting patterns, measuring fabric using rulers and tape, assembling geometric shapes (e.g., cuboids and cylinders), and sewing techniques. During these sessions, mathematical concepts such as area, perimeter, and volume were embedded through real tasks, implementing the Realistic Mathematics Education (RME) approach.
c) Digital Marketing Workshop (One Session)
   A separate session was held to introduce basic digital marketing skills. Participants were guided to create visual product content, write simple promotional captions, and simulate posting to social media platforms (e.g., Instagram and Facebook). An official account was created as a shared digital gallery to showcase their works.
d) Assistance and Monitoring
   The project team, including student volunteers, provided hands-on mentoring during the sessions to ensure each child was able to participate and follow instructions. They also monitored each child's cognitive, motoric, and emotional engagement. Feedback was collected through observational notes and informal discussions with shelter caregivers.
e) Evaluation and Reflection
   Evaluation was carried out using pre- and post-test instruments that measured the participants' understanding of geometry, self-confidence in production skills, and knowledge of digital promotion. The final session involved a reflective discussion where children shared their experiences, feelings, and aspirations after completing the training.

The entire program was designed with a gender-sensitive and inclusive approach, ensuring that both boys and girls had equal opportunities to participate. Throughout the activity, the role of shelter staff was not only as facilitators, but also as co-learners and co-motivators, ensuring program continuity beyond the intervention period.

C. RESULTS AND DISCUSSION

This community engagement program successfully involved 18 children from Rumah Yatim and 6 shelter administrators. The activities were carried out as scheduled, consisting of two sessions of quilted product training and one session of digital marketing introduction. All participants engaged actively throughout the sessions, with outputs including handmade bags, pencil cases, and decorative patchwork panels. In addition to tangible products, the program achieved cognitive and affective development outcomes.

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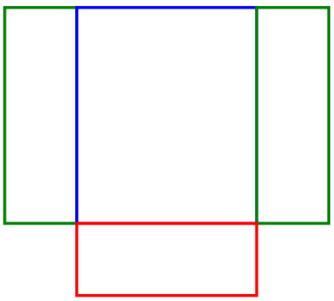
To ensure that the training was not only skill-oriented but also educational, the program emphasized the integration of mathematical concepts into the crafting process. Mathematics, particularly geometry, was embedded into the activities in order to strengthen participants' spatial reasoning and problem-solving skills. This integration was designed to align with the Realistic Mathematics Education (RME) approach, making abstract concepts more meaningful through direct application in quilting projects. One of the key focuses was the use of three-dimensional geometry in designing and constructing tote bags.

1.1. Integrating Three-Dimensional Geometry into Quilted Fabric Craft

The empowerment program integrated the concept of three-dimensional geometry into quilted fabric craft as both a mathematical foundation and a practical skill. Tote bags were chosen as the main project because their structure is simple yet highly functional, making them an ideal medium for connecting mathematics with real-life applications. In this activity, participants were introduced to the basic dimensions of a tote bag: length, width, and height. These measurements were then applied to calculate the volume of the bag, which represents its capacity, and the surface area, which corresponds to the amount of fabric required. For example, a tote bag with a base of 25 × 10 cm and a height of 30 cm was modelled as a cuboid with a volume of 7,500 cm^3 (approximately 7.5 litres). This exercise helped participants understand how mathematical formulas translate into everyday objects.

The process continued with the construction of nets, in which the three-dimensional shape of the tote bag was unfolded into two-dimensional patterns. By analysing the net—comprising the front and back panels, side panels, and base—participants could accurately estimate fabric needs, including allowances for seams. This step not only trained them to connect geometry with sewing but also fostered awareness of efficiency and sustainability in fabric use, particularly when working with quilt scraps. By embedding these geometric concepts into crafting practice, the program applied the principles of Realistic Mathematics Education (RME), where abstract ideas are grounded in meaningful contexts. As a result, participants developed not only quilting and sewing skills but also mathematical reasoning, problem-solving abilities, and entrepreneurial awareness that can support sustainable creative industries.



