Chapter

Educational Programs of Business Producers and System Creators for Future Strategy Design Based on Action Project Group Activities through Industry and University Cooperation

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Abstract

Our Japanese industry and university project group at Aoyama Gakuin University carried out two types of development and demonstration classes as part of new educational programs to create human resources focused on future strategy design over several years. In response to social issues related to SDGs and the circular economy (CE) that may arise in the future, new human resources who can formulate SDG/CE business scheme documents to solve these social issues are called "business producers." New educational methods that combine both project-based learning (PBL) and active learning (AL) to create business producers were developed to accommodate hybrid group work exercises. Specifically, educational digital transformation (DX) technology was integrated to ensure a flexible response to the new normal following COVID-19. As prerequisites to develop the four types of human resources that make up the SDGs/CE business scheme, the learning of theories and mechanisms pertinent to the various advanced technologies is desirable. These new human resources equipped with specialized knowledge and practical skills are called "system creators." A practical hands-on training program to enhance the skills of the system creators through future strategy design was created to cover the following subjects: IoT and platform services, as well as metaverse experiences.

Keywords: future strategy design, business producer, hybrid group work exercise, system creator, hands-on training program, sustainable development goals (SDGs), circular economy (CE), education DX

1. Introduction

The Future Strategy Design Promotion Conference features a focus onindustry-academia collaboration, of the Sustainable Development Goals (SDGs) Human Resources Development Partnership Research Institute of Aoyama Gakuin University in Japan aimed to develop two types of new human resources over several years: (1) business producers who are capable of future strategy design (hereafter business producer) and (2) system creators who are capable of future strategy design (hereafter system creator). In response to social issues related to the SDGs and the circular economy (CE) that may arise in the future, the present research group aimed to create new human resources who could formulate SDGs/CE business scheme documents to solve these social issues and thus called "business producers." As a prerequisite to the development of the four types of group human resources that can formulate SDG/CE business schemes, learning the theories and mechanisms related to the various advanced technologies is desirable. Therefore, a new human resource group equipped with specialized knowledge and practical skills is called "system creators."

The research team has been working on developing and demonstrating programs to be implemented in university education. Specifically, the research group focused on hybrid-type group work exercises for business producers and hands-on training education for system creators.

The COVID-19 pandemic made it impossible to conduct face-to-face classes for all subjects, and there was an urgent need to introduce online classes in the form of on-demand, real, and hybrid classes. As part of a digital transformation (DX) subsidy project promoted by the Ministry of Education, Culture, Sports, Science, and Technology (MEXT) in 2021, advanced higher education institutions in Japan further accelerated the conversion to educational DX in the post-COVID-19 era.

Therefore, to develop these new human resources, the research team has been engaged in developing new educational methods for hybrid-type group work exercises that combine both project-based learning (PBL) and active learning (AL) in industry-academia joint research.

The National Science Foundation (NSF) uses the broad term "Science, Technology, Engineering, and Math (STEM)" to encompass the fields of chemistry, computer science, information technology (IT), engineering, geosciences, life sciences, mathematical sciences, physics, astronomy, social sciences (anthropology, economics, psychology, and sociology), and STEM educational research [1]. The character of STEM education has evolved from a set of overlapping disciplines into a more integrated and interdisciplinary approach to learning and skill development. This new approach includes the teaching of academic concepts through real-world applications of theory and combines formal and informal learning methods in schools, the community, and the workplace. It seeks to impart various skills, such as critical thinking, problem-solving, cooperation, and adaptability.

Therefore, the research team has been engaged in developing another new practical hands-on training program to promote the future strategy design capabilities of system creators, aiming to promote the experiential learning of the theories and mechanisms for the various advanced technologies, such as the Internet of Things (IoT), platforms, artificial intelligence (AI), virtual reality (VR)/augmented reality (AR), and metaverse.

Thus, this research paper is organized as follows. Section 2 discusses two types of human resource development programs for future strategy design, with a specific focus on hybrid group work exercises for business producers and hands-on training for system creators. Section 3 discusses curriculum design and SDGs/CE business schemes for business producers, with a focus on hybrid group work exercises combined with PBL and AL. Team-based PBL as part of the multi-side platform (MSP) business model aimed at solving issues related to SDGs and CE are also discussed. Four different types of group roles for AL and SDGs/CE business schemes as final deliverables for each team/group are also outlined. In Section 4, shared digital whiteboards and DX learning environment systems for business producers are highlighted. Class operation management methods before, during, and after classes and how to use DX learning environment platforms (Eps) corresponding to regular class times are shared. Furthermore, class operation management methods corresponding to special class times and DX learning EP are discussed. In Section 5, the factors affecting the hands-on training of system creates are outlined. Specifically, these factors include the curriculum, the use of Micro:bit, the use of obniz, and experiences of the metaverse on the Spatial platform. This paper ends with a conclusion.

