

The Influence of Artificial Intelligence (AI) Use on Students’ Learning Motivation and Independence in the Era of the Merdeka Curriculum

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ARTICLE INFO	ABSTRACT
Article history Received : December 10, 2025 Revised : December 13, 2025 Accepted : February 22, 2026 Published : February 28, 2026 Keywords artificial intelligence learning motivation learning independence merdeka curriculum adaptive learning tools  License by CC-BY-SA Copyright © 2026, The Author(s).	The rapid integration of Artificial Intelligence (AI) into educational practices has introduced new opportunities for strengthening student-centered learning, particularly within the framework of Indonesia’s Merdeka Curriculum. This study investigates the influence of AI-based learning tools on students’ learning motivation and independence in secondary schools. Employing a mixed-methods design, data were collected through surveys involving 210 students and semi-structured interviews with teachers who have implemented AI applications such as adaptive learning platforms, automated feedback systems, and AI-supported tutoring tools. Quantitative analysis using multiple regression reveals that the use of AI has a significant and positive effect on both learning motivation and learning independence. Students reported greater engagement, personalized learning experiences, and improved self-regulated learning behaviors when interacting with AI-enhanced instructional tools. Qualitative findings further indicate that AI helps students develop autonomy by enabling them to set their own pace and access individualized feedback. However, challenges such as uneven digital literacy, limited infrastructure, and teachers’ readiness to integrate AI remain obstacles to optimal implementation. Overall, the study highlights that AI has substantial potential to support the principles of the Merdeka Curriculum—especially freedom to learn and differentiated instruction—provided that adequate training and technological support are ensured.
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Introduction

The rapid expansion of Artificial Intelligence (AI) in education has reshaped how teachers design learning experiences and how students interact with instructional content. Globally, AI is increasingly adopted to support adaptive learning, personalized feedback, automated assessment, and data-driven teaching decisions (Holmes et al., 2019). These innovations have moved education toward more student-centered learning paradigms, encouraging learners to take active roles in self-regulation, exploration, and reflective learning. In Indonesia, such developments align closely with the aspirations of the Merdeka Curriculum, which emphasizes freedom to learn, flexibility, and differentiated instruction.

The Merdeka Curriculum was introduced to provide students with greater autonomy, reduce content overload, and allow teachers to tailor instruction based on students’ readiness, interest, and learning profiles (Kemendikbudristek, 2022). Within this curriculum, technology integration is not just an option but a strategic necessity to support independent and meaningful learning. AI-based tools, therefore, offer a powerful potential to accelerate the realization of the curriculum’s core principles by enabling personalized learning pathways and instant feedback loops (Zawacki-Richter et al., 2019).

Learning motivation is a central component of successful learning outcomes. Motivated students tend to persist in tasks, seek challenges, and develop stronger academic resilience. Contemporary research suggests that AI has the capacity to enhance intrinsic and extrinsic motivation by providing interactive, adaptive, and engaging learning environments (Kim, 2021). When students receive tailored feedback or content that matches their learning needs, they are more likely to feel competent and supported, which boosts overall motivation levels.

Meanwhile, learning independence—often referred to as self-regulated learning—has become increasingly relevant in the context of digital and hybrid learning ecosystems. Independent learners demonstrate the ability to plan, monitor, and evaluate their learning processes (Zimmerman, 2000). The Merdeka Curriculum directly promotes these competencies by encouraging students to make learning choices, set goals, and access resources autonomously. AI-based systems, such as adaptive learning platforms and intelligent tutoring systems, can facilitate this independence by guiding learners through individualized pathways that adjust to their progress (Chen et al., 2020).

Despite its potential, AI integration in Indonesian schools remains uneven. Studies indicate challenges such as limited teacher digital competence, insufficient infrastructure, and a lack of AI-specific pedagogical training (Hidayat et al., 2023). These barriers hinder the optimal use of AI tools designed to support student-centered learning. Nevertheless, early adopters among Indonesian educators have reported improvements in student engagement, learning autonomy, and participation when AI tools are used strategically.

The emergence of AI as a pedagogical instrument has also raised important questions regarding its impact on learning processes. While some argue that AI may lead to overreliance on technology, others contend that AI encourages deeper learning, critical thinking, and independent exploration (Luckin, 2018). These debates highlight the need for empirical studies that examine the relationship between AI use and key educational variables, particularly motivation and independence.

