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IMPLEMENTATION OF LEARNING ON THE DEVELOPMENT OF ATOMIC THEORY AT MADRASAH ALIYAH ALAMIRIYAH DARUSSALAM BANYUWANGI USING CHATGPT APPROACHES

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ABSTRAK

Penelitian ini bertujuan untuk menganalisis integrasi *Artificial Intelligence* (AI) melalui ChatGPT sebagai alat bantu pembelajaran untuk mengatasi tantangan pendidikan tersebut di Madrasah Aliyah Alamiriyah Darussalam Banyuwangi. Dengan menggunakan desain penelitian deskriptif kuantitatif, data dikumpulkan dari 29 siswa menggunakan kuesioner terstruktur dan analisis pembelajaran untuk mengevaluasi persepsi mengenai aksesibilitas, kegunaan, efektivitas pemecahan masalah, serta keberlanjutan di masa depan. Hasil penelitian menunjukkan bahwa 93,1% siswa menilai lingkungan belajar berbasis ChatGPT ini mudah sehingga pengguna nyaman, yang membentuk faktor struktural krusial untuk mengurangi kecemasan belajar sekaligus meningkatkan keaktifan siswa. Dalam hal kegunaan akademik, 82,8% partisipan menilai ChatGPT efektif untuk menyelesaikan masalah rumit terkait model atom Dalton, Thomson, Rutherford, dan Bohr, Sebagian siswa (17,2%) mengalami kendala akibat tantangan dalam merumuskan instruksi. Data proyeksi jangka panjang menunjukkan trajektori penerimaan yang sangat positif, di mana 89,7% siswa menyatakan motivasi yang jelas untuk terus menggunakan ChatGPT dalam aktivitas akademik mereka di masa depan. Penelitian ini menyimpulkan bahwa integrasi ChatGPT secara efektif mengatasi hambatan instruksional tradisional dengan menumbuhkan kemandirian belajar siswa, memberikan kenyamanan psikologis, dan meningkatkan aksesibilitas materi. Meskipun temuan ini lebih merefleksikan persepsi subjektif dan kenyamanan siswa daripada mengukur prestasi akademik secara langsung, data tersebut menunjukkan bahwa platform AI yang adaptif ini memiliki potensi besar dan berkelanjutan untuk diintegrasikan secara permanen dalam transformasi digital pendidikan kimia.

ABSTRACT

This study aims to analyze the integration of Artificial Intelligence (AI) via ChatGPT as an instructional tool to address these educational challenges at Madrasah Aliyah Alamiriyah Darussalam Banyuwangi. Employing a quantitative descriptive research design, data were collected from 29 students using structured questionnaires and learning analytics to evaluate perceptions of accessibility, usability, problem-solving effectiveness, and future sustainability. The results indicate that 93.1% of students perceived ChatGPT as user-friendly and comfortable, establishing a crucial structural factor that mitigates learning anxiety and boosts engagement. In terms of academic utility, 82.8% of participants found ChatGPT effective for solving complex problems related to Dalton's, Thomson's, Rutherford's, and Bohr's atomic models, although a minor segment (17.2%) experienced limitations due to prompt formulation. Long-term projection data revealed a highly positive acceptance trajectory, with 89.7% of students expressing explicit motivation to continue utilizing ChatGPT in their future academic endeavors. The study concludes that integrating ChatGPT effectively resolves traditional instructional bottlenecks by fostering learner autonomy, providing psychological comfort, and enhancing material accessibility. While the findings reflect subjective student perceptions rather than direct academic performance, they demonstrate that adaptive AI platforms hold immense, sustainable potential for permanent integration within the digital transformation of chemistry education.

How to Cite

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INTRODUCTION

Artificial Intelligence (AI) in education, implemented through tools like chatbots, virtual assistants, and automated assessments, enhances learning by providing instant feedback, identifying student difficulties, and creating a more interactive and engaging learning environment (Ronsumbre et al., 2023). Globally, large language models (LLMs) such as OpenAI's ChatGPT, Google's Gemini, and DeepSeek have become the primary choices in educational settings due to their advanced natural language processing capabilities, which allow for human-like tutoring and rapid resource generation (Aydin & Karaarslan, 2023; Waqas et al., 2025; Demir & Yafuz, 2026).

