

## A Recommendation for the Digitalization of University Education (3)

~Series: Practical Implementation at Small-Scale Universities — From Knowledge Sharing and Visualization of Outcomes to the Use of AI ~

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### 1. Introduction

In the previous installments, we introduced our university's digital transformation efforts in education, including an e-learning project for pre-enrollment and introductory education, the development of a structured knowledge map, and the implementation of flipped classrooms in the core curriculum. This installment provides an overview of how such digitized educational data can be utilized through the application of AI, thereby offering a broader perspective on educational digital transformation (DX).

### 2. Overview of Fully Online Flipped-Classroom Instruction

This section supplements the description of the fully online flipped-classroom model introduced in the previous installment [1]. The courses that adopt this model are those that combine knowledge acquisition with practical application. In the information systems field, for example, relevant subjects include programming, algorithms, and networks. For knowledge acquisition, students engage in self-study by watching instructional videos and working through web-based training (WBT) exercises, followed by computer-based adaptive testing (CAT) to assess their level of mastery. For knowledge application, students complete individual tasks on their own PCs in advance, and then deepen their understanding by explaining their work to peers during Zoom-based group sessions on the day of class.

Because this model emphasizes self-paced learning, a student's degree of self-motivation strongly influences learning outcomes. To support this, WBT-based exercises are provided in advance for each instructional unit (typically covered over multiple weeks), corresponding to the four-tier knowledge structure discussed in the previous installment. These exercises are offered at multiple difficulty levels—basic, standard, and advanced—so that students are encouraged to engage in multi-week, self-directed study. For instance, in lessons focused on foundational content, students are expected to prepare using the basic-level WBT materials. Motivated

students, however, are free to explore the standard and advanced levels. Meanwhile, those unable to complete the preparation in time due to various circumstances can catch up in the following week, as earlier content remains accessible. To support this structure, the WBT exercises are also formatted as CBT, which students are required to complete at home by the day before class. This requirement serves a specific purpose: the system automatically generates mixed-level groups based on CBT scores, combining students with high and low levels of understanding. The intent is to promote active discussion during group work. This system is explained to the students in advance, including the rationale behind the grouping.

In practice, each group includes at least one higher-level student who is encouraged to take the lead in explaining key concepts during class. This promotes deeper understanding and leadership development. Students are also encouraged to actively pose questions or raise topics—a mindset we refer to as the “First Penguin” principle. This structure fosters collaborative learning even among students of varying proficiency levels. By understanding this setup, students can strategically decide how much preparation to do based on their intended role in the group work, thereby nurturing self-regulated learning. To support this reflective process, students record a summary of their learning at the end of each class session and create a plan for the following week, which is then logged in their e-portfolio.

### **3. Utilization of Generative AI**

As described in the previous installment, the fully online flipped-classroom design enables centralized, large-scale course management. However, as discussed in this installment, it also requires support for diverse learning styles tailored to each individual student’s progress, which introduces a trade-off: there is a natural limit to the number of students a teacher can personally support. A natural solution to this dilemma is the use of generative AI to automate aspects of learning support. Fortunately, within our university’s ongoing digital transformation efforts, the instructional structure had already been highly systematized, and most learning-related data had been digitized. This made it possible to design structured prompts and insert standardized, formatted data to support AI-driven educational interactions. Accordingly, a research team in the Department of Information Systems developed an AI support system using ChatGPT-4o via API, which engages in conversational learning support and reflective feedback for students [2][3]. As shown in Figure 1, when a student completes their learning reflection after a class session within the system, the following information is automatically collected and converted into a prompt for the generative AI: (1)the student’s written reflection, (2)their group work

participation status (as entered separately by TAs), (3)their WBT and CAT progress, and (4)their learning goals set in the previous week. At the same time, the system also automatically provides the generative AI with the instructional policies and content configured by the instructor on the course portal, as well as any individual work files (e.g., PDFs) uploaded by the instructor [4]. With this input, the AI can grasp the context of the course to a reasonable extent and conduct oral questioning tailored to each student's learning status. Based on this interaction, it ultimately provides learning advice for the following week, considering the students' overall comprehension. An example of the AI–student dialogue during an actual class session is shown in Figure 2, and an example of the final learning advice screen is presented in Figure 3.