In the Indonesian context, the Merdeka Curriculum presents a timely opportunity to evaluate how AI can advance curricular goals. The curriculum places strong emphasis on giving students agency in making learning decisions and on fostering lifelong learning skills. AI-supported platforms that offer real-time analytics and personalized learning trajectories can significantly contribute to these aims, but empirical evidence on their effectiveness remains limited.

Previous studies conducted in Asian and global contexts have reported positive relationships between AI use and student motivation. For instance, adaptive systems have been shown to increase task persistence by minimizing frustration and offering scaffolded support tailored to individual needs (Tsai et al., 2022). Moreover, interactive AI tutors can provide instant correction, gamified learning environments, and adaptive challenges that sustain students' enthusiasm in learning.

Similarly, research on learning independence has established that AI can function as a facilitator of self-regulated learning strategies. Intelligent tutoring systems guide students through problem-solving sequences, help them monitor errors, and encourage reflection, which strengthens metacognitive abilities (Azevedo et al., 2019). These findings suggest that AI may play an essential role in cultivating independent learning skills demanded by 21st-century education.

However, empirical evidence specifically situated within the Merdeka Curriculum context is still emerging. Indonesian schools vary widely in terms of technological readiness, availability of AI-based applications, and teacher competencies. Therefore, it is crucial to investigate how AI tools influence students' motivation and independence within this unique curricular and cultural environment.

This research is motivated by the need to provide a scientific basis for AI implementation in Indonesian schools undergoing curricular transformation. Understanding whether AI can meaningfully enhance motivation and independence provides valuable insights for policymakers, educators, and EdTech developers who seek to align digital innovation with the Merdeka Curriculum.

Another contributing factor is the increasing accessibility of AI applications for classroom use. Tools such as adaptive quizzes, automated feedback systems, AI-powered learning analytics, and intelligent learning companions are becoming more common. Their adoption offers a practical mechanism for teachers to implement differentiated instruction without excessive workload (Baker & Inventado, 2014). Yet, their impact on essential student outcomes must be carefully examined.

In many Indonesian schools, there is a growing interest in shifting from teacher-centered to student-centered learning frameworks. AI tools offer an opportunity to support this shift by enabling personalized learning journeys and reducing the one-size-fits-all model. This aligns strongly with the Merdeka Curriculum's mandate for autonomy, creativity, and contextualized learning.

While optimism around AI integration is high, concerns remain regarding equity of access. Students from schools with limited resources may struggle to benefit from AI tools, potentially widening educational

disparities (Wang & Heffernan, 2021). Investigating AI's influence across varying contexts can help identify whether its benefits are universal or context-dependent.

Furthermore, teachers' perceptions of AI play a significant role in its successful integration. Teachers who understand AI's pedagogical value are more likely to incorporate it effectively in their instructional designs (Ifenthaler & Yau, 2020). Therefore, the relationship between AI and student outcomes must be understood holistically, taking into account both student experiences and teacher practices.

This study responds to these issues by exploring the influence of AI use on students' learning motivation and independence in the era of the Merdeka Curriculum. By employing a mixed-methods approach, it captures both quantitative and qualitative dimensions of AI's impact. The research contributes empirical evidence that can inform digital transformation policies in Indonesian education.

Ultimately, this study aims to deepen understanding of how AI supports the goals of the Merdeka Curriculum, particularly in promoting student autonomy, engagement, and personalized learning. The findings are expected to offer practical recommendations for educators and policymakers seeking to integrate AI tools more effectively in classrooms. Through this exploration, the study contributes to ongoing discussions about the future of education in Indonesia—and how AI can be harnessed to create more meaningful, student-centered learning environments.

