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APPLICATION OF QUADRATIC BLOCKS AND GAFURAT MEDIA TO IMPROVE UNDERSTANDING OF QUADRATIC FUNCTIONS IN CLASS XI STUDENTS AT SMA

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ABSTRACT

This study aims to describe the implementation of Quadratic Blocks and Gafurat in enhancing students' understanding of quadratic functions. The research background is based on the limited use of instructional media at SMA Swasta ERIA Medan, which affects students' comprehension of factorization and graphing of quadratic functions. The study employed a qualitative descriptive method with an implementation study design. The participants were eleventh-grade students and a mathematics teacher who collaborated in the learning process. Data were collected through with observation and semi-structured interviews after the media implementation and analyzed using data reduction with documentation, presentation, and conclusion drawing techniques. The findings indicate that Quadratic Blocks media helped students concretely understand the factorization process of quadratic functions, while Gafurat facilitated the construction of parabola graphs. Students reported feeling more motivated, confident, and actively engaged in group discussions. The teacher highlighted that the media were practical, relevant to schools with limited facilities, and effective in supporting deep learning. Therefore, the use of Quadratic Blocks and Gafurat media can serve as an innovative alternative to improve students' conceptual understanding and is recommended for integration into high school mathematics instruction.

Keywords: *Instructional Media, Quadratic Functions, Quadratic Blocks*

ABSTRAK

Penelitian ini bertujuan untuk mendeskripsikan implementasi Balok Kuadrat dan Gafurat dalam meningkatkan pemahaman siswa tentang fungsi kuadrat. Latar belakang penelitian didasarkan pada keterbatasan penggunaan media pembelajaran di SMA Swasta ERIA Medan, yang memengaruhi pemahaman siswa tentang faktorisasi dan pembuatan grafik fungsi kuadrat. Penelitian ini menggunakan metode deskriptif kualitatif dengan desain studi implementasi. Partisipan adalah siswa kelas sebelas dan seorang guru matematika yang berkolaborasi dalam proses pembelajaran. Data dikumpulkan melalui observasi dan wawancara semi-terstruktur setelah implementasi media dan dianalisis menggunakan teknik reduksi data dengan dokumentasi, presentasi, dan penarikan kesimpulan. Hasil penelitian menunjukkan bahwa media Balok Kuadrat membantu siswa memahami secara konkret proses faktorisasi fungsi kuadrat, sedangkan Gafurat memfasilitasi pembuatan grafik parabola. Siswa melaporkan merasa lebih termotivasi, percaya diri, dan aktif terlibat dalam diskusi kelompok. Guru menyoroti bahwa media tersebut praktis, relevan dengan sekolah dengan fasilitas terbatas, dan

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efektif dalam mendukung pembelajaran mendalam. Oleh karena itu, penggunaan media Balok Kuadrat dan Gafurat dapat berfungsi sebagai alternatif inovatif untuk meningkatkan pemahaman konseptual siswa dan direkomendasikan untuk diintegrasikan ke dalam pengajaran matematika sekolah menengah.
Kata kunci: *Media Pembelajaran, Fungsi Kuadrat, Balok Kuadrat*

INTRODUCTION

Learning mathematics at the senior high school (SMA) level plays an important role in developing students' critical, logical and creative thinking skills. However, the results of observations at ERIA Medan Private High School show that the learning process, especially on quadratic function material, still does not utilize learning media. Teachers only rely on personal printed books without adequate infrastructure support, so students have difficulty understanding the material in depth. This has an impact on students' weak understanding in determining the factors of the quadratic function and drawing its graph. Furthermore, this pedagogical approach, heavily reliant on conventional methods, often results in a monotonous learning experience, diminishing student engagement and motivation, which ultimately leads to unsatisfactory academic performance in mathematics (Dila et al., 2025).