These specific platforms are preferred because they lower technical barriers for students and educators, offering cost-effective, multi-language support that adapts to diverse learning paces (Baidoo-Anu & Ansah, 2023). In Indonesia, the rapid integration of AI in education supports adaptive and personalized learning through tools like virtual tutoring, real-time feedback, and interactive instruction, significantly improving teaching quality and student engagement (Anas & Zakir, 2024). The adoption of platforms like ChatGPT and Gemini in Indonesian universities and schools is driven by their accessibility via mobile devices and their ability to comprehend contextual Indonesian pedagogical nuances, making them highly effective for localized, self-directed learning (Santoso & Kurniawan, 2024). As an example, ChatGPT, a widely adopted AI technology, can deliver comprehensive answers to various posed questions (Apriliani, 2024). The collected evidence demonstrates that ChatGPT can serve as an effective cognitive scaffold, bolstering students' analytical reasoning, conceptual clarity, and procedural execution when tackling intricate chemistry problems (Alli et al., 2026).

Meanwhile students face persistent difficulty understanding abstract chemistry concepts like atomic structure. Teacher centered approaches with limited technology lead to low motivation and suboptimal comprehension (Hakim et al., 2026). Atomic models are typically taught using abstract and rote methods, which limit conceptual understanding and reasoning skills (Kofter et al., 2026). Atomic structure is identified as a threshold concept that is troublesome for students to master (Iyamuremye & Ndihokubwayo, 2024).

Recent research has explored the application of AI in education, as exemplified by studies such as: based on a review of the literature in science education, AI-based assessments can be conducted automatically and in real time, allowing students to receive immediate feedback. This approach reduces teachers' grading time, enabling them to focus more on the teaching and learning process. Assessments can be conducted anytime and anywhere, unrestricted by time or location, and can integrate evaluation of knowledge, skills, attitudes, or other learning indicators. (Sudirman et al., 2022), Applying artificial intelligence (AI) in the context of chemistry learning using a literature study approach (Taruklembong & Hotmalina, 2023; Akbar dan Djakariah, 2024).

AI is reshaping chemistry education by offering new tools for teaching, learning, and research. Systematic integration of AI competencies into education is necessary (Huwer et al., 2025). The 2024 Nobel Prize in Chemistry (AI for protein folding) underscores that AI is now central to chemical research, creating an urgent need to reflect this in curricula (Berber et al., 2025). AI is reshaping experimental approaches and challenging established notions of scientific discovery, creating new opportunities for enhanced learning (Reyes & Regala, 2025).

High school students using GPT-4.0-powered scientific dialogues for atomic models reported high usability (M=4.07), good user experience (M=3.76), and low cognitive load (M=2.36). Increased participation and improved conceptual understanding were observed (Kofter et al., 2026). Student

performance improved by 16.6% after using ChatGPT. Three themes emerged: AI stimulates engagement and interactivity, curiosity and motivation, and enhanced learning experience (Iyamuremye & Ndihokubwayo, 2024). An AI framework was proposed that uses simulated dialogues with historical scientists, generative analogies, and misconception mapping to help students understand the evolution of the atomic model (Garba et al., 2025).

Most existing studies on AI for atomic theory were conducted in Western, Turkish, or East African contexts. No published study has examined AI-assisted learning of atomic theory in a pesantren-based Madrasah Aliyah in Indonesia**.** The learning of *the development* of atomic theory (its historical evolution from Dalton to quantum mechanics) through AI approaches has been proposed theoretically (Garba et al., 2025) but rarely tested empirically, especially not in a pesantren setting.

Madrasah Aliyah Alamiriyah Blokagung is a senior secondary education institution under the Darussalam Islamic Boarding School Foundation, where chemistry instruction, particularly on the development of atomic theory, is still conducted conventionally using verbal explanations and PowerPoint presentations. This study aims to examine how the utilization of Artificial Intelligence (AI) transforms the landscape of chemistry education, particularly in the topic of the development of atomic theory for 10th-grade students at Madrasah Aliyah Alamiriyah Blokagung Banyuwangi in the Society 5.0 era. The findings will contribute empirical evidence on AI integration in Indonesian Islamic secondary education and provide a model for digital transformation in pesantren-based science learning.

