



More Than AI: Developing Intelligent Chatbot to Empower Algebra Mastery for Grade VII Students

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ABSTRACT

The challenge of learning algebra for junior high students necessitates innovative educational tools. This study aimed to develop and evaluate an intelligent chatbot, powered by a fine-tuned Mistral AI model, to empower algebra mastery for Grade VII students. R&D methodology using the ADDIE model was employed, involving one expert validator, 20 students, and 5 teachers for the evaluation. Data were collected through questionnaires and a post-test. The findings revealed that the chatbot was highly successful, achieving an expert validation score of 91.11% ("Very Valid") and a user practicality score of 84.42% ("Very Practical"). Furthermore, the chatbot was proven effective, as 84% of students achieved the classical mastery threshold on the post-test with a class mean score of 82.0. This research concluded that a specifically customized AI chatbot is a valid, practical, and effective medium for mathematics education.

Keywords: artificial intelligence; chatbot; learning media

INTRODUCTION

Mathematics is a fundamental knowledge that has an important role in developing logical thinking and problem-solving skills (Lovianova et al., 2022; Yasin & Utomo, 2023). One of the important material in mathematics is algebra. Algebra, serves as a critical gateway to higher-level mathematical thought (Alam & Mohanty, 2024).

However, there are some obstacles in learning algebra especially for Grade VII (Decker-Woodrow et al., 2023). Algebra often presents significant challenges for Grade VII students, who face a difficult transition from concrete arithmetic to abstract reasoning (Larbi, 2025). This challenge shows that there are research urgencies, as it can led us to various learning obstacles, like teachers' limited time for personalized guidance and a lack of engaging, interactive learning media (Nurcahyono & Putra, 2022; Dewi et al., 2023). So that, students can experience a desperation, and lack of motivation and interest, both of which are key factors for effective learning (Chitrakar & P. M., 2023). Especially in so abstract material like algebra.

In response to these challenges, innovations in educational technology (EdTech), getting more often used since Covid-19, and it offers promising alternative solutions (Dishon, 2021; Kang & Sinn, 2024). One of the most significant breakthroughs in EdTech is the utilization and integration of Artificial Intelligence (AI), a branch of computer science focused on creating intelligent machines (Russell & Norvig, 2010; Pathil et al., 2023). In educational context, a really win-win solution to these problems is often embodied in Intelligent Tutoring Systems (ITS), systems designed to act as personal tutors capable of

adapting to the individual learning needs and pace of each student (Guo et al., 2021; Lin et al., 2023).

One of the most interactive and relevant ITS implementations for today's era is the chatbot, a computer program designed to simulate human conversation (Aloqayli & Abdelhafez, 2023). As a learning tool and media, chatbot can be used as a discussion and learning partner, also as a provider of instant feedback, than can be accessed anytime and anywhere (Laksana & Shofan, 2022). Previous research has demonstrated the potential of chatbots as learning media. For instance, Adesfiana, et al., (2022) found that chatbots can increase student engagement, while Dharmantara & Zhudi, (2022) highlighted their ability to support basic conceptual understanding. However, these prior implementations predominantly rely on standard rule-based architectures or generic AI models that lack deep pedagogical context. Consequently, a significant research gap persists: existing educational chatbots are often ill-equipped to handle the nuanced challenges of teaching Grade VII algebra, particularly in guiding students through the complex transition from concrete arithmetic to abstract reasoning. Furthermore, there is a distinct lack of studies leveraging the full potential of state-of-the-art Large Language Models (LLMs) that are specifically fine-tuned to provide relevant, adaptive, and subject-specific pedagogical feedback.

Although AI is increasingly utilized in educational settings, the specific challenge of facilitating the transition to abstract mathematical thinking in Grade VII algebra has not been adequately addressed by generic chatbots. To overcome this limitation and provide a significant methodological novelty, this study introduces an innovative approach by utilizing a Mistral AI model specifically fine-tuned on custom algebraic datasets and pedagogical dialogues. Therefore, the specific objectives of this research are: (1) to develop an intelligent tutoring chatbot powered by a fine-tuned Mistral AI tailored specifically for Grade VII algebra, and (2) to evaluate its validity, practicality, and effectiveness as a learning medium in empowering students' algebra mastery.