Students' difficulties in understanding quadratic functions were also found in previous studies. Quadratic functions are one of the challenging topics for students because it requires a connection between algebraic concepts and graphic representations (O'Connor and Norton, 2022). Similar research by Zunianto and Gusmarini (2021) also revealed that students often make mistakes in solving formative tests on the topic of quadratic equations and functions, both in calculation procedures and concept understanding. In fact, Islamiyah et al (2023) added that students often fail to solve quadratic function story problems due to basic misconceptions, which shows weak mathematical concept connections. This underscores the pervasive issue of students struggling with fundamental mathematical principles and their application, a problem exacerbated by teaching methodologies that fail to encourage active engagement and deeper conceptual understanding (Castillo et al., 2025; Çibukçiu, 2025; Pencawan et al., 2024; Rizky et al., 2025).

To overcome these problems, innovative concrete-based learning media can be a solution. Muhaimin and Juandi (2023) through a systematic review showed that mathematics learning media plays a significant role in increasing student engagement and learning effectiveness. By presenting visual and physical representations, students more easily connect abstract concepts with real understanding. In this context, the use of Quadratic Blocks can facilitate the factorization of quadratic functions through manipulative representations, while Gafurat helps students visually depict the graphs of quadratic functions. This is in line with Tiew and Teoh's (2023) research which states that understanding of algebraic concepts can be improved when students are given varied representational support. Furthermore, research indicates that the lack of specialized learning media to bridge abstract concepts into concrete understanding is a primary contributor to students' difficulties in mathematics (Nurjana & Rahayuningsih, 2025).

Furthermore, this media innovation can be linked to the deep learning paradigm in education. Deep learning approach that emphasizes deep understanding, interrelationships between concepts, and the application of knowledge in new situations. The integration of Kuadrat Blok and Gafurat media is expected to foster students' deep learning on quadratic function material, because it is procedurally oriented, conceptual, representational, and

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applicative understanding. This approach is crucial, especially in mathematics, where many students exhibit a lack of conceptual understanding due to the abstract nature of the subject and the scarcity of relevant learning resources (Hasibuan et al., 2025). The absence of visual aids often leaves students struggling to form a holistic understanding, leading to rote memorization rather than true comprehension (Dila et al., 2025). This gap in instructional resources often results in students struggling to identify and construct conceptual structures, particularly in mathematics, where approximately 78% of students reportedly face significant difficulties in grasping basic concepts (Hasibuan et al., 2025).

Based on this description, this research focuses on the application of Kuadrat Blok and Grafik Fungsi Kuadrat (Gafurat) media to improve the understanding of class XI students of ERIA Private High School on quadratic function material by integrating the principle of deep learning. This study aims to address the identified gap in pedagogical approaches by exploring how these innovative tools can transform abstract mathematical concepts into tangible, comprehensible experiences, thereby enhancing student engagement and academic performance. This research is critical given that traditional teaching methods often fail to connect mathematical abstractions with students' real-world experiences, thereby limiting their conceptual understanding (Hasibuan et al., 2025). By facilitating a more interactive and visual learning experience, these media are anticipated to significantly improve students' ability to grasp complex mathematical ideas and apply them effectively.

RESEARCH METHODS

This study employs a qualitative descriptive approach utilizing an implementation study design to document the practical application of innovative learning tools in a real-world setting. The primary objective is to illustrate how Quadratic Blocks and *Gafurat* media facilitate a deeper comprehension of quadratic functions among eleventh-grade students at SMA ERIA Medan during the 2025/2026 academic year. Participants were selected using a purposive sampling technique to ensure that the data reflected the actual classroom challenges and successes observed during the transition from abstract to concrete learning. Specifically, the study involved a group of students and their mathematics teacher, who functioned as an active collaborator throughout the pedagogical intervention. By focusing on real-world implementation rather than theoretical abstraction, the research aims to uncover the nuanced experiences of both educators and learners. This methodological choice allows for a comprehensive narrative regarding the shift from traditional, textbook-reliant instruction to a more manipulative and visual learning atmosphere.