2. Two types of human resource development programs for future strategy design

The Future Strategy Design Promotion Conference, with a focus on industry and academia collaboration, aimed to develop two types of new human resources: (1) business producers and (2) system creators. The conference attendees mainly focused on adult education. Based on the results of these studies, the research team in this paper worked on the development of programs and demonstrated their efficacy in university education. Specifically, the research team worked to develop hybrid-type group work exercises for business producers and hands-on training-based education for system creators.

2.1 Hybrid group work exercises for business producers

In response to future SDG- and CE-related issues, new human resources who can formulate SDG/CE business scheme documents are necessary and have been referred to as business producers. Considering the characteristics of education methods, the curriculum for hybrid group work exercises that consist of PBL and AL methods was proposed.

The theme of PBL was that the whole team (about eight learners) worked together at the beginning of class to create a business concept plan that could solve social issues related to SDGs/CE by adopting an MSP business model. The final educational goal was to ensure learners could formulate and propose a unique SDG/CE business scheme through collaborative AL by dividing one team into four different groups. Four different types of groups (each group had about two learners) and the business contents of each group are shown below:

Group 1—Business process model.
Group 2—SDGs/CE product planning and digital marketing.
Group 3—DX smart product design.
Group 4—Sharing platform services.

2.2 Hands-on training program for system creators

To enable the four types of groups to formulate the aforementioned SDG/CE business scheme, a prerequisite was for the groups to learn theories and mechanisms for the various advanced technologies described (e.g., IoT, platforms, AI, VR/AR, and metaverse). These learners equipped with specialized knowledge are referred to as "system creators."

It is not possible to understand the mechanisms of various advanced technologies simply by reading technical books or attending lectures. Therefore, our research team decided to develop and demonstrate new hands-on training programs that allowed learners to experience the technologies and theories discussed by themselves. Therefore, the training systems for this hands-on training program were designed in relation to the STEM education program mentioned above and were developed using computer education devices, software, and various platforms (e.g., Micro:bit and obniz for IoT platform, and Spatial for the metaverse) described later.

3. Business producers (1): curriculum design and SDG/CE business scheme

3.1 Curriculum design for hybrid group work exercises with PBL and AL

Considering the characteristics of the education methods, a curriculum for hybrid group work exercises consisting of PBL and AL methods was proposed, as shown in **Table 1**.

3.2 PBL among the entire team: Business concept for MSP business model aimed at the SDGs/CE

In the first to fifth classes, as demonstrated in **Table 1**, each team formulated a business concept for future strategic design, with all team members participating by applying the PBL method. The theme of PBL for future strategic design adopted the MSP business model. This MSP business model involves the usage of platform and application software that mediates between the supply side that provides products/services and the demand side (customers who want these products or services). In other words, the MSP built a new business model by acting as an intermediary between the providers of products/services and customers.

When deciding on the theme of this MSP platform service, each team was required to draft a business concept that would be useful in solving social issues. Therefore, the instructor (Professor Tamaki, who was in charge of this course) suggested that each team choose a theme for MSP platform services related to SDG 12.3: reduction of food loss or SDG 12.5: reduction of waste part of SDG 12: responsible consumption and production.

SDG target 12.5, "By 2030, substantially reduce waste generation through prevention, reduction, recycling, and reuse," is related to the CE. The shift from a linear economy to a CE requires new marketing methods. The European Commission suggested that the successful adoption of CE would require new consumer behaviors. Therefore, it is necessary to conceive a CE business model and consider how to solve CE-specific social business issues.

3.3 Four different types of group roles for AL

In team-building exercises for the AL method, learners were separated into four project groups (Groups 1–4) with different business roles, and each group worked on virtual project management (**Table 1**):