RESEARCH METHODS

This study was using a Research and Development (R&D) methodology. This approach was selected as the primary objective was to produce a new educational product (Okpatrioka, 2023), an intelligent chatbot, and then to test, evaluate and validate its function as a learning media. This development and research process using ADDIE model, with five phases: Analysis, Design, Development, Implementation, and Evaluation (Asdar et al., 2023).

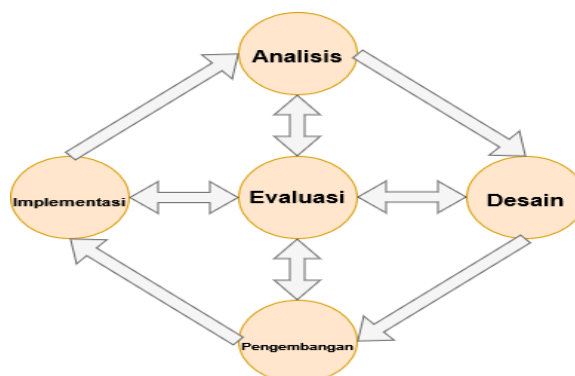


Figure 1. ADDIE Diagram

Research Participants

The participants in this study consisted of three phase. The first phase, was selected through purposive sampling for validation stage, one media and material experts. The second phase is for the practicality dan effectiveness of medium, involved in the user trial, comprised 20 Grade VII students from one of the Junior High School in Kota Bima, Indonesia who were studying algebra in VII grade as the effectiveness and practicality subject. To support that, 5 mathematics teachers at the same school also participated in practicality test.

Research Procedure

The research procedure meticulously followed the five stages of the ADDIE model. The initial phase focused on identifying core learning challenges. This was achieved through an informal interview with the mathematics teacher at the school to understand the specific difficulties students face with algebra. The analysis also involved defining the chatbot's content scope to align with the official curriculum and understanding the target students' digital literacy.

Based on the analysis, a detailed blueprint for the chatbot was created. This process included designing the research workflow, the software architecture, and the database structure. Storyboard, designed using draw.io, which visualized the user interface (UI) and user experience (UX) for every page of the website, from the home page to the main chatbot dashboard.

This phase actualized the design blueprints into a functional product. The core technical achievement was the creation of the AI engine, which involved fine-tuning a Mistral AI model on a custom dataset of algebra-specific questions and pedagogical dialogues. This fine-tuned model was then integrated into a website, developed to serve as the user-facing platform for the intelligent chatbot.

The developed chatbot was then implemented in a two-step process. First, it underwent a validation stage where the media experts and the mathematics teacher reviewed the product for content accuracy and media practicality. Following their approval, a user trial was conducted with the 20 students. During the trial, students accessed the chatbot via a local host setup and used it to practice algebra problems.

The final stage is evaluation, aimed to assess the quality of the developed product. Data from the expert validation and the student user trial were collected to be analyzed, with the detailed results presented in the subsequent section of this paper.

Data Collection and Instruments

Data were collected using three primary instruments. Expert Validation Questionnaire was provided to the media and material experts to assess the chatbot's quality in terms of content validity, instructional design, and interface usability. 5 mathematics teachers participated in the practicality assessment by completing a questionnaire after reviewing the learning medium. 20 Grade VII students participated in both the effectiveness and practicality studies. They completed a pre-test and post-test to measure learning effectiveness and a response questionnaire to assess practicality. Both instruments utilized a 5-point Likert scale (ranging from 1 to 5) to quantify responses (Riduwan 2013). The

effectiveness of medium as a learning tool was assessed using post-test that conducted by the students.

Data Analysis Technique

The data from the questionnaires (validity and practicality) were analyzed using descriptive statistics to determine the practicality of the chatbot. First, the total score obtained from each participant's questionnaire was summed up. This score was then converted into a percentage to provide a standardized practicality rating, calculated with the following formula adapted from Aziz & Prasetya (2018):

$$Score(\%) = \frac{\text{Total Score Obtained}}{\text{Maximum Possible Score}} \times 100\%$$

The resulting percentage was then interpreted by mapping it to a five-level criteria scale, as proposed by Riduwan (2013). A score between 81% and 100% was categorized as "Very Feasible," 61-80% as "Feasible," 41-60% as "Fairly Feasible," 21-40% as "Infeasible," and 0-20% as "Very Infeasible." which modified based on the criteria that want to be measured (valid and practical).