The research procedure was systematically executed in three distinct phases beginning with the preparation stage, which involved the physical design and construction of the Quadratic Blocks and *Gafurat* media. These tools were specifically tailored to address the conceptual gaps in factoring and graphing quadratic functions by transforming symbols into tactile objects. In the subsequent implementation phase, the media were introduced into regular classroom activities, where students engaged in hands-on exploration under the guidance of their teacher. This stage prioritized direct interaction, allowing learners to manipulate physical blocks to represent algebraic factors and use the *Gafurat* board to plot parabolic curves. Finally, the evaluation phase focused on capturing the impact of these interventions through a combination of field observations, photographic documentation, and semi-structured interviews. This procedural sequence ensured that every aspect of the media application, from initial contact to

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conceptual internalization, was carefully monitored. The materials used were designed to be durable yet accessible, reinforcing the practicality for schools with constrained budgets.

To ensure the depth and authenticity of the gathered information, the study utilized semi-structured interview guidelines as the primary data collection instrument. These interviews were conducted in an oral and flexible manner, encouraging students and teachers to share their honest perceptions regarding the media benefits, usability, and effect on motivation. Complementary data were gathered through continuous classroom observation and thorough documentation of the students' work during group discussions. Once the raw data were collected, a qualitative analysis technique was applied, consisting of data reduction, data presentation, and the final drawing of conclusions. This analytical process involved filtering the vast amount of descriptive information to identify recurring themes related to conceptual clarity and student engagement. By meticulously organizing field notes and interview transcripts, the research was able to synthesize a clear picture of how concrete manipulative tools bridge abstract mathematical symbols with visual understanding. The resulting analysis provides a robust foundation for recommending iniative media as viable alternatives for secondary school mathematics instruction.

RESULTS AND DISCUSSION

The implementation of this research was carried out by implementing the media *of Quadratic Blocks* and *Gafurat* in learning square functions in grade XI students of SMA ERIA Medan. After the learning activity, interviews were conducted with students in groups and teachers individually to obtain data on learning experiences, ease of understanding, and perception of the media used.

Results

To facilitate analysis, the results of the interviews are categorized into the following rubrics:

Table 1. Results of Triangulation of Student Response Data, Teachers, and Researchers' Interpretations of the Use of Learning Media

Aspects	Student Response	Teacher Response	Researcher Interpretation
Conceptual Understanding	Students find it easier to understand factorization with Block Squares and graphs with Gafurat.	Teachers stated that media helps students understand concepts more meaningfully.	Concrete media supports deep learning by connecting abstract concepts.
Learning Experience	Students feel more confident and interested when using media.	Teachers see students being more active and participating in class.	Media increases student engagement and motivation to learn.
Engagement in Learning	Students are more engaged in group discussions when using media.	Teachers assess students as being more focused on the learning process rather than just waiting for explanations.	Media acts as a stimulus for interaction and collaborative learning.
Perceptions of the Media	Students rated the media as simple, easy	Teachers assess media as relevant to the	Media is considered practical, appropriate,

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to use, and helpful for understanding.	conditions of schools with limited resources.	and suitable for use in routine learning.

Most students stated that Quadratic Blocks helped them understand the process of factoring quadratic functions more concretely (Table 1). Previously, students only relied on the abc formula without understanding the relationship between quadratic forms and their factors. With Quadratic Blocks, students find it easier to discover the relationship between the concept of factoring and concrete visual representations. Quadratic Blocks helps students more easily understand the factoring of quadratic functions because it makes abstract concepts concrete. When students only use the abc formula, they tend to memorize the procedure without really understanding why a quadratic equation can be factored into a two terms multiplication form. With the buildable blocks, students can directly see the relationship between the algebraic form and its visual representation. This makes it easier for them to find the roots of equations and factor patterns without relying solely on memorization.

This relationship makes the concept of quadratic functions feel more real. When students see that each factor in the form (x+a) (x+b) arises from the length and width of the rectangles they arrange, they not only understand the end result but also the reasoning behind the process. In other words, Quadratic Blocks strengthen the bridge between mathematical symbols and concrete visualization. This is what makes it easier for students to understand quadratic functions, because they can connect what they do physically with what is written in algebraic form.