(a)

(b)

Figure 1. (a) Net Blocks for Tote bag; (b) Presentation of The Three-Dimensional Concept in Bag Pattern Making

1.2. Learning Outcomes and Empowerment Indicators

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The pre- and post-tests administered to the 18 participants assessed three domains: (1) understanding of three-dimensional geometry, (2) product-making skills, and (3) awareness of digital promotion. A similar instrument was provided to the 10 staff members to assess their perception and support toward the program.

The validity and reliability of the instruments were confirmed through internal consistency analysis. The results are summarized in Table 1.

Table 1. Instrument Validity and Reliability Summary

Instrument	Number Of Items	Number Of Respondents	Cronbach's Alpha	Average Item Validity (R)
Participants	10	18	0.906	0.668
Partners	10	6	0.906	0.664

These results indicate that the instruments used were highly reliable ($\alpha > 0.90$) and had strong internal validity ($r > 0.66$), supporting the credibility of the data collected.

1.3. Learning Outcomes and Skill Development

Throughout the two sessions of product-making training, participants demonstrated significant improvement in both cognitive and psychomotor domains. They learned how to measure and cut fabric accurately, use geometric templates, and assemble patchwork into three-dimensional objects such as bags and pencil cases. These tasks required them to apply fundamental mathematical concepts including area, perimeter, volume, and spatial reasoning, which were embedded into the activity using the Realistic Mathematics Education (RME) approach.

Figure 2. Product-Making Training

The effectiveness of this integrated method was evaluated using a pre-test and post-test instrument. The test measured participants' understanding of mathematical geometry, technical production skills, and digital marketing awareness. Figure 3 illustrates the average scores obtained before and after the training across the three domains.

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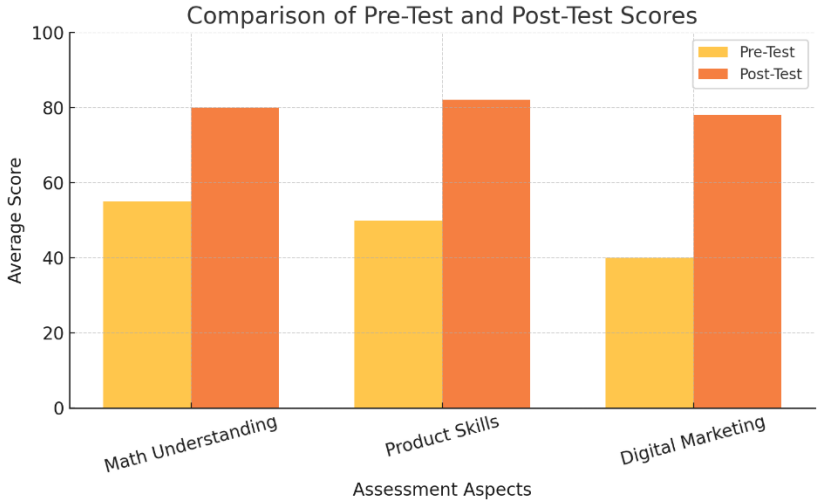

Figure 3. Comparison of Pre-Test and Post-Test Scores in Key Learning Domains

Participants' comprehension of geometric principles improved from an average score of 55 to 80, reflecting better conceptual understanding. In terms of practical skills, the average score increased from 50 to 82, indicating mastery in assembling and constructing patchwork-based products. The most notable improvement was in digital marketing awareness, which rose from 40 to 78, highlighting the participants' enhanced ability to promote their work online using visual and textual tools.

These outcomes confirm that combining mathematical education with hands-on craft production can result in both academic reinforcement and practical skill development. This is consistent with the findings of Zulkardi et al. (2021) and Wijaya (2012), who emphasize the benefits of contextualized learning in improving mathematical literacy and student engagement. The success of this approach also demonstrates the importance of experiential learning in building confidence, independence, and transferable skills in vulnerable youth populations.

