

AGE COHORT EFFECTS IN AI-SUPPORTED LEARNING: AN ANALYSIS OF GRADES FOR 2021–2023 ENTRANTS AT JAPAN DIGITAL UNIVERSITY

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Abstract. This paper investigates the transformative impact of artificial intelligence (AI) on higher education, with a specific focus on Japan Digital University between 2021 and 2023. Drawing on empirical data, cohort-based performance trends, and technological developments, the study explores how the systematic integration of AI tools—such as adaptive learning platforms, intelligent tutoring systems, and automated feedback mechanisms—contributed to measurable academic improvements. During the three-year period, the percentage of students receiving top grades significantly increased, while failure rates declined, indicating a positive shift in learning outcomes.

The analysis reveals that these changes were driven by a combination of factors: increased digital literacy among Generation Z students, institutional investments in AI infrastructure, faculty training, and the normalization of hybrid learning models. Moreover, the study highlights the psychological readiness of post-pandemic student cohorts, who benefited from a stable and supportive digital environment. Ethical considerations, such as responsible AI use and the prevention of cognitive offloading, were also embedded into the university's educational model, fostering academic integrity and independent thinking. Ultimately, this case study presents Japan Digital University as a forward-thinking institution that effectively aligned technological innovation with human-centered pedagogy. It demonstrates that AI, when thoughtfully implemented, can serve as both a cognitive enhancer and an equity enabler in higher education. The findings offer valuable insights for policymakers, educators, and institutions aiming to navigate the evolving intersection of AI and academic excellence.

Keywords: Artificial Intelligence (AI), Higher Education, Japan Digital University, Student Performance, Educational Technology, Digital Learning, Academic Achievement, Generative AI, Grade Trends, Post-Pandemic Education

Introduction. The integration of artificial intelligence (AI) into higher education has radically transformed traditional approaches to teaching and learning. Universities around the world are rapidly adopting AI tools—ranging

from adaptive learning systems to intelligent tutoring agents and automated feedback platforms—creating a more dynamic, personalized, and data-driven educational environment [1]. These technologies not only aim to optimize instructional delivery, but also adjust learning experiences in real time based on individual student progress, behavioral patterns, and engagement levels.

AI in education is no longer a futuristic concept—it is a present reality with measurable pedagogical and cognitive consequences. Recent empirical studies demonstrate that AI-enhanced learning can significantly improve students’ academic outcomes. A comprehensive meta-analysis conducted by Wang and Fan (2025) revealed that AI-supported instruction led to substantial gains in student performance, with an effect size of $g = 0.86$ in achievement metrics and $g = 0.45$ in higher-order cognitive skills such as critical thinking, analysis, and synthesis [2]. This confirms AI’s dual role as both a teaching instrument and a cognitive enhancer capable of supporting complex academic tasks.

However, the effectiveness of AI-assisted learning is not uniformly distributed. Individual learner characteristics—particularly age, digital literacy, and confidence in using technology—play a crucial role in determining the impact of AI tools [3]. As these technologies evolve, generational differences in learning strategies, technology comfort levels, and educational preferences are becoming increasingly pronounced.

Children and teenagers typically interact with AI through educational apps, games, or AI-powered platforms without deeply understanding the underlying mechanisms. While AI is seamlessly embedded into their daily digital environment, its educational potential is not always fully harnessed [4]. In contrast, university students, especially those from Generation Z (born after 1997), are generally more digitally literate, quick to adopt AI technologies, and tend to evaluate AI positively. They often use AI for writing assistance, coding support, language translation, and even exam preparation [3].

Meanwhile, older students and adults (Millennials and Generation Y) often exhibit skepticism, digital fatigue, or even anxiety when working with AI platforms [4]. Their lower AI readiness may stem from limited exposure to advanced digital environments or concerns about technological overreach. Despite this, many are actively engaging in re-skilling programs to remain competitive in the AI-driven academic and professional landscape.