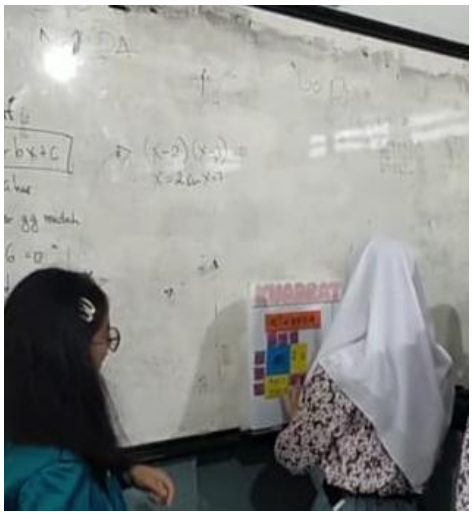

Figure 1. Students use the *Quadratic Block* media

In addition, Gafurat is considered to make it easier to draw quadratic function graphs. Students admit that they can determine the intersection points, axis of symmetry, and parabola shape more quickly than before. This positive response indicates that the Gafurat media has succeeded in reducing students' difficulties in understanding the relationship between quadratic equations and their graphs.

After implementing Gafurat media in learning, students showed positive responses to its use. Based on the interview results, one student with the initials AP revealed that before using Gafurat media, he had difficulty determining the intersection point, axis of symmetry, and parabolic shape because the determination process was abstract. Through Gafurat media, these steps became more concrete and systematic. A similar positive response was also expressed by a student with the initials IP, who stated that Gafurat media helped him better understand the material and increased his interest in learning. This shows that the success of

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Gafurat media lies in its ability to bridge symbolic understanding into visual forms, so that students become more confident and motivated in learning quadratic functions. In addition, 25 students also stated that the use of Gafurat media made them more motivated to learn the material on Quadratic Function. They considered that this media helped visualize abstract concepts in a more concrete and easy-to-understand manner.

Figure 2. Students use the *Gafurat* media

Mathematics teacher stated that the Quadratic Blocks and Gafurat media helped students understand the material more easily. This media is considered a practical solution in schools with limited resources and is in line with the principles of deep learning, as it encourages students to understand concepts rather than simply memorizing formulas. Thus, the interview results show that the use of the Quadratic Blocks and Gafurat media successfully improved students' conceptual understanding, engagement, and motivation to learn. In addition, teachers considered this media suitable for use in schools with limited facilities, making it relevant in the context of mathematics education in Indonesia.

Discussion

The analysis of student performance at SMA ERIA Medan reveals that the implementation of quadratic blocks has significantly altered the way learners perceive algebraic factorization. Before this intervention, students primarily depended on the *abc* formula, often memorizing procedures without grasping the underlying logic of quadratic expressions. The data suggests that these visual tools successfully transformed abstract symbols into tangible geometric shapes, where the length and width of rectangles directly represent the factors of a given function. By physically manipulating ini *quadratic blocks*, students moved beyond rote memorization to a state of *deep learning*. They could witness the emergence of the form (x+a)(x+b) through their own arrangements, creating a robust cognitive bridge between mathematical notations and concrete visualization. This shift is vital because it addresses a fundamental hurdle in mathematics education where symbols often feel disconnected from reality. The empirical evidence from group interviews confirms that this hands-on approach clarifies the reasoning behind the factoring process, making the results feel authentic rather than just a calculated output from an opaque mathematical equation (Canner & Clinkenbeard, 2023; Kurtuluş & Ünlüer, 2020; Wei et al., 2025).

Regarding the visualization of parabolic trajectories, the introduction of the *gafurat* media has provided a systematic framework for students to master complex graphing tasks. Participant feedback, particularly from individuals such as student *AP*, highlights that previously abstract steps like menentukan intersection points and the axis of symmetry became far more accessible and concrete. Before the use of this media, students struggled with the parabolic shape, viewing the process as an intimidating series of disconnected steps. However,

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the *gafurat* tool allowed for a more integrated understanding of how quadratic equations dictate the curve of a graph. Approximately twenty-five students explicitly stated that this visualization teknik improved their interest in the material, as it simplified the transition from symbolic algebra to visual geometry. Student *IP* also noted a marked peningkatan in understanding, suggesting that the media acts as an effective bridge for тити who find traditional methods too elusive. By making the plotting process more intuitive, the tool effectively reduced the cognitive load required to translate numerical data into a physical curve, thereby enhancing overall conceptual clarity (Johansen, 2024; Offenwanger et al., 2023; Robinson et al., 2023; Zhang et al., 2024).

