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A Case Study on the Effectiveness of the "Theory and Methods for the Utilization of ICT in Education" in the Japanese Teacher Training Curriculum: An Intensive and Remote Format

Mitsuhiro Watanabe [*], Tatsuya Horita [†]

Abstract

In this study, we examined the effectiveness of the subject "Theory and Methods for the Utilization of ICT in Education" recently introduced to the Japanese teacher training curriculum. In AY2024, the course was conducted at S University in an intensive and remote format using practical tools, videos, cloud-based collaboration, and class plan creation. Pre- and post-course surveys using a 16-item checklist on ICT utilization revealed improved student confidence across all items after the course. The results of the intensive and remote classes were comparable to those of regular face-to-face classes conducted in AY2023, indicating that the proposed instructional design is effective regardless of the instructional format.

Keywords: ICT Utilization, Remote Class, Japanese Teacher Training Curriculum, Theory and Methods for the Utilization of ICT in Education, University

1 Introduction

Fostering students' information literacy and reforming teachers' working styles have become national priorities in Japanese schools. Accordingly, university-based teacher training programs are expected to respond to the improved ICT infrastructure and the advancement of educational digital transformation (DX). In line with these trends, a new subject titled "Theory and Methods for the Utilization of ICT in Education" (hereinafter "the new subject") has been introduced to the Japanese teacher training curriculum and made compulsory since AY2022 [1]. The new subject comprises three components: (1) the significance and theoretical foundations of ICT utilization, (2) methods for applying ICT in teaching and school tasks, and (3) instructional strategies for development of information literacy, including information ethics.

Based on previous studies and our experiences in both elementary and higher education, we designed the subject's instruction based on four elements: (1) the use of actual school-based tools and training materials, (2) the use of videos to visualize ICT use, (3) promotion of collaboration via cloud platforms, and (4) creation of ICT-integrated class plans and the conduction of mock lessons [2].

To evaluate the effectiveness of the proposed instructional design, pre- and post-course surveys were conducted in three universities where the first author taught the subject [3]. The checklist

[*] Minami Kyusyu University, Miyazaki, Japan
[†] Tokyo Gakugei University, Tokyo, Japan

for teachers' ICT utilization skills was used in the survey [4]. The analysis of the 106 responses from the three universities revealed a significant improvement in students' confidence in ICT utilization teaching competency after completing the course.

At S University, the subject was intensively offered in AY2024, with four class periods per day over four days (August 27–30), totaling 15 class periods and one period for report writing. On the first day, classes were conducted in person; however, due to the occurrence of a typhoon, the university was closed on the second day. Thus, the remaining classes were delivered remotely via livestreaming, and the recorded videos were made available to the students.

Furthermore, we compared the pre- and post-course survey results for AY2024. To examine the effectiveness of the proposed instructional design when the classes were intensive and remote, we compared the post-course results for AY2024, during which the classes were intensive and remote, and AY2023, when the classes were regular and face-to-face. These analyses were performed to determine whether the learning outcomes of the new subject can be sustained under various conditions.

2 Research Methods

2.1 Participants

The participants of this study were 36 second-year students enrolled in the new subject at S University. Although not majoring in teacher education, they were affiliated with the Faculty of Human Relations and Faculty of Law and were pursuing various teaching licenses. The Japanese language and literature majors aimed for junior and senior high school licenses in Japanese, the English and American culture majors aimed for licenses in English, the history and geography majors aimed for licenses in social studies (junior high) and geography/history (senior high), the school education and psychology majors aimed for licenses in school nursing, and the law majors aimed licenses in social studies and civics at both levels.

Upon admission, the students were instructed to prepare their personal computers; however, because the campus Wi-Fi was unreliable, the computers were not actively used in regular classes; instead, the students used their devices for administrative and academic notifications.

In their first year, the students took a subject on basic information device operation, during which they learned to use word processors, spreadsheets, presentation software, web browsers, and search engines and acquired foundational knowledge in information ethics.