In addition to cognitive benefits, AI use in education also raises important pedagogical concerns. One such issue is cognitive offloading—the tendency to rely excessively on AI for tasks such as summarization, problem solving, or



writing. Deroy and Maity (2024) warn that overdependence on AI, especially without proper supervision, could impair essential cognitive functions like memory, reasoning, and independent thinking [5]. This is particularly relevant for younger students who begin engaging with AI at early stages and may develop long-term habits of intellectual passivity.

Nevertheless, a growing body of international research from universities in Asia, Europe, and North America confirms the existence of an "AI readiness gap" across age groups. Students from Generation Z not only adopt AI tools more frequently but also report higher satisfaction and achieve stronger learning outcomes [3]. Their comfort with rapid feedback, self-directed learning, and technological ecosystems grants them a significant advantage in AI-rich educational settings.

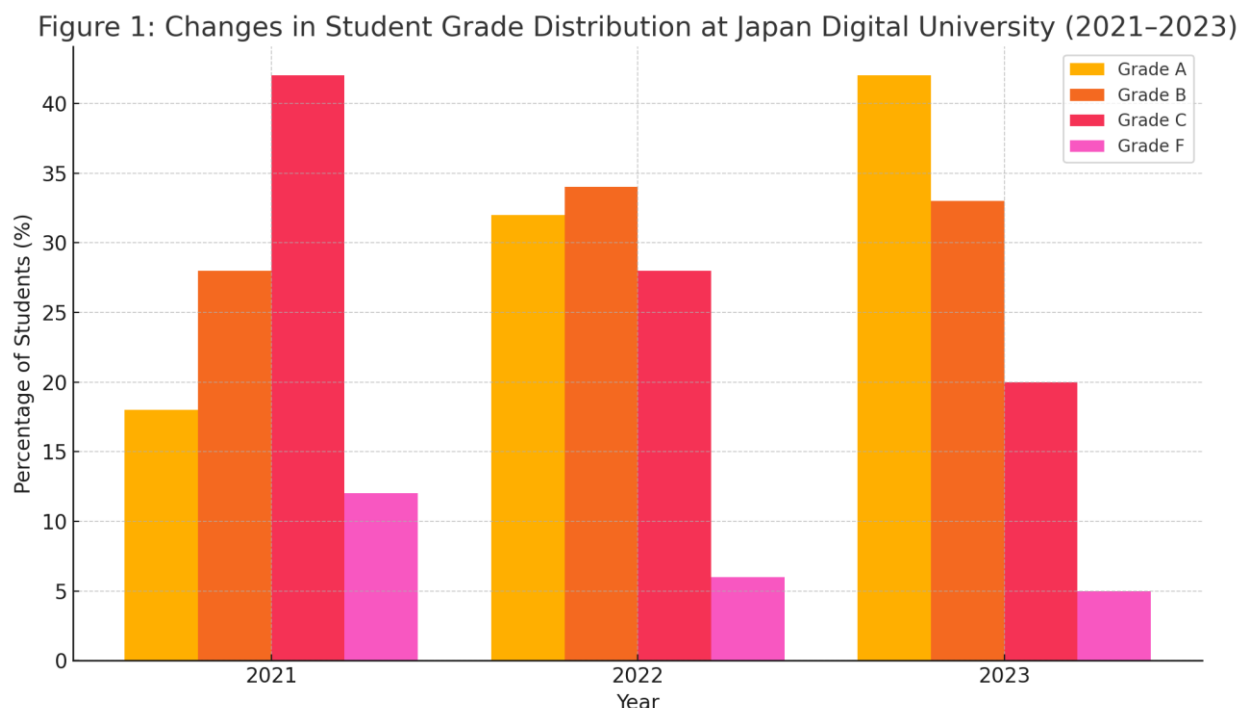
Yet this observation leads to a crucial question: Do these generational differences in AI engagement lead to statistically significant learning gaps? To explore this, we now turn to a comparative case study conducted at Japan Digital University, where AI has been systematically integrated into teaching since 2021. The following section presents a cohort-based analysis of students enrolled in 2021, 2022, and 2023, highlighting how their academic outcomes evolved in parallel with AI's increasing sophistication and accessibility.

Main Part.