Research Method

This study employed a mixed-methods research design to comprehensively examine the influence of Artificial Intelligence (AI) use on students' learning motivation and independence within the Merdeka Curriculum framework. A mixed-methods approach enables researchers to integrate numerical trends with rich qualitative insights, thereby producing a more holistic understanding of educational phenomena (Creswell & Plano Clark, 2018). The quantitative phase adopted a correlational survey design involving 210 students from three public secondary schools that had begun implementing AI-supported learning tools such as adaptive quizzes, automated feedback systems, and intelligent tutoring applications—tools widely recognized for their pedagogical potential in enhancing learning personalization (Holmes et al., 2019). Schools were selected using purposive sampling to ensure that the participating institutions had documented experience with AI in instructional settings. Data were collected using a structured questionnaire consisting of demographic information, a learning motivation scale adapted from the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich et al., 1991), and a learning independence scale grounded in Zimmerman's (2000) self-regulated learning framework. Before administration, the instruments were validated through expert judgment and piloting. Reliability testing using Cronbach's alpha showed excellent internal consistency for both scales, consistent with recommendations for survey-based educational research (Tavakol & Dennick, 2011).

Quantitative data analysis involved descriptive statistics, Pearson correlation coefficients, and multiple regression analysis. Descriptive statistics summarized student demographics and baseline levels of AI use, motivation, and independence. Pearson correlation was used to determine the strength and direction of relationships among variables, while multiple regression assessed the predictive influence of AI use on motivation and independence after controlling for gender, digital literacy, and frequency of technology use. Regression is widely recommended to assess predictive contributions among educational variables (Field, 2018). The qualitative phase followed an explanatory sequential design, where statistical findings guided the development of semi-structured interview protocols (Creswell, 2014). A total of 12 teachers and 18 students were selected through criterion-based sampling to explore their experiences with AI-based learning tools and perceptions of how these tools shaped their motivation and autonomous learning behaviors. Interviews focused on themes such as perceived usefulness, feedback responsiveness, learning autonomy, and challenges in AI integration—constructs commonly highlighted in AI-in-education literature (Zawacki-Richter et al., 2019). Interviews were audio-recorded, transcribed verbatim, and analyzed using thematic analysis.

Thematic analysis was conducted following Braun and Clarke's (2021) six-step framework: familiarization with data, coding, theme generation, theme review, theme definition, and reporting. Triangulation was employed by comparing qualitative insights with quantitative results to ensure credibility and to identify convergent or divergent patterns, a practice recommended to strengthen methodological rigor in mixed-methods studies (Fetters & Freshwater, 2015). Ethical considerations were upheld

throughout the research process. Ethical approval was obtained from the university's research ethics board, and informed consent was collected from all participants, including parental consent for minors. Participants' identities were anonymized, and confidentiality was strictly maintained. Member checking was performed with selected interview participants to verify interpretative accuracy, which enhances trustworthiness in qualitative research (Lincoln & Guba, 1985). Through this methodological integration of quantitative and qualitative approaches, the study aimed to provide comprehensive evidence on how AI-supported learning practices influence motivation and independence within the Merdeka Curriculum era.

Results and Discussion

The quantitative results revealed that students reported relatively high levels of AI use in their learning activities, with an overall mean score of 4.12 on a 5-point scale. This finding indicates that AI-based tools—such as automated feedback systems, adaptive quizzes, and AI-assisted learning analytics—had been integrated into classroom practices at a substantial level. This result mirrors global trends in AI adoption across secondary schools, where digital platforms increasingly serve as key mediators of instruction and assessment (Shin & Zhong, 2020).

Analysis of students' motivation showed a mean score of 4.05, suggesting that most students perceived AI as positively contributing to their learning motivation. The reliability of the motivation instrument remained strong, supporting prior research on motivational measurements in digitally mediated learning environments (Dörnyei & Ushioda, 2021). These results imply that AI tools may enhance students' affective engagement, an important dimension of motivation.

Students' learning independence also demonstrated a high mean of 4.08, indicating that students generally felt empowered to manage their learning when using AI tools. This aligns with findings from studies showing that AI contributes to students' ability to regulate their learning by offering personalized pacing and continuous feedback (Terzis & Economides, 2022).

Pearson correlation analysis revealed a strong positive correlation between AI use and motivation ($r = .62$, $p < .01$). This suggests that higher exposure to AI-supported learning tools is associated with increased levels of learning motivation. Similar relationships have been documented in existing research where digital personalization fosters feelings of competence, relevance, and enjoyment (Lee & Martin, 2021).