The psychological and behavioral impact of these tools is evident in the heightened levels of student engagement and confidence during mathematics sessions. Findings indicate that learners became significantly more active in group discussions when tasked with using the *quadratic blocks* and *gafurat* devices. This surge in participation suggests that the media serves as a potent stimulus for collaborative interaction rather than a passive teaching aid. A total of twenty-five students reported a noticeable increase in their motivation to explore quadratic functions, a subject often perceived as dry or difficult. The transition from being passive recipients of information to active participants in the learning process is a core achievement of this study. Teachers observed that students were lebih focused on the actual process of discovery rather than merely waiting for a final explanation from the front of the classroom. This shift in classroom dynamics points to a successful reduction in math anxiety, as students felt lebih empowered to experiment with their answers and engage with their peers to solve problems in a social and interactive environment (Azizan et al., 2021; Bajrami et al., 2025; Mizuhara et al., 2025; Pará & Johnston-Wilder, 2023; Stone-Johnstone, 2023).

From a pedagogical standpoint, the teacher's feedback underscores the practicality of these innovative tools within the specific context of the Indonesian education system. The instructor at SMA ERIA Medan emphasized that these media provided a high-value solution for a school environment characterized by limited resources and facilities. Because the *quadratic blocks* and *gafurat* are relatively simple to implement, they offer a sustainable alternative to expensive digital software while still delivering profound educational results. The teacher noted bahwa the students moved toward a more meaningful understanding of concepts, which aligns perfectly with the principles of *deep learning*. Instead of rushing to apply a memorized formula, students were encouraged to explore the *why* behind the mathematics. This approach is especially relevant for schools that lack extensive laboratory equipment but wish to improve the quality of their instructional delivery. The relevance of this media lies in its ability to democratize high-quality conceptual instruction, ensuring that even in resource-constrained settings, students can develop the analytical skills necessary for advanced mathematical reasoning and more effective problem-solving in their future academic pursuits (Carrillo, 2021; Castillo et al., 2025; Pujiastuti et al., 2020; Sofroniou et al., 2025).

Despite the overwhelmingly positive outcomes, this research acknowledges certain limitations that must be addressed in future studies. The study was localized to grade XI students at a single institution in Medan, which may limit the generalizability of the findings across different demographics or school types. While the data from twenty-five students showed a clear trend of improvement, larger sample sizes would provide a more comprehensive statistical overview of the efektifitas of the *gafurat* and *quadratic blocks*. Furthermore, the reliance on interview data means that the results are based on subjective perceptions of ease and motivation, which should ideally be cross-referenced with longitudinal test scores to

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measure long-term retention. Nevertheless, the implication is clear: concrete media is an essential component for bridging the gap between abstract mathematical theory and student comprehension. The success of this intervensi suggests that incorporating physical tools into routine learning can transform the classroom into a lebih inclusive and stimulating space. Moving forward, refining these tools for broader topics and larger class sizes could further strengthen the resilience of mathematics education in varied socio-economic contexts across the country.

CONCLUSION

The results of the study shows that the use of the Quadratic Blocks and Gafurat media effectively helps 11th grade students at SMA ERIA Medan understand quadratic functions. This media makes it easier for students to understand the concepts of factorization and quadratic function graphs, while also increasing their engagement and confidence. Teachers also consider these media practical and suitable for learning needs. Therefore, it is recommended that teachers utilize these simple media as an alternative learning tool, encourage students to actively use them to explore concepts, and that schools provide support for media innovation. Further research is expected to expand the measurement instruments so that the effectiveness of these media can be tested more comprehensively.

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