A Recommendation for the Digitalization of University Education (1)

~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

Amid ongoing higher education reforms, increasing attention is being paid to a variety of learning opportunities made possible through online education (e-learning), the visualization and quality assurance of learning outcomes through e-portfolios, and efficient and effective educational reforms utilizing AI (promotion of DX in education). However, in the current wave of digital transformation, many universities are likely still experimenting to determine where and how to begin. This article introduces a case study aimed at such institutions, presenting a university-wide implementation realized with the agility unique to small-scale universities over the past 20 years. The goal is to offer a practical insight for promoting digital education — a "recommendation for digitalization."

2. Background

The Chitose Institute of Science and Technology, where the author is affiliated, was established in 1998 in Chitose City, Hokkaido as a public-private single-department university focused on science and engineering (Faculty of Science and Technology, 240 students). Although the university has since become publicly operated, its early days as a private local institution led to an early awareness — ahead of many other universities — of the importance of ensuring educational quality despite diverse academic backgrounds among incoming students. Additionally, due to operational constraints similar to those faced by large universities under national educational standards, efficient management of human resources became essential. These circumstances are directly connected to what is now referred to as the "digital transformation (DX)" of education. Given this background, the idea of delegating tasks to computers wherever possible was relatively well accepted among both faculty and administrative staff from the university's founding. Within this context, the university first undertook (1) the implementation of e-learning for remedial education through high school–university collaboration, followed by (2) the promotion of ICT-integrated education aimed at cultivating competencies across the entire university with a view toward students' post-graduation outcomes, and finally progressed to (3) the trial use of learning analytics accumulated on ICT platforms to provide effective learning support through AI utilization. This article is the first in a series introducing these initiatives, beginning with (1).

3. E-learning Initiatives for Remedial Education through High School–University Collaboration

At the time of the university's founding in 1998, information technology was beginning to attract widespread attention. However, the actual implementation of e-learning in higher education was still far from common practice. At our university as well, the development of e-learning systems and content began as a bottom-up initiative, originally led by a few faculty members in the field of information science and by first- and second-year students from the inaugural cohorts who were interested in IT, through voluntary student-driven projects. Leveraging the programming knowledge they had acquired as freshmen, the students started by developing a Web-Based Training (WBT) system using Perl and CGI. By their third year, the system had evolved into a Java Servlet-based version, proudly claiming "Scalable for any number of users!" — a fashionable technological upgrade at the time. These efforts were carried out as independent research by young faculty and students, embodying a spirit of self-driven innovation. The university administration effectively recognized the value of these bottom-up initiatives and strategically incorporated them into the institution's remedial education strategy, aimed at addressing the diverse academic levels of incoming students. This led to a top-down approach that secured budget allocations and established a supporting institutional framework.

One reason why our university's e-learning initiative has been sustainable is likely due to its university-wide deployment that originated from efforts targeting pre-enrollment and first-year education. From the perspective of faculty members teaching first-year courses, the content was directly relevant to their classes, offering immediate and tangible benefits. Meanwhile, for faculty involved in the specialized curriculum, since the content was not directly related to their own teaching, there was no reason to oppose it in the first place. On the contrary, they saw clear potential for positive effects on their own course management as students progressed through the academic years. With such institutional understanding and support, we began full-scale efforts to address remedial subjects related to high school education — such as mathematics, physics, and chemistry — through e-learning. This initiative was selected for a competitive grant program by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) focused on educational reform, specifically the 2003 “Good Practice” Program for Supporting Distinctive University Education (Tokushoku GP) [1]. This recognition positioned the initiative as a university-wide effort, allowing it to gradually expand from pre-enrollment education to first-year education and then into foundational courses in the specialized curriculum.

At the time, remedial e-learning materials were not yet widespread, and as such, we university faculty members took it upon ourselves to develop instructional content covering high school-level subjects. However, when we applied our prototype materials in supplementary classes, the students’ responses were not entirely favorable. We came to recognize the limitations of university instructors in truly empathizing with students who had struggled with high school subjects. Accordingly, following the principle of “leaving it to the experts,” we decided to seek the cooperation of high school teachers to supervise the development of instructional manuscripts for high school-level content. Figure 1 shows a sample content screen created by students, based on a hand-drawn draft by a high school mathematics teacher. The manuscript was designed to resemble actual blackboard writing from classroom instruction, created by an experienced teacher. In this format, mathematical formulas and graphs appear one by one in the same sequence as they would be written on the board during a lecture.

Thanks to this design, the content was very well received by our students, many of whom struggle with intuitive visual understanding. It left a strong impression as content that genuinely contributes to remedial — in the sense of *healing* — education [2].