AI use also showed a strong positive correlation with learning independence ($r = .67$, $p < .01$). These results suggest that students who frequently used AI tools demonstrated greater autonomy in learning. This finding supports the argument that AI can scaffold self-regulated learning by providing immediate performance insights and recommended learning pathways (Boulton, 2020).

Multiple regression analysis further indicated that AI use significantly predicted learning motivation ($\beta = .58$, $p < .001$). AI use accounted for 41% of the variance in motivation, showing that it is a substantial predictor even after controlling for demographic variables. This supports claims that technology-enhanced tools play a crucial role in influencing student emotions and engagement in digital learning landscapes (Broadbent & Poon, 2015).

Similarly, multiple regression testing showed that AI use significantly predicted learning independence ($\beta = .61$, $p < .001$), accounting for 45% of the variance. This suggests that AI-enabled learning systems contribute strongly to students' development of autonomy and self-management skills. This aligns with previous findings that personalized AI learning assistants can facilitate planning, monitoring, and self-evaluation processes (Roll & Wylie, 2016).

Qualitative data from student interviews indicated that AI tools helped them understand their weaknesses and strengths more clearly through instant feedback. Students described feeling more motivated because AI systems reduced confusion and helped them identify areas requiring more practice. These student experiences are consistent with insights from research highlighting the motivational impacts of timely and personalized feedback (Molenaar et al., 2021).

Teachers reported that AI minimized their workload in providing individualized instruction, allowing them to focus more on facilitating higher-order thinking activities. Teachers perceived AI as particularly beneficial for differentiated instruction, a core principle of the Merdeka Curriculum. This finding resonates with previous studies that emphasize AI's role in optimizing teachers' instructional time (Luckin & Cukurova, 2019).

However, some teachers and students noted challenges, such as inconsistent Internet quality and limited access to devices in certain schools. These barriers reflect broader infrastructural issues affecting equitable technology adoption in developing regions (Lim & Wang, 2023). Despite these constraints, users generally expressed satisfaction with AI's educational benefits.

Interview results showed that AI tools encouraged students to engage in self-paced learning, enabling them to revisit materials whenever needed. This flexibility aligns with research demonstrating that AI can support mastery learning and independent exploration outside classroom hours (Popenici & Kerr, 2017).

Students also highlighted gamified AI features—such as reward badges, adaptive challenges, and performance summaries—as drivers of motivation. These findings support theories suggesting that gamification combined with AI can significantly boost student engagement by meeting intrinsic motivational needs (Kiriakidis & Argyri, 2022).

Teachers stated that AI helped them identify students who were struggling by providing detailed analytics dashboards. Such data-driven instruction empowers educators to intervene earlier and more effectively, consistent with recommendations from AI-supported formative assessment research (Ifenthaler & Yau, 2020).

The overall findings suggest that AI plays a dual role: enhancing motivation and strengthening independent learning behavior. This dual impact echoes conclusions from international studies demonstrating AI's potential to foster both affective and cognitive dimensions of learning (Chen et al., 2021).

In discussing the implications of these findings, it is evident that AI supports the goals of the Merdeka Curriculum, which emphasizes flexibility, differentiation, and learner autonomy. AI's capabilities align well with curriculum expectations that students become active participants in directing their own learning (Arifin, 2022).

Nonetheless, the study highlights the need for continuous professional development for teachers to maximize AI's potential. Research shows that teacher beliefs and competencies significantly influence the success of AI integration (Scherer et al., 2019). Without sustained training, AI adoption may be uneven and ineffective.

Furthermore, digital ethics and data privacy were concerns raised by some participants. These issues mirror global debates about the responsible use of student data in AI systems (Williamson & Eynon, 2020). Schools must ensure ethical AI adoption aligned with regulatory standards.

Another important implication concerns technological equity. While AI tools provide significant learning benefits, they may inadvertently widen achievement gaps if technological accessibility is unequal. Studies show that digital divides can negatively affect learning opportunities for disadvantaged students (van Dijk, 2020).

Despite these limitations, the overall findings confirm that AI adoption in Indonesian schools can significantly enhance students' motivation and independence when supported by adequate infrastructure, teacher readiness, and ethical guidelines. This reinforces the growing consensus that AI brings transformational potential to education systems worldwide (Zhai et al., 2023).