<table>
<tr><th>No.</th><th>New educational methods</th><th>G1: business model</th><th>G2: SDGs product planning</th><th>G3: smart product design</th><th>G4: platform service management</th></tr>
<tr><td>1</td><td rowspan="5">PB: Collaborative learning with all team members</td><td colspan="4">Introduction: team and group building and learning goals of the educational program for business producers</td></tr>
<tr><td>2</td><td colspan="4">Survey of advanced cases of platform services and application software</td></tr>
<tr><td>3</td><td colspan="4">Determining the theme of SDGs product planning and MSP platform for each team</td></tr>
<tr><td>4</td><td colspan="4" rowspan="2">Create the business concept plan for platform service management for each team (1), (2)</td></tr>
<tr><td>5</td></tr>
<tr><td>6</td><td rowspan="9">AL: Collaborative learning within the same group and/or Collaborative learning between different groups</td><td rowspan="2">Own required management resources and business partners</td><td rowspan="2">Target customer and customer purchasing decision process</td><td rowspan="2">Image of the service utilization of smartphones and mobile products</td><td rowspan="2">Required functions and specifications of platform services</td></tr>
<tr><td>7</td></tr>
<tr><td>8</td><td rowspan="2">[G1⇔G4] Business and service process model for platform services and application software</td><td>SDGs product planning to reduce food loss</td><td>Product architecture of smartphones and mobile products</td><td>[G1⇔G4] Platform services and application software</td></tr>
<tr><td>9</td><td rowspan="2">[G1⇔G2] Materials and functions required for SDGs product planning (1)</td><td>[G3⇔G4] Application software</td><td>[G3⇔G4] Application software</td></tr>
<tr><td>10</td><td rowspan="2">Improved business model canvas with customer behavior and service processes</td><td rowspan="2">[G3⇔G4] Processing algorithm for application software linked to smartphones and mobile products</td><td rowspan="2">[G3⇔G4] Processing algorithm for application software linked to platform systems</td></tr>
<tr><td>11</td><td>[G1⇔G2] Customer benefits and value required for SDGs product planning (2)</td></tr>
<tr><td>12</td><td rowspan="2">Revenue business model</td><td rowspan="2">[G2⇔G3⇔G4] Digital marketing strategy for SDGs product sales promotion</td><td rowspan="2">[G2⇔G3⇔G4] Usability of application software linked to smartphones and mobile products</td><td rowspan="2">[G2⇔G3⇔G4] Algorithm for the collection/ accumulation/ analysis of customer usage data and behavior data</td></tr>
<tr><td>13</td></tr>
<tr><td>14</td><td rowspan="2">PBL:</td><td colspan="4" rowspan="2">Submission of final business scheme planning
⇒ Learner's grade evaluation (evaluated from the point of team, group, personal contribution)</td></tr>
<tr><td>15</td></tr>
</table>

Table 1.
Curriculum that combines PBL and AL methods for business producers [2].

Group 1—Business model.
Group 2—New product planning and digital marketing.
Group 3—Smart product design and usability.
Group 4—Platform service management.

There were two types of collaborative learning for AL group work. One involved carrying out collaborative learning within the same group, and the other involved collaborative learning between different groups, as described, for example, by [G1⇔G2] in **Table 1**.

3.4 Items in the SDG/CE business scheme as final deliverables for a team/group

The following SDG/CE business schemes were the deliverables for each team/group, as outlined by the instructors at the end of the class.

PBL team common work:

1. Invent a new value chain management (VCM) system aiming to reduce food loss/waste and identify various stakeholders engaged in the VCM.

2. Build an MSP business model used by various stakeholders and plan products and services for new application software operated by the MSP.

3. Outline the MSP business model proposal.

    1. Where in the value chain did you focus on reducing food loss?

    2. Who are the target customers?

    3. Who are the collaborating stakeholders?

    4. What is the business purpose of the MSP?

    5. What is the impact of MSP services on society (effects, market size, etc.)?

    6. Provide an MSP business concept planning/use case diagram.

AL collaborative learning among the four types of groups:

4. G1/G4 (collaboration between groups); MSP business model WS

5. G3/G4 (collaboration between groups); smart products and application software (APS) WS

6. G1 (group work); business process model diagram, business model canvas, and profit model WS

7. G2 (group work); SDG product plan for food loss reduction, touch points for target customers, and website construction for the promotion of WS

8. G3 (group work); system design of smart products, APS service content, and usability WS

9. G4 (group work); platform data flow/information processing flow chart WS

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4. Business producers (2): shared digital whiteboard and DX learning environment

In 2022, as the impact of COVID-19 gradually subsided, Japanese universities reduced the ratio of online classes to around 30% and promoted a return to face-to-face classes. Therefore, this study group decided to use the form of a face-to-face class for the hybrid group work exercises of this research target in 2022. However, digital lecture materials were distributed at the same time *via* the LMS to use the on-demand class format.

Furthermore, even in the classroom, we decided to use the digital whiteboard platform service so that team/group members could conduct collaborative learning together by sharing data online during group work exercises.

The following describes how to manage a class before, during, and after the group work exercises corresponding to regular class times and how to use the DX learning EP. Next, the class management method and DX learning EP corresponding to special class times are shown.

4.1 Class operation management methods before, during, and after classes and how to use DX learning EP corresponding to regular class times

Table 2 shows how to manage classes before, during, and after classes and how to use the DX learning EP for ordinary class times. To accomplish "1. Class management/ creation of digital teaching materials," instructors created digital lecture materials necessary for group work exercises corresponding to each ordinary class time. The teaching assistants (TAs) created team/group exercise WSs that served as guides for each learner to proceed with their own individual exercises.