In addition to this quantitative analysis, any written comments and suggestions from the participants were analyzed thematically to identify key insights for product improvement.

The effectiveness of the learning medium was determined based on the classical mastery learning criteria proposed by Yamasari (2010). According to this framework, the chatbot is considered "effective" if a minimum of 80% of the students achieve a post-test score of 75 or higher (out of a maximum score of 100).

RESULT AND DISCUSSION

This section presents the findings from the product evaluation, followed immediately by a discussion that contextualizes these results in relation to the research objectives and relevant theories. The data were collected through expert validation, user practicality questionnaires, and pre-test/post-test assessments to measure effectiveness.

Table 1. Validity Score

No.	Aspects	Average Score
1.	Content of Medium	4.25
2.	Interface and Language	4.78
3.	User Experience	5.00
4.	Usefulness of the Learning Medium	4.00
Score (%)		91.11%

The initial evaluation phase involved an assessment by one expert validator to determine the content and media validity of the chatbot. The expert validation yielded a highly positive assessment of the chatbot. The overall validity score was calculated to be 91.11%, placing the medium in the "Very Valid" category. A detailed breakdown of the scores per aspect is presented in Table 1. As shown, the chatbot received excellent scores across all categories, with Usability and Functionality achieving a perfect average score of 5.00. Indicates that the chatbot's interface successfully minimized cognitive load, allowing students to focus on the algebra content rather than struggling with the navigation. The

intuitive design of the homepage (Figure 2) and the conversational interface (Figure 3) mimics popular messaging applications, which likely contributed to this high usability rating.



Figure 2. Menu Interface of Chatbot Website

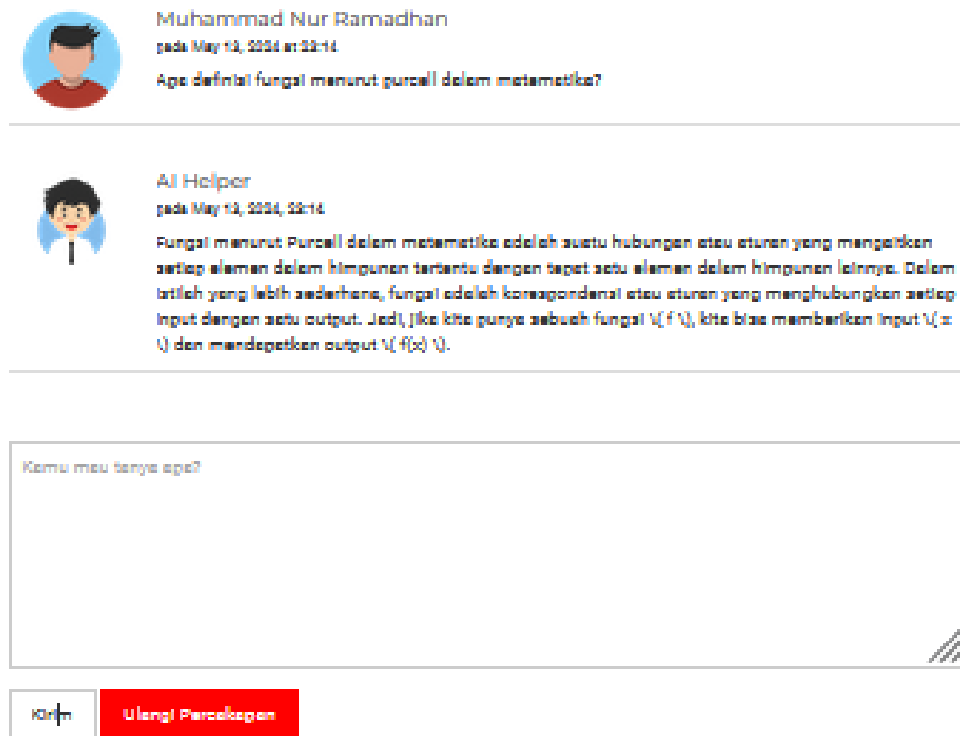


Figure 3. Main Chatbot Feature of Chatbot Website

Following the expert validation, the medium was implemented with teachers and Grade VII students at a Junior High School in Kota Bima. The practicality assessment (Table 2) yielded an overall score of 84.42% ("Very Practical"). Interestingly, the highest sub-scores were observed in Clarity of Content Presentation (4.37) and Motivation for Further Learning (4.33). This suggests that the Mistral AI's natural language processing capabilities successfully translated abstract algebraic concepts into conversational, easy-to-understand explanations. The students were not just passively reading; the interactive nature of the chatbot fostered an engaging environment that stimulated their curiosity to learn more.