2.2 Course Implementation Plan

In Japan, the "Core Curriculum for Teacher Training Programs" (hereinafter "Core Curriculum") defines the essential competencies required across all university-level teacher training programs, as stipulated by the Teacher Certification Act and its Enforcement Regulations [1]. To address the rapid changes in ICT environments and the growing societal demand for information literacy, universities are required to teach basic competencies in data science and AI. In response, a new subject titled "Theory and Methods for the Utilization of ICT in Education" was added to the Core Curriculum.

The first author teaches the new subject at three universities, and the two authors jointly developed the instructional design based on their experience in both elementary and higher education, as well as previous studies on instructional design in Japanese teacher training programs [2]. The instructional design incorporates (1) tools and training materials used in actual schools, (2) videos to visualize ICT utilization in class, (3) collaborative learning via cloud platforms, and (4) class plan creation and ICT-integrated mock lessons.

At S University, the new subject was intensively delivered in AY2024, with four class periods per day over four days (August 27–30), totaling 15 instructional periods and one report-writing period.

According to the Core Curriculum, the subject covers (1) the significance and theoretical basis of ICT utilization, (2) methods for applying ICT in teaching and school tasks, and (3) strategies for development of information literacy, including information ethics. Table 1 presents the course plan at S University, which reflects the above structure.

Table 1: Course Plan at S University

* Pre-course questionnaire	10) ICT Utilization in Special Needs Education
1) Orientation	11) Digitalization of School Administration
2) ICT Utilization by Teachers in the Class	12) Use of Educational Data and Information Security
3) ICT Utilization by Students in the Class	[Students view and comment on shared class plans prepared by
4) Preparation for Class Plan Development	group members outside of class time]
[Class plan creation is conducted outside class time]	13) Collaboration with External Institutions and ICT Environ-
5) Remote and Online Education	ment Maintenance
6) Development of Information Literacy	14) Discussion on Class Plans
7) Information Ethics Education	15) Course Wrap-Up
8) Programming Education (1)	* Post-course questionnaire
9) Programming Education (2)	Final report assignment completed

2.3 Course Implementation

This section outlines the implementation of the 15 class periods for the new subject.

On the first day, four class periods were conducted in person. Due to an anticipated typhoon, the university closed on the second day, and subsequent classes were streamed live via Zoom. The first author routinely recorded each session with screen content and uploaded the recordings as unlisted YouTube videos for review or absentees. The videos were also made available to students who were unable to join the live sessions due to power outages or connectivity issues. Although we expected to resume in-person classes, the university remained closed due to the impact of the typhoon. Therefore, the remaining sessions, including report writing, were conducted remotely.

Students typically use platforms designed for higher education as instructional support and collaborative learning tools. However, in the new subject, the Google Workspace for Education was used to enable the students to familiarize themselves with tools commonly used in elementary, junior high, and high schools. To help the students learn about actual classroom practices, videos provided by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) and the Japan Institution for Educational Measurement, as well as those recorded by the first author in school settings, were made available to the students. In addition, paid and free tools, including teaching materials on information ethics and programming and MEXT's CBT system, were used.

2.4 Questionnaire Survey

To evaluate the effect of the implemented subject on students' confidence in teachers' competency in ICT utilization for teaching, pre- and post-course surveys were conducted through questionnaires. The pre-course survey was conducted at the beginning of the first class, and the post-course survey was conducted at the end of the last class.

The questionnaires were based on the 16 sub-items of Question 4 from the Checklist for Teachers' ICT Utilization Skills (2018 revision), which is used in national surveys on the status of ICT utilization in schools [4] (Table 2).