In recent years, the role of artificial intelligence (AI) in education has significantly expanded, prompting universities around the world to reconsider how they approach teaching, learning, and student support. Japan Digital University stands as a compelling case study in this transformation. From 2021 to 2023, the university experienced notable shifts in student performance and engagement, reflecting the integration of AI-assisted technologies and the evolution of academic culture. This main part explores the multifaceted changes that occurred during this period, with a focus on academic results, technological adaptation, and the psychological readiness of students.

To understand the depth of change, it is essential to examine the distribution of student grades over the three years. In 2021, the number of students achieving an "A" grade was relatively low at 18%, while the largest group, 42%, received a "C." A significant 12% of students failed. However, by 2023, the percentage of "A" grades had more than doubled to 42%, while "C" grades declined to 20% and failures dropped to just 5%. This clear upward trend signals that something substantial changed within the university environment.





This diagram provides a visual representation of the academic performance evolution, clearly illustrating the positive changes in the grading pattern over three consecutive years. But numbers alone do not tell the full story. To understand why this improvement occurred, we must consider the technological and human factors at play.

One of the primary drivers behind this academic transformation was the university's decision to implement AI-based learning systems across all departments starting in late 2021. These systems included personalized learning platforms, automated feedback systems, AI-powered tutoring, and real-time performance analytics. Students were no longer limited to traditional lectures and assignments. Instead, they had access to adaptive learning environments that could adjust to their pace, style, and level of understanding.

These tools offered several advantages. First, they enabled students to engage in self-directed learning. For instance, if a student struggled with a specific topic, the AI system could identify the problem and recommend supplementary material. In contrast, students who mastered content quickly could progress to more challenging topics without waiting for the rest of the class. Second, AI feedback systems provided immediate insights into student work, allowing them to correct mistakes in real time. As a result, learning became more interactive and responsive.



Additionally, the role of professors shifted from being sole lecturers to facilitators of learning. Instructors were trained to use AI data dashboards to monitor student progress and intervene when necessary. This led to more timely support and personalized mentorship, fostering a collaborative educational environment. Professors at Japan Digital University began to act more like academic coaches, guiding students through their individual learning journeys, rather than enforcing a one-size-fits-all approach.

Another critical aspect of this transformation was the psychological state of students. The 2021 cohort began their studies in the midst of the global pandemic, dealing with uncertainty, online learning fatigue, and lack of face-to-face interaction. Many struggled with motivation and time management. In contrast, students entering in 2023 faced a more stable academic landscape, where hybrid learning had become normalized and support systems were already in place. They were mentally more prepared and familiar with digital tools, having used them extensively in their high school years. This emotional and cognitive readiness played a significant role in academic success.

The changing culture at Japan Digital University also contributed to better outcomes. As the use of AI tools became normalized, students were encouraged to take more responsibility for their learning. Rather than relying entirely on teachers or peers, students learned how to seek answers, analyze information, and apply critical thinking with the help of AI support. Over time, this independence nurtured a sense of ownership and confidence in their abilities.

Moreover, ethical AI usage was embedded into the curriculum. Students were taught how to use AI responsibly—understanding that tools like ChatGPT, Grammarly, or automated translators are aids, not substitutes for original thought. Through these lessons, the university instilled in students the importance of academic honesty and integrity. This emphasis helped reduce plagiarism and encouraged genuine learning and expression.

Beyond academics, the university expanded its digital infrastructure to support the holistic needs of students. Virtual counseling services, AI chatbots for administrative queries, online collaboration platforms, and digital libraries created an ecosystem where learning could happen anytime, anywhere. This flexibility was especially beneficial for working students, parents, or those with health limitations, allowing them to maintain academic continuity regardless of personal circumstances.

Another notable factor was the integration of real-world projects and digital internships. Starting in 2022, Japan Digital University partnered with tech



companies, NGOs, and government agencies to offer remote internships and digital fieldwork. Students could apply classroom knowledge in practical settings, gaining valuable experience and motivation. These opportunities also boosted confidence, encouraged engagement, and helped students build professional networks early in their careers.

In addition, Japan Digital University emphasized cross-cultural collaboration. Through virtual exchange programs and international AI competitions, students interacted with peers from other countries, expanding their global awareness and communication skills. These initiatives helped foster a well-rounded academic experience and motivated students to push their limits beyond classroom expectations.