Given that the materials were internet-based, we invited high schools to participate on the condition that the developed content would be made available for use throughout the entire Hokkaido region (commonly referred to as *Zendō*). Although the initiative initially started with mathematics, it gradually expanded to include physics and chemistry through horizontal networks among teachers. Since high school teachers in Hokkaido are subject to regular relocations within the region, the materials were designed to remain usable regardless of where a teacher was reassigned. As a result, the network of users steadily grew. In Hokkaido, it is customary for new teachers to be assigned to remote areas far from Sapporo. High schools in such regions welcomed the opportunity to provide their students with access to instructional content that reflected the blackboard-style teaching methods of veteran teachers in Sapporo — a valuable resource for after-school learning. As a

testament to the program's impact, we once received a heartfelt thank-you letter from a high school student in a rural town with no nearby cram schools, who expressed gratitude for being able to gain admission to a national university by studying through our system. While the letter was a touching affirmation of the initiative's significance, I also recall feeling slightly conflicted that the effort had not directly contributed to enrollment at our own university.
From the university's perspective, the development of content and systems was positioned as an information services project, with high school teachers seen as the "clients." The project engaged volunteer students in their second year or above from the information systems department, along with research laboratories in the same field. These students were informed that the materials they developed would be used by their own juniors and actual high school students, instilling in them a strong sense of responsibility and an awareness of the importance of user-oriented design. Furthermore, we made deliberate efforts to minimize the involvement of university faculty, instead encouraging direct communication and collaboration between high school teachers and students. This approach fostered student autonomy and resulted in a high level of satisfaction among the participants. The initiative was passed down naturally from senior to junior students. Because the entire initiative was rooted in the daily educational practices of both high schools and the university, it has continued to the present day. It has expanded beyond the high schools of Hokkaido to include collaborations with junior high and elementary schools, as well as with other universities. As of 2025, under a comprehensive partnership with the Hokkaido Board of Education, the system has tens of thousands of active users across the region. Additionally, through licensing agreements coordinated by the University e-Learning Consortium, the materials are now used for pre-enrollment education at 20 universities nationwide [3].

4. Subsequent Developments

As introduced earlier, our university's use of ICT began with pre-enrollment education. It then extended to supplementary lessons provided by first-year course instructors, leading to various applications such as use in preparatory learning for flipped-classroom-style instruction and in proficiency-based testing. Based on the judgment — particularly by research laboratories in the information systems field that had been involved in content development — that such ICT resources could be effectively used in foundational courses within the information discipline, the development and practical deployment of related materials continued to advance [4]. As of 2025, we have established a comprehensive suite of instructional materials covering the fundamentals of computer science, information ethics, and programming (in C language, Java, and Python), as well as algorithms and computer networks — all aligned with the foundational knowledge level expected for basic information processing qualifications. Furthermore, content sharing across courses has also been practiced, particularly within the information-related curriculum.

From these experiences, we have come to believe that the successful initiation of ICT-enhanced education depends on a bottom-up approach led by stakeholders with commitment— namely, both faculty and students — in a way that imposes no undue burden. At the same time, it is critically important for the university organization to strategically adopt and incorporate these grassroots efforts into a top-down framework. This combination, we believe, is essential for long-term sustainability. Indeed, the foundational bottom-up efforts at our university ultimately led to a top-down initiative that systematized and visualized a university-wide digital curriculum. This development will be introduced in the next installment of this series.

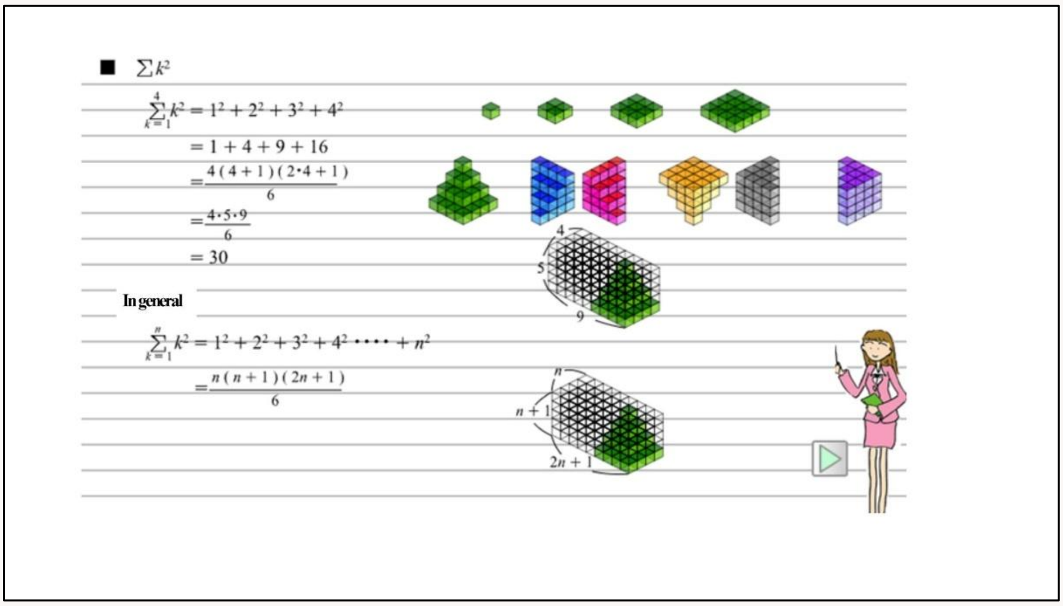

Figure1: A Mathematics Teaching Material Designed to Reflect Blackboard-Style Instruction by a High School Teacher

References

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