There were three types of WSs. The first was to organize the template WSs that indicate description contents, such as tables, diagrams, and explanations, so that each learner could easily describe and express the results of collaborative learning according to the individual exercises. The WS was formatted to allow descriptive expression. Hence, it was also referred to as a "*white WS*," as it did not describe anything other than the format. In the second type of WS, instructors and TAs guided case examples corresponding to the contents of the respective exercises in the white WS, so that learners could visualize how to respond to the WS. This WS was referred to as the "*case study introduction WS*." The third type of WS was a summary of the results of collaborative learning by each team/group in response to the group work exercises presented by the instructor. This WS was referred to as the "*deliverable WS*."

In "2. Lesson preparation/learning support/learning EP," first, through LMS, the learner was instructed on how to deliver the digital lecture materials and how to proceed with the class and group work exercises on the day of the class. Next, the following two types of digital whiteboard platforms were utilized for the group work exercises. In addition, each team's own working board was set up on each platform, and WS materials were uploaded onto their own boards for collaborative learning corresponding to each group work exercise.

4.2 Collaborative learning method using the Google Docs platform

Google Docs and the other apps in the Google Drive suite served as a collaborative tool for the cooperative editing of documents in real time. Documents can be shared, opened, and edited by multiple users simultaneously, and users can see character-by-character changes as other collaborators make edits [4]. Changes are automatically

	1. Class management and creation of digital teaching materials	**2. Class preparation, learning support, and learning EP**	**3. Collaborative learning and submission of deliverables by learners**
Before class	1.1 Lecture materials: Theories/techniques for each lesson 1.2 Exercise procedure and worksheet (WS) materials: • White WS • Case study introduction WS • Deliverable WS	2.1 Upload lecture materials to Learning Management System (LMS) 2.2 Exercise materials for team/group collaborative learning: • White WS for collaborative learning in Google Drive • Submitting deliverable WS in miro	
During class	1.3 During each class: Lectures by instructors, explanations of exercise methods, learning support, and educational guidance corresponding to the learning situation of each team and group.	2.3 Utilization of AI chatbot's question and answer system: • Enter the question code/question keyword in each case study introduction WS. • Each learner uses question-and-answer system above during the learning process involved in exercises.	3.1 Collaborative learning using the sharing function of Google Drive: • Team common collaborative learning • Inter-group collaborative learning • Group collaborative learning 3.2 Attach each learner deliverable WS to the corresponding sheet in miro
After class		2.4 Each learner uses the question-and-answer system during the learning of 3.1 to 3.4	3.3 Homework using Google Drive 3.4 After completing homework, submit deliverable WS for each exercise to miro.
		2.5 TA gives feedback to each deliverable WS using miro's comment function on miro in 3.4.	

Table 2.
*Class management method corresponding to before, during, and after classes for **regular class times** [3].*

saved to Google's servers, and a revision history is automatically stored so that past edits may be viewed and reverted to. An editor's current position is represented using an editor-specific color/cursor, so if another editor happens to be viewing that part of the document, they can see edits as they occur. A sidebar chat functionality allows collaborators to discuss edits. The revision history allows users to see the additions made to a document, with each author distinguished by different colors. Only adjacent revisions can be compared, and users cannot control how frequently revisions are saved. Files can be exported to a user's local computer in a variety of formats (ODF, HTML, PDF, RTF, Txt, Office Open XML). Files can be tagged and archived for organizational purposes.

The collaborative learning method using Google Docs during the group work exercise in this research is described below. Based on the group work exercise procedures and method explanations shown in the digital lecture materials created by the instructor, the TAs prepared a WS flock that summarized multiple white WSs according to the exercise procedures. TAs uploaded the WS flocks into their own work board within the Google Drive platform for each team/group before class.

While referring to the group work exercise methods and case study introduction WSs mentioned in the lecture materials, each team/group member could work with each other using the same white WS on their own workboard.

4.3 Collaborative learning method using the miro platform

Miro is an online collaborative whiteboard platform that enables distributed teams to work effectively together, from brainstorming using digital sticky notes to planning and managing agile workflows [5]. Miro allows users to take advantage of a full set of collaboration capabilities, make cross-functional teamwork effortless, and organize meetings and workshops using video chat, presentation, sharing, and other features.

Miro empowers user's own design, development, and engineering teams to align and innovate on a platform that makes all their endeavors possible in real time. They can create concepts, map user stories or customer journeys, or engage in roadmap planning easily, enabling them to focus on delivering the right products to customers.

The instructors further instructed teams/groups to place individual deliverable WSs on their own miro work boards, according to the fixed order of the exercise procedure. After the deadline for the submission of the deliverables, the specific TA in charge of each group provided feedback on the deliverable WS using miro's comment function.