Table 2: Checklist for Teachers' ICT Utilization Skills

A :	Ability to Utilize ICT for Instructional Preparation, Evaluation, and School Administration	1 :	Plan and utilize ICT tools such as computers and the Internet to enhance educational effectiveness.
		2 :	Use the Internet to collect materials for lessons or school responsibilities and to share information necessary for collaboration with parents and the local community.
		3 :	Use word processors, spreadsheet software, and presentation tools to create handouts and instructional materials for classes, as well as documents and reports for classroom management and school duties.
		4 :	Record and organize students' work, reports, and worksheets using ICT tools to understand their learning progress and utilize the results for evaluation.
B :	Ability to Instruct Using ICT in the Classroom	1 :	Use computers and display devices to effectively present materials that stimulate students' interest, clarify tasks, and help summarize the learning content.
		2 :	Use computers and display devices to effectively present students' ideas and opinions in order to facilitate sharing and comparison among them.
		3 :	Use educational software to assign repeated learning tasks or differentiated tasks based on each student's level of understanding and skill acquisition.
		4 :	Facilitate collaborative learning activities such as group discussions and the cocreation of reports, materials, or products using ICT tools.
C :	Ability to Instruct Students in ICT Utilization	1 :	Teach students the basic operational skills necessary for learning activities, such as typing and file management.
		2 :	Instruct students on how to use computers and the Internet to gather information and to select reliable and relevant information based on their purposes.
		3 :	Teach students to organize and present their research findings and ideas clearly using word processing, spreadsheets, and presentation software, including the use of text, tables, graphs, and diagrams.
		4 :	Guide students to use ICT tools to exchange and share ideas and engage in discussions with peers.
D :	Ability to Instruct on Foundational Knowledge and Attitudes for Information Utilization	1 :	Teach students to act responsibly in the information society, consider others, respect the rights of themselves and others, and follow appropriate rules and etiquette when gathering and sharing information.
		2 :	Instruct students on how to avoid antisocial or illegal behavior and online crimes when using the Internet and to be mindful of health-related risks.
		3 :	Teach students basic knowledge of information security, including how to set and manage passwords appropriately to ensure safe use of computers and the Internet.
		4 :	Foster students' interest in the usefulness of ICT, encouraging them to use it for learning and to develop curiosity about how ICT works.

For in-service teachers, respondents were asked to answer the questions with "Can do," "Can somewhat do," "Cannot do very well," or "Cannot do at all." However, because the students in this study had not experienced actual classroom teaching, the response options were modified to "I think I can do it," "I think I can somewhat do it," "I don't think I can do it very well," and "I don't think I can do it at all."

Google Forms were used for both the pre- and post-course surveys. Students were informed that participation in the surveys was voluntary and that although email addresses would be collected to enable comparison between pre- and post-course responses, they would not be used to identify individuals.

3 Results

Among the 36 students enrolled in the course, 21 students (58.3%) responded to both the pre- and post-course surveys on teachers' competency in ICT utilization for teaching.

Responses were scored using a four-point scale: "I think I can do it" = 4, "I think I can somewhat do it" = 3, "I don't think I can do it very well" = 2, and "I don't think I can do it at all" = 1. The average scores were calculated based on these values.

3.1 Comparison of Pre- and Post-course Results

For each of the 16 items related to Teachers' Competency in ICT Utilization for Teaching, the mean scores and standard deviations were calculated from the results of the pre- and post-course questionnaires (Table 3).

Table 3: Confidence in Teachers' Competency in ICT Utilization for Teaching (Pre- and Post-course)

(n = 21)		A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4
AY2024 Pre	*M*	2.48	2.52	3.00	2.90	2.52	2.48	2.57	2.90	2.76	2.81	2.76	2.71	3.24	3.10	3.05	3.10
	SD	0.93	0.87	0.77	0.83	0.87	0.68	0.68	0.89	0.77	0.81	0.77	0.90	0.77	0.94	0.86	0.83
AY2024 Post	*M*	3.48	3.43	3.62	3.43	3.52	3.57	3.43	3.71	3.43	3.14	3.33	3.57	3.67	3.62	3.48	3.62
	SD	0.51	0.60	0.50	0.60	0.51	0.51	0.60	0.46	0.60	0.65	0.73	0.51	0.48	0.67	0.68	0.50

The mean scores for all items increased after the course. The pre-course mean scores ranged from 2.48 (A1) to 3.24 (D1), indicating an overall tendency toward "I think I can somewhat do it." In contrast, the post-course mean scores were 3.14 or higher for all items, indicating a consistent increase in students' self-assessed confidence in ICT use.