Table 2. Practicality Score

No.	Aspects	Average Score
1.	Ease of Use	3.93
2.	Clarity of Content Presentation	4.37
3.	Engagement and Attractiveness	4.03
4.	Motivation towards Mathematics	4.27
5.	Encouragement of Active Learning	4.10
6.	Motivation for Further Learning	4.33
7.	Clarity of Instructions	4.17
8.	Visual Appeal	4.22
Score (%)		84.42%

The positive user experience directly translated into strong learning outcomes, as seen in the effectiveness score (Table 3). With 84% of students achieving the classical mastery threshold (score ≥ 75) and a mean score of 82.0, the data confirms that the chatbot is not merely an attractive digital tool, but an effective pedagogical instrument.

Table 3. Effectiveness Score

No.	Statistic	Value
1.	Number of Students	20
2.	Mean Score	82.0
3.	Highest Score	100
4.	Lowest Score	50
5.	Students Achieving Mastery (Score ≥ 75)	21
Percentage of Students Achieving Mastery		84%

The discussion for why these positive outcomes were achieved points to a synergy between systematic pedagogical design and advanced AI implementation. The high validity and practicality are direct results of the user-centered ADDIE framework, which ensured the product was both instructionally sound and easy to use. However, the significant learning effectiveness is primarily attributed to the study's core technology, the fine-tuned Mistral AI model. Unlike static learning materials or generic chatbots, the custom-trained AI's ability to provide instant, personalized, and context-aware feedback simulated a one-on-one tutoring environment. This is crucial for a subject like algebra, where students can correct misconceptions in real-time, thereby building both competence and confidence.

The success of this implementation can be attributed to the synergy between the systematic ADDIE instructional design and the advanced capabilities of the fine-tuned Mistral AI. These findings strongly support the theory of Intelligent Tutoring Systems (ITS), which posits that personalized, immediate feedback loops significantly accelerate conceptual mastery (Guo et al., 2021). Furthermore, this study significantly extends previous research on educational chatbots. While prior studies, such as Adesfiana, et al. (2022) proved that standard chatbots could increase engagement, they often struggled with dynamically generating solutions for complex mathematical problems. The novelty of this research lies in the use of a specifically fine-tuned Large Language Model (LLM). Unlike static rule-based systems, this chatbot acted as a virtual tutor capable of diagnosing student misconceptions in real-time and providing adaptive scaffolding, which is crucial for mastering the abstract transition in Grade VII algebra.

Despite these strong results, the study has several limitations. The research was conducted with a relatively small sample size at a single institution, and the chatbot was deployed on a local host, which limits the generalizability of the results. Future research

should therefore focus on larger-scale, multi-school trials to validate these findings. A longitudinal study to assess the long-term effects of the chatbot on student knowledge retention would also be a valuable next step.

CONCLUSION

This study concludes that the intelligent chatbot, developed using the ADDIE model and powered by a fine-tuned Mistral AI, is a valid, practical, and effective learning medium for empowering Grade VII algebra mastery. This conclusion is based on the strong empirical evidence obtained throughout the evaluation: an expert validation score of 91.11% ("Very Valid"), a user practicality score of 84.42% ("Very Practical"), and a classical mastery rate where 84% of students successfully achieved the learning objectives (score ≥ 75) after using the chatbot. The findings have significant implications for integrating tailored AI into mathematics education. The research was conducted with a relatively small sample size at a single institution in Kota Bima, and the system was deployed via a local host. These factors may limit the immediate generalizability of the results. Future research should prioritize large-scale, multi-school deployments using cloud-based infrastructure. Additionally, a longitudinal study examining the long-term retention of algebraic knowledge would provide deeper insights into the chatbot's sustained impact.

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