How to use the question-and-answer system of the AI chatbot platform service is explained in detail in the next chapter.

4.4 Class operation management method corresponding to special class times and DX learning EP

Table 3 shows the class operation management method and how to use the DX learning EP for special class times.

The method for submitting deliverable WSs (e.g., SDG/CE business concepts, interim deliverable WSs, and final deliverable SDG/CE business schemes) per team was the same as described above. Specifically, learners were instructed to place individual deliverable WSs on their miro work boards according to a fixed order of the exercise procedure.

TAs provided feedback to the respective WSs in the same manner. The merits of being able to provide feedback using the miro platform for the instructor and TA are as follows: Instructors and each TA in charge of each team/group could cross-observe their work boards for different teams/groups, as well as select and add comments to the specific deliverable WS related to each TA from remote environments.

Figure 1 shows an example of "2.9: Pasting each WS submitted by each team/group in the above format table" for the "1.5 AL Interim Results Report."

The instructor prepared a concept map using one of miro's templates for the presentation of the SDG/CE business scheme assignment results in the final class. Then, the instructor instructed all learners to place each deliverable WS for the assignment into this concept map. This concept mat was used to visually represent the interrelationship structure connecting various deliverable WSs related to team common, inter-group, and specific group collaborative learning.

Moreover, as a creative way to use miro to present the results, a separate new board for results presentation was established instead of the usual miro work board. In this new board for results presentation, the instructor arranged the deliverable WS of the business scheme for each team in the same concept map format. As a result, instructors/TAs and all learners could assess each other's business scheme

Class	1. Class management and creation of digital teaching materials	2. Class preparation, learning support, and learning EP	3. Collaborative learning and submission of deliverables by learners
6th	1.4 PBL learning outcomes: How to submit the SDG/CE business concept	2.6 Prepare the format sheet for the business concept in miro.	
		2.7 TA gives feedback to each WS using miro's comment function for the deliverables submitted in miro in 3.5.	3.5 Collaborative learning shared by the team: Submit the deliverable of the business concept to the format sheet in miro.
11th	1.5 AL interim result report: Explanation of how to review the results of collaborative learning according to group collaboration and individual groups	2.8 Prepare a format table for each team's interim result presentation in miro. 2.9 Attach the deliverable WS submitted by each team/group to the corresponding format table in miro.	3.6 Each team/group member mutually evaluates all deliverable WSs, including those not in charge of their own, by commenting on good points and points to be improved.
		2.9 For the deliverables in miro in 3.6 above, TAs provide feedback for each WS using miro's comment function.	
14th	1.6 PBL/AL final result report meeting: Explanation of how to submit the SDG/CE business scheme for each team. 1.7 Prepare class evaluation questionnaire.	2.10 Prepare concept map formats for announcing the business scheme in miro.	3.7 Using the LMS, each learner filled out an online class evaluation questionnaire.
			3.8 Each team/group member improved all deliverable WSs and added explanatory documents corresponding to each WS. 3.9 Paste the WSs for SDG/CE business schemes in the 2.10 concept map format. 3.10 Prepare presentations for all 15 classes' results.
15th	1.8 Present the results of the SDG/CE business scheme for each team. 1.9 Explain the mutual evaluation method for the presentation content of other teams.	2.11 Questions and comments from instructors and TAs for each team's presentation.	3.12 Presentation by each team using 3.9 above and Q&A. 3.13 Online mutual evaluation of other teams' presentations using LMS.
After classes	1.10 Prepare quiz questions corresponding to knowledge Bill of Materials (BOM) by each group, which becomes the basis of the AI chatbot's question-and-answer system.		3.11 Each learner took online comprehension tests in each group after using the AI chatbot's question-and-answer system.

Table 3.
Class management method for ***special class times*** *and how to use the DX learning EP.*