The mean scores for A1, B1, and C4 significantly increased (+1.0, +1.0, and +0.86, respectively) after the course. These items are related to the students' ICT usage, support for sharing ideas among students, and facilitation of collaborative learning. The increase in confidence can be attributed to the students' experiences with online instruction and ICT use, including watching videos and engaging in class plan creation.

Although items such as D1 and D2, which relate to information ethics and responsible participation in the information society, exhibited relatively high scores before the course, their scores significantly improved after the course (from 3.24 to 3.67 for D1 and from 3.10 to 3.62 for D2). These results suggest that the use of learning materials designed for students and training tools for teachers improved students' understanding from both theoretical and attitudinal perspectives.

Overall, the average scores after the course increased across all items, indicating that the course improved students' confidence in ICT utilization for teaching.

3.2 Comparison of Post-course Results Between AY2023 and AY2024

At S University, the course was conducted in different formats during the two academic years. In AY2023, the classes were held weekly and face-to-face, whereas in AY2024, they were intensive and online due to external factors. Thus, the major difference between AY2023 and AY2024 was the instructional format—regular face-to-face versus intensive remote classes—and was used as the basis for comparison.

Table 4 lists the post-course questionnaire results for AY2023 and AY2024.

Table 4: Confidence in Teachers' Competency in ICT Utilization for Teaching (AY2023 and AY2024)

		A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4
AY2023 Post	*M*	3.56	3.64	3.68	3.64	3.52	3.48	3.44	3.56	3.20	3.48	3.36	3.36	3.48	3.80	3.72	3.68
(*n* = 25)	*SD*	0.50	0.62	0.47	0.56	0.50	0.57	0.57	0.64	0.69	0.57	0.69	0.74	0.64	0.49	0.53	0.55
AY2024 Post	*M*	3.48	3.43	3.62	3.43	3.52	3.57	3.43	3.71	3.43	3.14	3.33	3.57	3.67	3.62	3.48	3.62
(*n* = 21)	*SD*	0.51	0.60	0.50	0.60	0.51	0.51	0.60	0.46	0.60	0.65	0.73	0.51	0.48	0.67	0.68	0.50

A two-way ANOVA was conducted with the instructional format (regular face-to-face vs. intensive remote) as a between-subjects factor and survey items as a within-subjects factor. The main effect of the instructional format was not significant ($F(1, 44) = 0.09$, $p > .10$, partial $\eta^2 = 0.00$, $1–\beta = 0.34$). In contrast, the main effect of the survey item was significant ($F(15, 660) = 3.27$, $p < .001$, partial $\eta^2 = .07$, $1–\beta = 1.00$). The interaction between the instructional format and the survey item was also significant ($F(15, 660) = 1.70$, $p < .05$, partial $\eta^2 = .04$, $1–\beta = 1.00$).

A simple main effects analysis ($\alpha = 0.15$) was conducted to further examine the significant interaction. The results showed that the simple effects of the instructional format were not significant at any level of the survey items (adjusted ps > 1). However, the simple main effect of the survey item for the regular face-to-face group was significant ($F(15, 660) = 2.96$, adjusted $p < .01$, partial $\eta^2 = .06$).

To examine the validity of the statistical analyses, we employed the statistical power ($1–\beta$) for both the main effect of the instructional format and the interaction between the instructional format and the survey item. The power values were calculated based on average correlations among levels using Fisher's z-transformation.

Considering the assumptions of ANOVA, Bartlett tests confirmed that the assumption of homogeneity of variance among participants was satisfied for all levels of the survey item factor ($\chi^2(1)$ s< 3.26, ps > .10).

Mauchly's test of sphericity revealed that the within-subjects factor (survey item) does not satisfy the sphericity assumption ($W = 0.007$, $p < .001$). Therefore, Greenhouse–Geisser corrections were applied. The corrected tests revealed a significant main effect of the survey item ($p < .001$) and a marginally significant interaction effect between the instructional format and the survey item ($p < .10$).