METHODS

Research Design

This study employs a quantitative approach with a descriptive survey design. The quantitative method was chosen to collect measurable data from respondents using a structured instrument, enabling objective analysis of students' perceptions regarding the impact of Artificial Intelligence (AI), specifically ChatGPT, on the chemistry learning process focusing on the Development of Atomic Theory in 10th grade at Madrasah Aliyah Al-Amiriyah. In this study, students independently learned the development of atomic theory using ChatGPT. Subsequently, a comparative analysis was conducted to evaluate student comprehension and engagement, contrasting autonomous AI-assisted learning with conventional teacher-led instruction to determine which approach yields higher efficacy and pedagogical appeal.

Time and Place

The research was conducted at Madrasah Aliyah Al-Amiriyah during the 2025 first semester in the 10th-grade academic year.

Population and Sample

The population of this study consisted of all 29 students enrolled in the 10th grade at Madrasah Aliyah Al-Amiriyah Blokagung Banyuwangi. Given the relatively small population size, a saturated sampling technique was employed, making the sample size equivalent to the total population (n = 29). The sole instrument used in this study was a structured questionnaire developed and distributed via Google Forms. The questionnaire consisted of closed-ended statements designed to capture students' perceptions of AI-assisted learning in the context of atomic theory development. Responses were measured using a 4-point Likert scale with the following categories: Strongly Agree (SA), Agree (A), Disagree (D), Strongly Disagree (SD). The 4-point scale was deliberately chosen to eliminate a neutral midpoint, thereby encouraging respondents to express a definite opinion.

Data Collection Procedure

Data were collected by distributing the questionnaire link through Google Forms to all 29 respondents after learning the Development of Atomic Theory using ChatGPT . Students accessed the form independently, and responses

were automatically recorded in a Google Sheets spreadsheet linked to the form. No other data collection instruments (interviews, observations, or offline questionnaires) were used.

RESULT

The central concern addressed in this study is the functional importance of integrating Artificial Intelligence (AI) using ChatGPT in teaching the development of atomic theory, as conventional methods often fail to make abstract chemical concepts accessible to students. This issue is significant because inaccessible learning materials hinder conceptual understanding and reduce students' engagement in chemistry. The survey data strongly reinforce this point: all 29 respondents agreed that AI using ChatGPT makes atomic theory materials easier to access, with 62.1% selecting "Agree" and 37.9% selecting "Strongly Agree," and none expressing disagreement. Rather than simply indicating that AI is useful, these findings suggest a possible reason for students' positive perceptions. The topic of atomic theory contains abstract concepts that are often difficult to understand through traditional lecture-based instruction. ChatGPT allows students to obtain immediate explanations, request clarification when misconceptions arise, and revisit information repeatedly without time constraints. Such features may reduce learning barriers and support independent knowledge construction, which explains why students reported greater accessibility to the learning materials. Supporting literature also highlights similar findings, noting that AI-based tools improve accessibility, motivation, and comprehension in science learning environments (Akbar & Djakariah, 2024; Taruklimbong & Sihotang, 2023). Therefore, the diagram demonstrates that AI using ChatGPT effectively addresses the instructional dysfunctions present in traditional chemistry teaching.

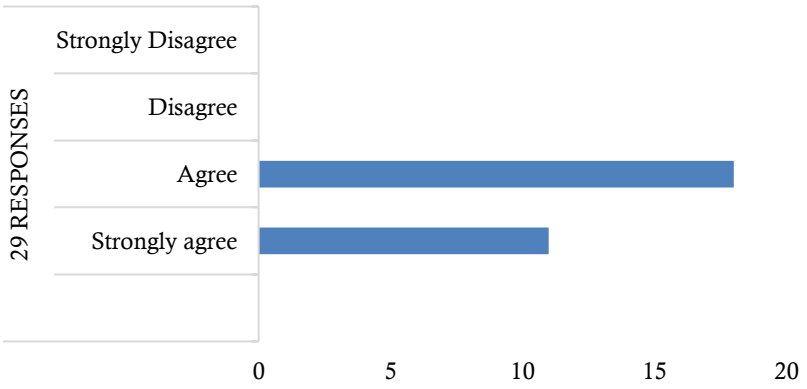

Figure 1. AI using ChatGPT makes chemistry materials more accessible

The structural reason behind the effectiveness of ChatGPT learning tools becomes evident when examining students' comfort and usability perceptions, as illustrated in the second diagram. The data show that 51.7% of students agreed and 41.4% strongly agreed that ChatGPT applications feel comfortable to use for learning the development of atomic theory, with only 6.9% disagreeing and none expressing strong disagreement. This positive response suggests that students generally perceive AI using ChatGPT learning environments as user-friendly and supportive of their learning activities. One possible explanation for this perception is that ChatGPT provides immediate access to information, interactive responses, and flexible learning opportunities that allow students to explore concepts at their own pace. In the context of atomic theory, which involves abstract and microscopic concepts that are often difficult to visualize, such features may help students feel