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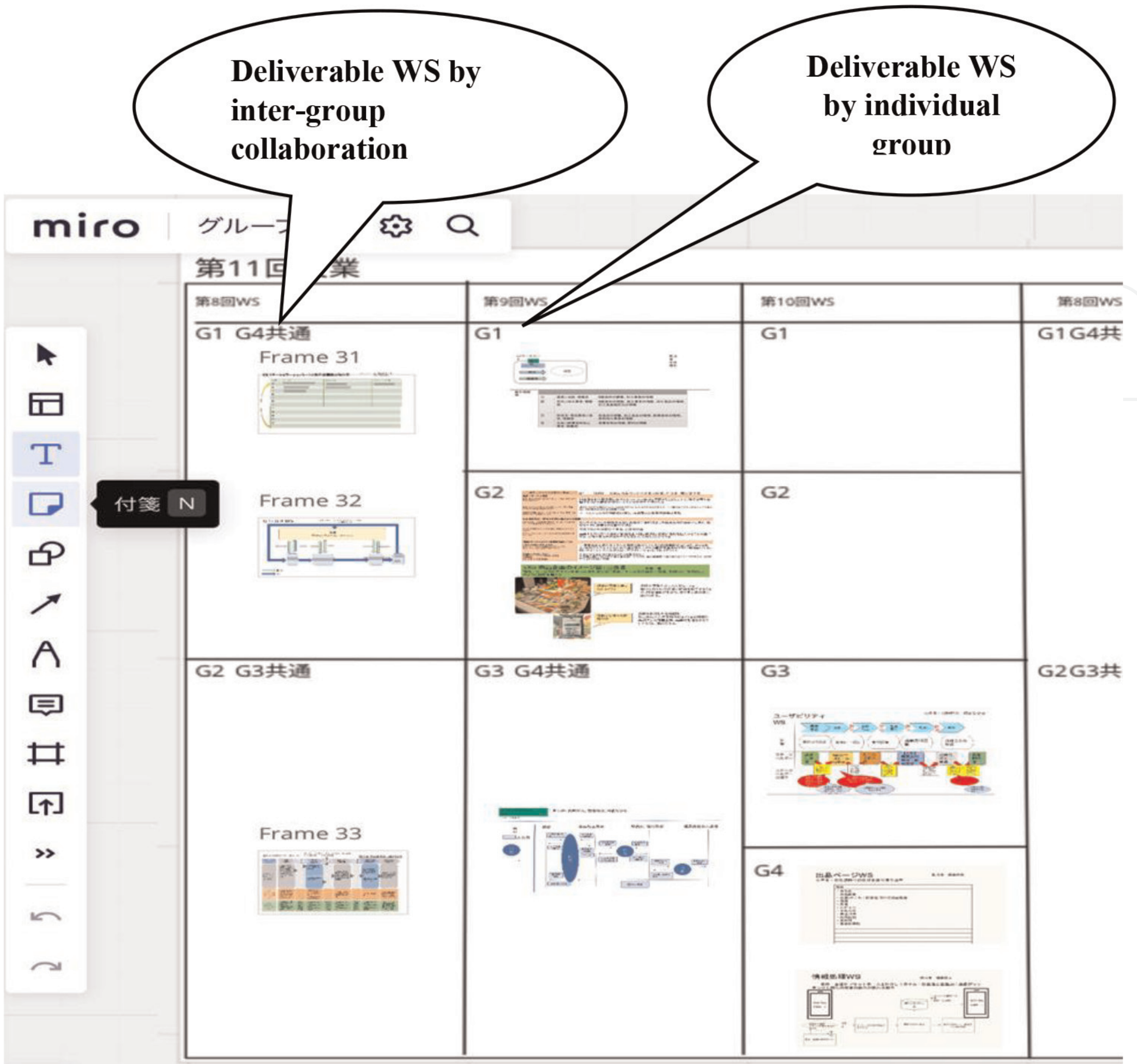

Figure 1.
Example of "2.9: Pasting each WS submitted by each team/group in the format table."

proposals on the miro platform while comparing the characteristics of each team/group.

5. Hands-on training of system creators

5.1 Curriculum for the hands-on training of system creators

A 2022 second-semester curriculum for system creators consisted of three lesson themes, as shown in **Table 4**, that indicated the necessary educational instruments, software, and platforms according to the respective hands-on training sessions shown below:

1. IoT and service—Micro:bit

2. IoT and service—obniz

3. Metaverse experience—Spatial

Lesson theme	Computer education devices and software and platform	Hands-on training contents
1. IoT and platform service: Micro: bit	Educational one-board microcomputer: Micro:bit	Lecture: IoT and platform mechanism, *embedded programming, and algorithms* in service (programming editor: MakeCode)
	Block programming by using the Micro:bit and browser-based programming editor: MakeCode	Hands-on training (1) for *programming algorithm:* event-driven mechanism, sequential processing, setting variables and calculation operations, programming procedures, such as conditional branching (if–then)/repetition (for, while)
		Hands-on training (2) for *embedded programming:* 1. Programming practice for the *pedometer system* 2. Programming practice of the *timer system*
2. IoT and platform service: obniz	IoT hardware platform from Japan with high utility value: obniz	Hands-on training (1): Lighting by using red LED and green LED properly
	Block programming editor by using the obniz cloud platform service	Hands-on training (2): Programming a distance sensor system
	LED: Red, Green	Hands-on training (3): Attendance confirmation system using the above training contents of (1) and (2)
	Distance sensor	
	Group work exercise four learners organized as a group	Report Submission Assignment: Social system design of attendance confirmation system aiming to solve future social issues, to elucidate the design system mechanism, and to achieve the required function and information transmission of IoT platforms.
3. Metaverse experience: Spatial platform	VR headset Meta Quest 2	Lecture: VR/AR, latest trends in the metaverse, Virtual World Office: Meta "Horizon Workrooms," Social VR Platform: VRChat.
	Meta Quest platform service	Hands-on training (1): For the Meta Quest platform and Meta Quest 2, how to create a personal account, how to create a personal avatar, and how to operate Meta Quest 2.
	Spatial platform service: Tamaki Lab Virtual Museum produced by our research team	Hands-on training (2): For the Spatial platform, how to create a personal account, how to create a personal avatar, and how to browse the Tamaki Lab Virtual Museum.
	Group work exercise	Group presentation in Spatial: Proposal of future laboratory for each group in Spatial, specifically the Tamaki Lab Virtual Museum, presentation of each individual avatar, and mutual evaluation between groups.