A second simple main-effects analysis ($\alpha = 0.15$) was performed. Level-specific and pooled error terms were used for the between-subject and within-subject effects, respectively.

Multiple comparisons using paired-sample t-tests ($\alpha = 0.05$, two-tailed) revealed that in AY2023, the mean score for C1 (3.20) was significantly lower than that for D2 (3.80, $t(24) = 3.93$, adjusted $p < .10$) and D3 (3.72, $t(24) = 3.98$, adjusted $p < .10$).

Bonferroni correction was applied to adjust the p-values in all analyses.

These results indicate no significant differences in the improvement of confidence in teachers' competency in ICT utilization for teaching based on the instructional format.

4 Discussion

Through analysis of questionnaire responses, we found that the subject "Theory and Methods for the Utilization of ICT in Education" effectively improves students' confidence in ICT utilization for teaching, even when delivered in an intensive and remote format.

Notably, the average scores improved across all 16 survey items after the course, indicating that the shift to an intensive and remote instructional format did not affect the learning outcomes. Furthermore, no significant differences were observed in the post-course survey results between AY2023, in which the subject was delivered through regular face-to-face classes, and AY2024, during which it was delivered in an intensive and remote format, indicating that the instructional design improved learning outcomes regardless of the instructional formats.

Student reflections in their final reports corroborate the effectiveness of the instructional design. The following comments were provided by the students: "I learned how to use educational tools," "Watching actual classroom videos was helpful," "We could use comments to teach each other," "I found meaning in the effort to design realistic class plans," and "By viewing others' plans, I gained new perspectives and ideas."

Students also provided the following comments regarding the remote learning format: "Although the class was moved online due to the typhoon, I was able to learn while actually using ICT, which deepened my understanding," "The format allowed me to engage more deeply with the texts and slides," and "Even in the online environment, I could still view others' ideas." One student also noted, "There were times when I could not attend live due to power outages or poor network conditions, but because the videos were uploaded, I was able to review the class in detail." These responses suggest that the quality of learning was maintained even in a remote format and that the recorded lectures served as an effective means of support.

However, some students expressed concerns about their unfamiliarity with the systems used for assignment submission and communication. Although the tools were selected to reflect those commonly used in schools, students who were accustomed to the university's regular platforms found the transition challenging. The choice of tools was intentional as part of the instructional design to expose the students to school-based digital environments. The students' responses highlight the importance of clearly communicating the instructional rationale when introducing unfamiliar systems.

Considering the intensive class format, students had limited time to prepare for and conduct mock lessons, unlike when the course was delivered weekly. Therefore, students' engagement was limited to class plan development, reducing the opportunity for hands-on, practice-oriented learning activities. These results highlight the need to balance theoretical instruction with practical learning activities, especially in intensive class formats where time and interactions are constrained.

This study has certain limitations. First, the participants were limited to a specific university. Second, the remote instruction was not part of the preplanned design but rather an adaptive response to external conditions. These factors should be considered when interpreting the findings.

5 Conclusion

This study confirms that the proposed instructional design for the new subject introduced to the Japanese teacher training curriculum can effectively support the development of ICT utilization competency among preservice teachers, even when delivered in an intensive and remote format. Pre- and post-course surveys revealed significant improvements in students' self-assessed confidence across all 16 checklist items after taking the course. In addition, the results for AY2024, in which classes were delivered in an intensive and remote format, were comparable to those for AY2023, when regular face-to-face classes were adopted, indicating that the instructional design was effective regardless of the delivery format.

The students' reflections confirmed the effectiveness of the class plan development, peer interaction, and visualization of ICT use in authentic classroom contexts. However, the students noted some limitations, including insufficient hands-on programming experience and the use of unfamiliar platforms for assignment submission and communication. These insights highlight the importance of balancing theoretical instruction with practical learning activities while ensuring clear communication of instructional intentions. The survey results confirm that the proposed instructional design is both adaptable and effective. Although this study represents an exploratory practice for a newly established subject, overcoming the identified challenges will facilitate the development of future instructional designs in teacher training programs.

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