more comfortable when seeking explanations or clarifying misunderstandings. However, it is important to note that this study measured students' perceptions rather than actual learning achievement. Therefore, the findings indicate that students perceive AI as a comfortable learning tool, but they do not provide direct evidence that AI improves academic performance or learning outcomes. Recent studies confirm that user-friendly AI platforms enhance student engagement, reduce anxiety, and support adaptive learning pathways(Candra, 2025; Nasution et al., 2025; Shaniya et al., 2024). Therefore, the comfort experienced by students is not merely a preference but a structural factor that directly strengthens the effectiveness of AI using ChatGPT in chemistry education, particularly in mastering abstract topics like the development of atomic theory.

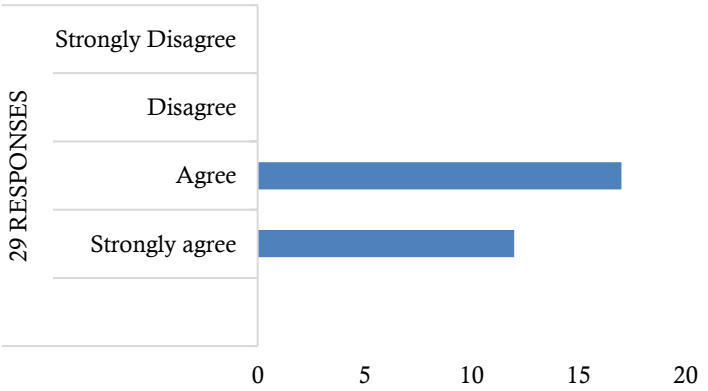

Figure 2. AI using ChatGPT helps present the material more attractively

The diagram illustrates students' perceptions regarding the statement that ChatGPT is an effective tool for helping to solve chemistry problems related to the theory of atomic development. Out of 29 respondents, the majority expressed a positive view toward the integration of AI in learning chemistry. A total of 14 respondents (48.3%) selected Strongly Agree, followed by 10 respondents (34.5%) who chose Agree, indicating that 82.8% of participants believe AI provides meaningful support in understanding atomic theory concepts. Meanwhile, only 5 respondents (17.2%) stated Disagree, and none selected Strongly Disagree, suggesting minimal resistance to using AI as an educational aid. The presence of this group suggests that the perceived usefulness of ChatGPT for problem-solving may not be uniform across all learners. One possible explanation is that some students may experience difficulties in formulating effective prompts when interacting with AI systems. As a result, the responses generated by AI may not fully address their specific learning needs. Another possibility is that atomic theory involves conceptual reasoning and scientific interpretation that some students prefer to discuss directly with teachers rather than through digital tools. In addition, AI-generated explanations may sometimes be too general or insufficiently aligned with the learning context provided in the classroom, leading certain students to perceive limited benefits for solving chemistry problems. These results highlight that AI is perceived as a valuable tool in addressing the challenges of abstract chemistry topics such as Dalton's, Thomson's, Rutherford's, and Bohr's atomic models. This explanation is in line with research conducted by (Kasprianto et al., n.d.; Simamora et al., 2025) which states that AI using ChatGPT can help students solve problems. The high percentage of positive responses indicates that students not only accept the presence of ChatGPT in learning but also recognize its ability.