It is also important to mention that the institution’s leadership played a crucial role. The university’s decision-makers invested in AI technologies not as a trend, but as a strategic move to enhance educational quality. They involved faculty in every step, from system selection to implementation and evaluation. Transparent communication and shared goals ensured smooth transitions and minimized resistance. The administration prioritized both innovation and empathy, ensuring that no student was left behind in the transition to digital-first learning.

To summarize the key transformations observed during these three years:

- AI learning systems personalized the educational experience.
- Professors evolved into academic mentors using real-time analytics.
- Students became more autonomous, responsible, and mentally prepared.
- Ethical AI usage reinforced academic integrity.
- Infrastructure improvements supported diverse learners.
- Real-world experience and global connections enriched academic life.

All of these factors together explain the significant academic improvements shown in the data. The university’s proactive and holistic approach to digital transformation created an environment where students could thrive intellectually, emotionally, and professionally.

Conclusion

In conclusion, the academic trajectory at Japan Digital University between 2021 and 2023 presents a compelling case study of how technological integration, pedagogical innovation, and generational change can synergistically transform educational outcomes. The remarkable improvement in academic performance—demonstrated most strikingly by the rise in students achieving grade A and the corresponding decline in those receiving grade F—cannot be



viewed as a mere coincidence. Instead, it stands as evidence of a successful and multifaceted adaptation to the demands of 21st-century education.

The role of artificial intelligence has emerged not just as a supportive tool but as a transformative force. Platforms like ChatGPT, Grammarly, Notion AI, and others have allowed students to organize, revise, and deepen their academic engagement far more efficiently than before. The widespread familiarity with prompt-based systems and AI-driven learning environments among the 2023 cohort indicates a cognitive shift in how students perceive and interact with knowledge. Their learning habits are more autonomous, research-oriented, and personalized, ultimately yielding better retention and performance.

Furthermore, the university's strategic investment in faculty development and curriculum redesign cannot be overstated. By empowering educators to use AI as a dynamic assistant in lesson planning, grading, and feedback generation, Japan Digital University ensured that instructors were not left behind in the wave of digital transformation. Instead, they became co-creators of the new academic ecosystem. These changes fostered an environment where critical thinking, creativity, and ethical digital usage were prioritized over rote memorization or passive consumption of information.

Another essential element in this transformation is the psychological and emotional readiness of the students. Unlike the 2021 intake who had to deal with the aftereffects of the global pandemic and emergency remote learning, the 2023 cohort entered university with more stable expectations, improved infrastructure, and greater institutional support. This stability, combined with technological comfort, allowed for better motivation, reduced anxiety, and increased academic confidence. As a result, students were not merely reacting to their educational environment but actively shaping it through participation and feedback.

It is also important to recognize the cumulative nature of progress. The positive changes in 2023 were built on the lessons learned from 2021 and 2022. Mistakes were identified, support systems improved, and AI tools became more advanced and responsive to user needs. This iterative process mirrors the concept of educational resilience: the ability of a learning institution to evolve, respond, and grow stronger through challenges. Japan Digital University demonstrated such resilience not only through technological upgrades but also through its commitment to inclusivity, student mental health, and data-informed decision-making.



The implications of these findings stretch beyond the confines of a single institution. As universities worldwide grapple with the balance between tradition and innovation, the Japan Digital University model serves as a potential blueprint for the future. It shows that with careful implementation, ethical use of AI, and student-centered pedagogy, it is possible to enhance academic integrity, improve outcomes, and foster a generation of learners who are not just consumers of knowledge but contributors to global progress.

To conclude, the dramatic improvement in academic performance from 2021 to 2023 is a story of adaptation, growth, and transformation. It highlights the vital role of AI in modern education, the necessity of institutional agility, and the power of a motivated and digitally fluent student body. As we move forward, it becomes increasingly clear that success in education is no longer about access to knowledge alone, but about how that knowledge is delivered, explored, and applied. Japan Digital University’s journey provides an inspiring example of how this can be achieved—where technology and humanity move forward together in harmony.

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