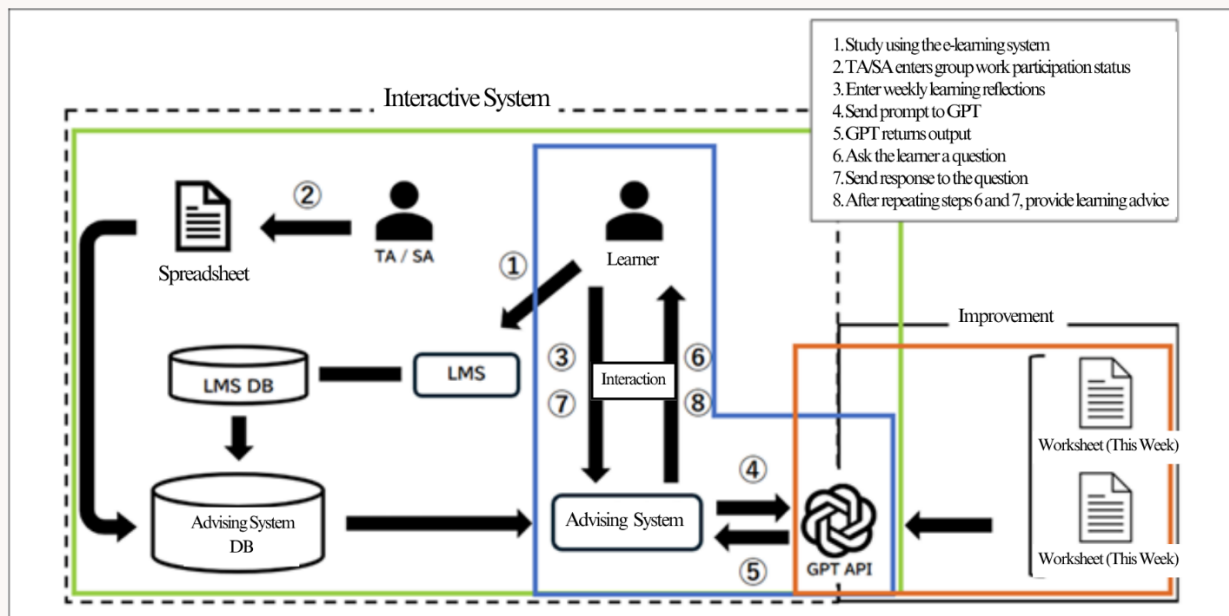


Figure1: Overview of the Automated Advising System Using Generative AI

AI

**Assistant** 2025年1月14日 12:00

In this week's assignment, you learned how to process Japanese text using Python through morphological analysis with Mecab. The main objective was to vectorize the text using TF-IDF and calculate cosine similarity.

First, it is important to understand the content of this lesson, particularly the calculation method and theoretical background of TF-IDF. Please explain what TF-IDF is and how it quantifies the similarity between texts.

U

**User** 2025年1月14日 12:04

TF-IDF is a method for quantifying the importance of words that appear in a document. By using this method to vectorize text, we can calculate the cosine similarity and numerically represent the similarity between documents.

Figure2: Sample Dialogue Between the AI and a Student (U): Triggered by the AI

[Introduction] Your steady efforts in learning the fundamentals of natural language processing in the AI Algorithms and Programming course are commendable.

[Current Status] Your learning history shows a proactive attitude toward solving practice exercises and a strong ability to collaborate with peers on assignments. However, the relatively short time spent reviewing the textbook suggests that allocating more time for supplementary reading could deepen your understanding further.

[Efforts on the Worksheet] This week's worksheet focused on sentence analysis using Mecab and implementing TF-IDF. You seem to have encountered some difficulty with the vectorization process. Utilizing libraries such as scikit-learn can help simplify these procedures.

[Potential for Growth] Your previous work demonstrates a growing grasp of algorithms, which is likely to be reflected in the upcoming final assignment. To further improve, try paying closer attention to the efficiency and readability of your code.

[Toward Next Week's Goal Setting] The final assignment will likely require you to apply the algorithms you have learned to develop more advanced programs. To achieve a high score, it is advisable to consider the efficiency and originality of your code, and to work collaboratively with team members to tackle complex problems. For next week, set a concrete plan and make it a habit to regularly track your progress.