1.4. Digital Literacy and Social Empowerment

The third session introduced children to basic digital marketing skills such as visual branding, photo documentation, and online promotion. Each participant practiced uploading content and writing short captions. A shared Instagram account was established as a digital product gallery managed collaboratively by the shelter and the children. While still modest, this effort demonstrated an initial understanding of digital entrepreneurship, and several participants expressed interest in continuing this practice. Beyond measurable knowledge, qualitative observations noted a boost in self-confidence, initiative, teamwork, and creative expression. During the final reflection, participants articulated their pride in creating tangible products and their excitement about learning to share them with others online.

Shelter staff also reported increased motivation among the children, and expressed their willingness to maintain the momentum through future mentoring. All 6 staff members who completed the partner instrument confirmed the usefulness and sustainability of the program.

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Figure 4. Group Photo with Participants, Organizers, and Shelter staffs

1.5. Discussion

The results confirm that integrating mathematics, creative production, and digital entrepreneurship is an effective model for empowering marginalized youth. This finding supports previous research emphasizing the impact of contextual learning (Wijaya, 2012) and life skill training (UNESCO, 2016) in promoting independence and competence among vulnerable populations.

Additionally, the use of upcycled fabric materials introduced ecological awareness, linking this program to the principles of SDG 12 (Responsible Consumption and Production) and SDG 8 (Decent Work and Economic Growth). By producing meaningful artifacts from fabric waste, children not only acquired technical skills but also learned about sustainability and resourcefulness—skills essential for future resilience.

D. CONCLUSION

This community empowerment program successfully demonstrated how integrating mathematical education, vocational skill-building, and digital literacy can effectively support the personal and intellectual growth of orphaned and underprivileged youth. By employing the Realistic Mathematics Education (RME) approach within a creative product-making context, the program enabled participants to internalize complex geometric concepts through tangible, meaningful activities.

The participants exhibited significant improvements in three key domains: understanding of three-dimensional geometry, confidence and ability in producing quilted fabric items, and awareness of digital marketing strategies. These learning outcomes were supported by strong quantitative data, with instruments validated through high reliability scores (Cronbach's Alpha = 0.906). Furthermore, shelter staff reported enhanced motivation and were willing to continue supporting such initiatives.

Beyond technical skills, the program also fostered soft skills such as creativity, collaboration, and self-confidence, which are essential for long-term empowerment. The digital component—creating and managing a shared social media gallery—provided a foundation for future entrepreneurship and online engagement.

This model of contextualized, interdisciplinary learning shows strong potential for replication in other shelters or communities with similar socio-economic backgrounds. It aligns with global development targets, particularly SDG 4 (Quality Education), SDG 8 (Decent Work and Economic Growth), and SDG 12 (Responsible Consumption and Production). Future programs may benefit from expanding production and marketing capacity, enabling participants to build micro-enterprise models from recycled materials while continuing to learn, grow, and inspire.

E. ACKNOWLEDGEMENTS

The authors would like to express their sincere gratitude to Rumah Yatim Medan, especially the children and staffs who actively participated in this program and contributed with enthusiasm and full cooperation. Special thanks are extended to the Ministry of Higher Education, Science, and Technology of the Republic of Indonesia for providing funding through the Community Service Grant Program in 2025.

The authors are also grateful to Universitas Islam Sumatera Utara (UISU) for their administrative support and to the student volunteers who contributed their time and skills in mentoring, facilitation, and documentation throughout the program.

F. AUTHOR CONTRIBUTION

Activity implementation: Afnaria (AF), Isnaini Halimah Rambe (IHR), Metrilitna Br. Sembiring (MBS). Article preparation: AF, IHR. Impact analysis: AF, MBS. Results presentation: IHR. Article revision: MBS. Other contributions (coordination with shelter, documentation, and field assistance): AF, IHR, MBS**,** Arba Atikah (AA), Yundari Arimbi (YA)**.**

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