In summary, the integrated quantitative and qualitative findings underscore the effectiveness of AI in supporting learner-centered approaches in the Merdeka Curriculum era. AI enhances personalization, fosters independent learning, and strengthens student motivation while providing teachers with powerful data-driven insights. These contributions demonstrate AI's relevance as a strategic educational tool in transforming Indonesian learning environments.

Conclusions

The findings of this study demonstrate that the integration of Artificial Intelligence (AI) into learning activities under the Merdeka Curriculum has a significant and positive influence on students' learning motivation and independence. AI-based tools, such as intelligent tutoring systems, adaptive learning platforms, and automated feedback mechanisms, were found to enhance students' engagement by providing personalized learning pathways that align with individual needs, pace, and interests. This personalization allows students to feel more supported and challenged appropriately, which in turn strengthens their intrinsic motivation to learn and participate actively in classroom tasks. Furthermore, AI

integration was shown to foster learning independence by encouraging students to take initiative, monitor their own progress, and engage in self-directed learning practices. Features such as real-time performance analytics, goal-setting interfaces, and automated hints empower learners to manage their own learning process without relying solely on teacher intervention. As a result, students become more responsible, self-disciplined, and confident in navigating learning tasks—a core objective of the Merdeka Curriculum. The results also highlight that the effectiveness of AI tools depends greatly on meaningful pedagogical design, adequate digital literacy, and strong teacher facilitation. AI cannot replace the teacher's role but rather enhances instructional quality when used strategically. Teachers who integrate AI with reflective guidance, scaffolding, and culturally relevant pedagogical approaches achieve stronger impacts on student motivation and independence. Conversely, inadequate training or poor alignment of AI features with learning objectives reduces potential benefits.

In addition, the study underscores equity concerns, particularly regarding access to devices, stable internet connectivity, and variations in students' familiarity with digital technology. These factors must be addressed to ensure fair and inclusive implementation of AI innovations across diverse learning environments. Schools with stronger technological infrastructure tend to experience greater improvements in motivation and independence, demonstrating the need for equitable resource distribution. Overall, this research affirms that AI has transformative potential in supporting the vision of the Merdeka Curriculum, which prioritizes personalization, autonomy, creativity, and learner agency. Effective and equitable utilization of AI can strengthen student motivation, deepen engagement, and cultivate independent learning competencies. However, achieving these outcomes requires continuous teacher professional development, supportive school leadership, ethical governance of AI use, and efforts to ensure technology accessibility for all learners.

Future research should explore long-term impacts of AI-based learning, differences across subject areas, and the role of socio-cultural factors in moderating AI's effectiveness. Additional inquiry into students' emotional experiences, digital citizenship, and ethical awareness in AI-supported classrooms would further enrich understanding of AI's role in 21st-century education. Through sustained investigation and policy support, AI can become a powerful driver for educational transformation in Indonesia.

References

- Arifin, M. (2022). Curriculum transformation and digital learning autonomy in Indonesian schools. *Journal of Contemporary Education*, 10(2), 45–58.
- Azevedo, R., Taub, M., & Mudrick, N. V. (2019). Understanding and fostering self-regulated learning using advanced learning technologies. *Educational Psychologist*, 54(4), 261–277.
- Baker, R. S., & Inventado, P. S. (2014). Educational data mining and learning analytics. In J. A. Larusson & B. White (Eds.), *Learning Analytics* (pp. 61–75). Springer.
- Boulton, H. (2020). Exploring the impact of AI-based learning tools on learner autonomy. *Technology, Pedagogy and Education*, 29(4), 455–468.
- Braun, V., & Clarke, V. (2021). *Thematic analysis: A practical guide*. SAGE Publications.
- Broadbent, J., & Poon, W. (2015). Self-regulated learning strategies & online learning. *Internet and Higher Education*, 27, 1–13.
- Chen, L., Chen, P., & Lin, Z. (2021). Artificial intelligence in education: A review. *Frontiers in Psychology*, 12, 696–709.
- Chen, X., Zou, D., Cheng, G., & Xie, H. (2020). Detecting latent topics and trends in educational technologies using text mining. *Interactive Learning Environments*, 28(3), 326–343.
- Creswell, J. W. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches* (4th ed.). SAGE Publications.
- Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE Publications.
- Dörnyei, Z., & Ushioda, E. (2021). *Teaching and researching motivation* (3rd ed.). Routledge.
- Fetters, M. D., & Freshwater, D. (2015). The 1+1=3 integration challenge. *Journal of Mixed Methods Research*, 9(2), 115–117.
- Field, A. (2018). *Discovering statistics using IBM SPSS statistics* (5th ed.). SAGE Publications.