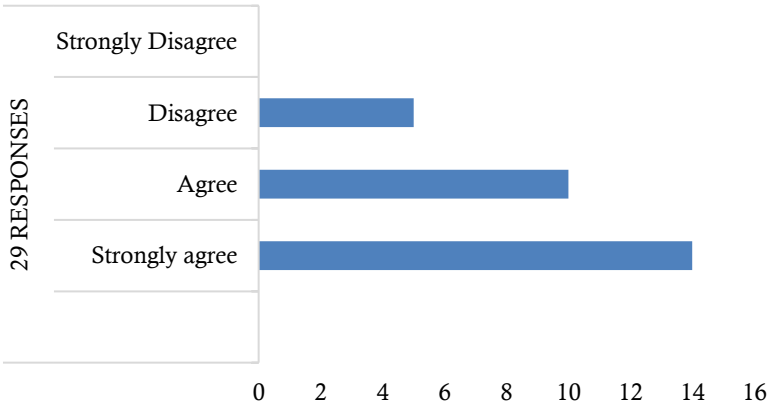

Figure 3. AI using ChatGPT serves as an effective tool for problem solving

The diagram further reinforces the positive attitude toward AI integration in chemistry learning by highlighting students' intentions to continue using AI using ChatGPT in the future. Out of 29 respondents, 20 students (69%) agreed, and 6 students (20.7%) strongly agreed that they intend to keep utilizing ChatGPT as a learning tool. Only 3 respondents (10.3%) disagreed, and none selected "strongly disagree," which indicates very limited reluctance. This distribution suggests that not only do students find AI useful in the present, but they also recognize its potential long-term benefits in supporting their academic progress, particularly in mastering challenging chemistry concepts.

These findings are consistent with recent research showing sustained student interest in technology-based learning tools. A study by (Su, 2022) revealed that students are more likely to continue using AI when they experience improvements in conceptual understanding and faster problem-solving. Similarly, (Mohebbi, 2025) and (Shikina, 2025) found that AI integration increases learner autonomy and confidence, encouraging continued application in future study contexts. (Duong et al., 2024; Lam, 2025) also reported that long-term intentions to use AI correlate strongly with perceived usefulness and learning satisfaction. Therefore, the data from this diagram not only reflects current positive perceptions but also demonstrates a strong future acceptance trajectory, suggesting that AI has a sustainable role in chemistry education moving forward.

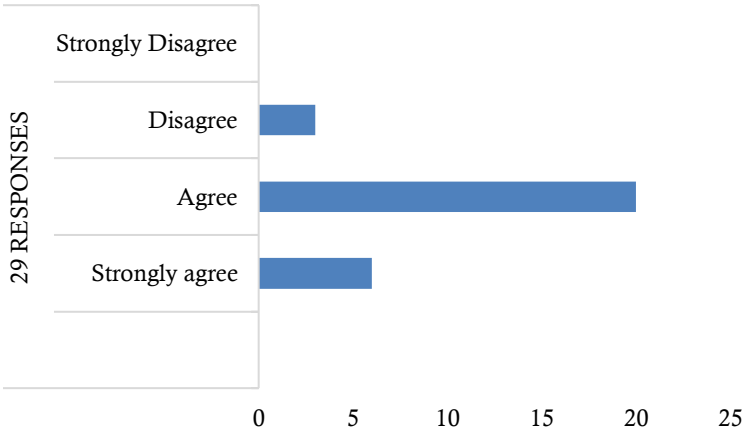

Figure 4. Motivation for sustainable AI

CONCLUSION

In Conclusion, the data analysis and discussion regarding the integration of Artificial Intelligence (AI) using ChatGPT in teaching the development of atomic theory suggest that the utilization of this technology significantly resolves the instructional bottlenecks frequently encountered in conventional methods. All

respondents (100%) agreed that ChatGPT makes abstract and microscopic atomic theory materials more accessible through its features of immediate explanations, clarification of misconceptions, and flexibility for independent study. This high level of accessibility is further supported by the perceived usability of the platform, with the vast majority of students (93.1%) finding the AI-driven learning environment highly user-friendly. This psychological comfort is not merely a cosmetic preference, but a crucial structural factor that reduces learning anxiety while enhancing student engagement when exploring complex chemistry concepts.

Furthermore, from a practical standpoint, 82.8% of the students evaluated ChatGPT as an effective tool for solving chemistry problems related to Dalton's, Thomson's, Rutherford's, and Bohr's atomic models. Although a small percentage of students (17.2%) perceived limited benefits—which is attributed to challenges in formulating effective prompts or a preference for face-to-face teacher interaction—the general acceptance of this technology remains remarkably strong. This is reflected in their high motivation for sustainable use, with 89.7% of students expressing a commitment to continue utilizing ChatGPT in their future learning endeavors.

Overall, this study underscores that ChatGPT effectively addresses the dysfunctions of traditional chemistry teaching by serving as a medium that improves accessibility, provides psychological comfort in learning, aids in problem-solving, and fosters learner autonomy. While this study primarily captures students' perceptions and subjective comfort rather than directly measuring academic achievement, the resulting data demonstrates a positive trajectory, suggesting that this adaptive AI platform holds immense potential for permanent integration to support digital transformation in chemistry education.

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