Figure3: Goal-Setting Suggestions for the Following Week Generated by the AI

In the latter half of academic year 2024, a pilot implementation was conducted in a course with approximately 100 students. As a result, more than 80% of the students responded positively, indicating that the AI-generated messages were directly relevant to the course content and contributed meaningfully to their learning support. Initially, instructors were concerned that a text-based interactive questioning with AI at the end of each class might place an additional burden on students. Therefore, students were asked whether they wished to continue the activity in future sessions. Contrary to expectations, a large number of students provided favorable responses. Representative comments included, "If I don't understand something, I can just tell the AI, and it explains it carefully," and "It's hard to ask the teacher, but I can ask the AI right away." These responses highlighted how students perceived AI as more approachable than anticipated by faculty. Separately, we also experimented with having AI evaluate student reports assigned as coursework. The results showed that AI was able to replicate the instructors' scoring criteria with over 90% accuracy. The instructors shared the AI's grading outcomes—including justifications—with all students, encouraging them to interpret discrepancies between their own self-assessment and the AI's evaluation. Students who disagreed with the results were invited to challenge them, while others who found the feedback helpful were encouraged to revise and resubmit their reports. As

a result, approximately 10% of the students actively revised their work. This behavior reflects one possible model of learning in an era of coexistence with AI. Notably, some students commented in post-class surveys that “human grading is sometimes inconsistent, but AI doesn't have that problem, which is better,” further demonstrating changing perceptions.

The use of generative AI represents a breakthrough, in that it has made previously impractical educational practices realistically implementable, while maintaining a certain level of quality—as confirmed by student feedback. While it may be ideal for instructors to review student reflections after every class and provide real-time support for goal setting in the following week, such an approach is unrealistic due to the substantial time and staffing demands. Similarly, grading written assignments with detailed rationales and then accepting revised submissions poses a heavy workload for instructors. If such practices can be scaled efficiently across the institution through AI support, it could enable a fundamental shift in university education—from traditional, knowledge-centered instruction to more holistic and student-centered pedagogies. In this sense, such an approach truly embodies Educational DX: using digital technologies to enhance efficiency, create new value, and drive meaningful societal transformation.

## 4. Conclusion

In university education, where instructors teach based on their individual expertise, top-down digital transformation in education does not naturally align—except in exceptional circumstances such as the COVID-19 pandemic. For this reason, the first installment of this series recommended beginning with bottom-up initiatives based on internal needs. In particular, we presented a case in which digital tools were used to address the growing diversity of academic preparedness among first-year students—an issue shared by many institutions. This allowed both high schools and universities to construct an efficient and collaborative support system for student learning. In the second installment, we showed how university leadership could strategically build upon these bottom-up efforts to advance digitalization of the curriculum structure and learning outcome assurance, which are core responsibilities of higher education institutions. We emphasized that such progress should not rely solely on the efforts of a few faculty members, but rather involve all instructors in some form, thereby enhancing institutional value through curriculum visualization and enabling more effective course design and instruction. As learning activity data became increasingly digitized through this process, the groundwork for educational digital transformation (DX) naturally began to take shape. In the third

installment, we explored how recent advances in AI technology could support a vision of personalized, fine-grained learning assistance at scale—something that had previously been infeasible. This represents a tangible realization of Educational DX. We do not assume that the initiatives introduced in this series can be directly applied to other institutions. However, considering the increasing diversity of students entering higher education in Japan, the ability to provide individualized educational services will undoubtedly become a key factor in defining the value of a university. We hope that the ideas presented here will serve, at least in part, as a reference point or inspiration for other universities working to realize this potential.

## References

- [1] Takano, Y., Maekawa, K., Ueno, H., Yamakawa, H., & Komatsugawa, H. (2024). Practice and Evaluation of a Full Online Mastery Learning Type Flipped Classroom. *Transactions of Japanese Society for Information and Systems in Education*, Vol. 41, No. 3, pp. 224–239.
- [2] Ueno, H., & Komatsugawa, H. (2025). Learning Support Advising System Using Generative AI. *Human Interface Society, Special feature article on Education and Human Interface*, pp. 20–23.
- [3] Takano, Y., Sunahara, K., Someya, G., Tsurube, T., Ueno, H., & Komatsugawa, H. Development and Evaluation of a Generative AI-Based Advising System—Real-Time Advice on Learning Methods Based on Learning History and Reflection Writing. *Transactions of Japanese Society for Information and Systems in Education* (in press).
- [4] Sato, H., Nagata, K., Ueno, H., & Komatsugawa, H. Research on a Dialogue-based Advising System for Supporting Reflection on Class Assignments. *Student Research Group, Hokkaido Branch, Japanese Society for Information and Systems in Education*.