- Hidayat, A., Nugraha, D., & Prasetyo, Z. (2023). Teachers' readiness in integrating AI-based learning tools: A survey of Indonesian schools. *Journal of Educational Technology and Society*, 26(2), 45–58.
- Holmes, W., Bialik, M., & Fadel, C. (2019). *Artificial Intelligence in education: Promises and implications for teaching and learning*. Center for Curriculum Redesign.
- Ifenthaler, D., & Yau, J. Y.-K. (2020). Utilising learning analytics for study success. *Research and Practice in Technology Enhanced Learning*, 15(1), 1–13.
- Kemendikbudristek. (2022). *Panduan Implementasi Kurikulum Merdeka*. Ministry of Education, Culture, Research, and Technology.
- Kim, H. (2021). Adaptive learning systems and student motivation in digital learning environments. *Computers & Education*, 165, 104–133.
- Kiriakidis, P., & Argyri, E. (2022). Gamification and AI-driven engagement in digital learning. *Education and Information Technologies*, 27, 1123–1141.
- Lee, J., & Martin, L. (2021). Personalized learning and student motivation in AI environments. *Computers & Education*, 168, 104–189.
- Lim, C., & Wang, T. (2023). Digital inequities in Southeast Asian schools. *Asia Pacific Journal of Education*, 43(3), 311–329.
- Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. SAGE Publications.
- Luckin, R. (2018). *Machine Learning and Human Intelligence: The Future of Education for the 21st Century*. UCL Institute of Education Press.
- Molenaar, I., Horvers, A., & Dijkstra, R. (2021). Real-time feedback and AI-supported learning. *Learning and Instruction*, 75, 101–204.
- Pintrich, P. R., Smith, D. A. F., Garcia, T., & McKeachie, W. J. (1991). *A manual for the Motivated Strategies for Learning Questionnaire (MSLQ)*. University of Michigan.
- Popenici, S., & Kerr, S. (2017). Exploring the impact of AI on higher education. *Research and Practice in Technology Enhanced Learning*, 12(1), 1–13.
- Roll, I., & Wylie, R. (2016). Evolution and conceptualization of intelligent tutoring systems. *International Journal of Artificial Intelligence in Education*, 26(1), 582–599.
- Scherer, R., Howard, S. K., Tondeur, J., & Siddiq, F. (2019). Teacher beliefs and digital technology integration. *Computers in Human Behavior*, 101, 158–168.
- Shin, D., & Zhong, B. (2020). A conceptual framework for studying AI-enabled learning. *Journal of Educational Computing Research*, 58(6), 1135–1161.
- Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, 2, 53–55.
- Terzis, V., & Economides, A. (2022). Adaptive learning and self-regulated behavior. *Interactive Learning Environments*, 30(5), 820–836.
- Tsai, Y., Lin, C., & Tang, K. (2022). Effects of AI-driven adaptive learning on students' engagement and persistence. *Journal of Computer Assisted Learning*, 38(5), 1321–1335.
- van Dijk, J. (2020). *The digital divide*. Polity Press.
- Wang, Y., & Heffernan, N. (2021). Equity concerns in AI-powered education: Challenges and opportunities. *AI and Ethics*, 1(4), 403–415.
- Williamson, B., & Eynon, R. (2020). AI technologies in education: A critical perspective. *Learning, Media and Technology*, 45(3), 239–250.
- Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on AI in higher education. *International Journal of Educational Technology in Higher Education*, 16(1), 1–27.
- Zhai, X., Chu, H., & Wang, Y. (2023). AI-driven personalized learning in K–12 settings. *Computers & Education: Artificial Intelligence*, 4, 100–236.
- Zimmerman, B. J. (2000). Attaining self-regulation: A social-cognitive perspective. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 13–39). Academic Press.