Table 4.
The curriculum of the system creator, computer education device, and software and platform.

After organizing the learners into one group of four people, hands-on training was conducted. After the training, the group work exercise was executed as an output that utilized the results of the training. This group work exercise involved having learners propose a social system design for an IoT platform that aims to solve social issues.

5.2 IoT and platform service: hands-on training using Micro:bit

In the lecture, first, to understand the mechanism of cooperation with IoT devices and platform services, the functions equipped with Micro:bit, which has a practical track record as computer education device, were explained (see **Figure 2**).

Micro:bit (also referred to as BBC Micro:bit) is open-source hardware based on an embedded system designed by the British Broadcasting Corporation (BBC) for use in computer education in the United Kingdom. The device is described as half the size of a credit card and has an ARM Cortex-M0 processor, accelerometer, magnetometer sensors, Bluetooth and USB connectivity, a display consisting of 25 LEDs, two programmable buttons, and can be powered by either a USB or an external battery pack [6]. The device's inputs and outputs are through five-ring connectors that form part of a larger 25-pin edge

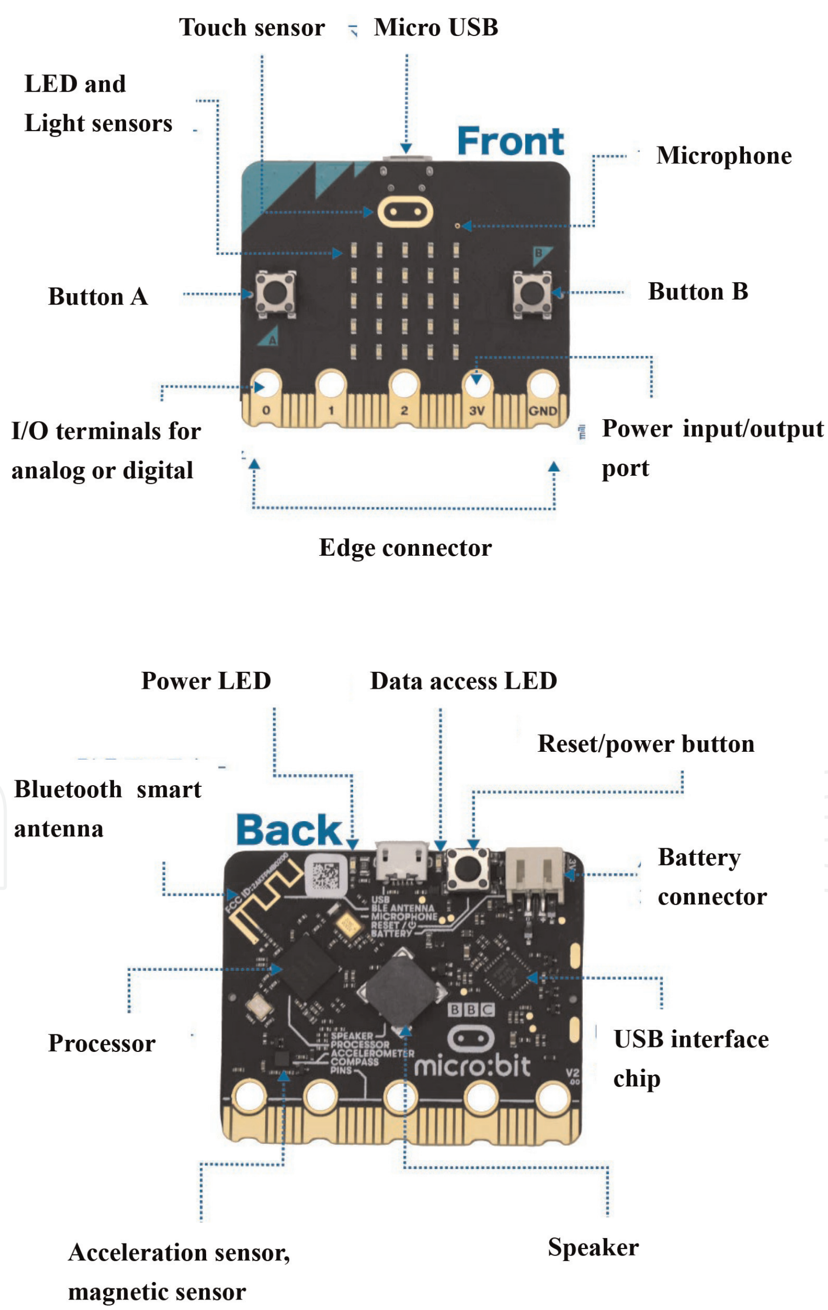

Figure 2.
Various devices and functions are placed on the front and back of the Micro:bit [6].

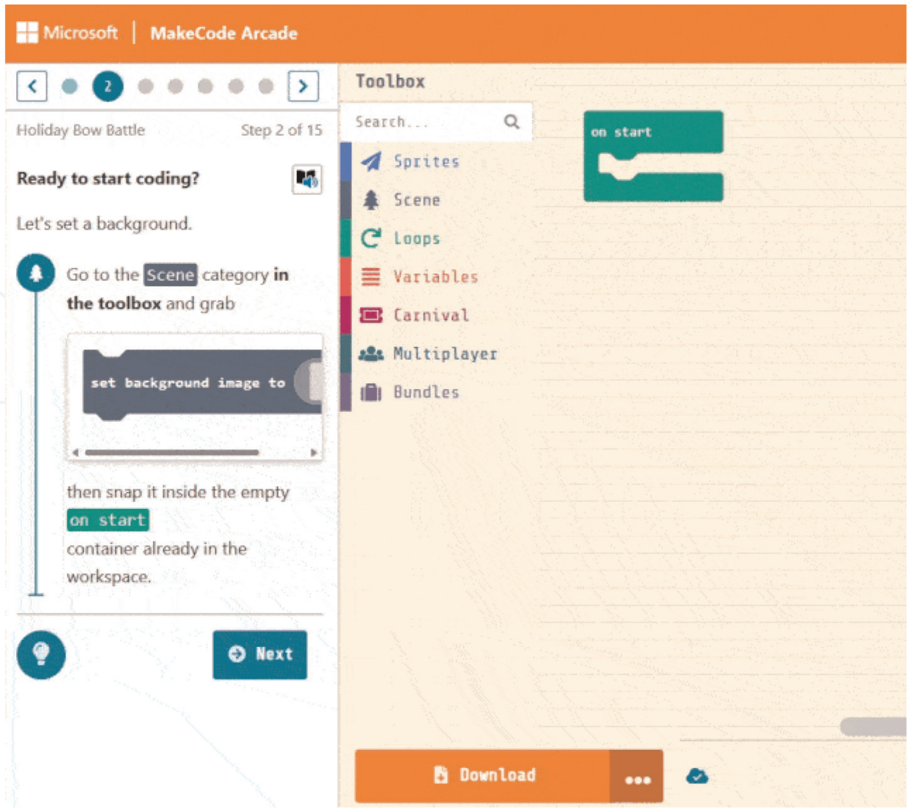

Figure 3.
MakeCode as a visual editor [7].

connector. In October 2020, a physically nearly identical v2 board was released that features a Cortex-M4F microcontroller with more memory and other new features.

In parallel with the lectures on the various algorithms mentioned above, the learners created programming that applied each algorithm. The learners used MakeCode, a program editor available in the browser environment from Microsoft that supports the operation method of Micro:bit. After creating various embedded programs, the learners were able to implement the programming on Micro:bit and check whether the IoT mechanism worked well.

MakeCode is a visual editor that can be used in the browser environment of a platform service that allows programming practice. In other words, in MakeCode, programs are prepared in advance as block-type commands, and learners can visually express the programming process by combining each block (**Figure 3**).

The advantage of using MakeCode in class management is that individual learners could practice programming through the same Microsoft browser environment not only in the classroom but also when doing homework. In addition, many of the students at the School of Business were beginners who had no experience in implementing specialized programming languages and grammar. However, while receiving lectures on the procedures for operating IoT systems, it became possible for them to create programming easily by selecting the appropriate blocks according to each procedure and connecting the blocks to each other.

5.3 IoT and platform service: hands-on training using obniz

The Japanese company obniz provides IoT hardware devices called the obniz Board, which has preinstalled obnizOS and the obniz Cloud service as a development

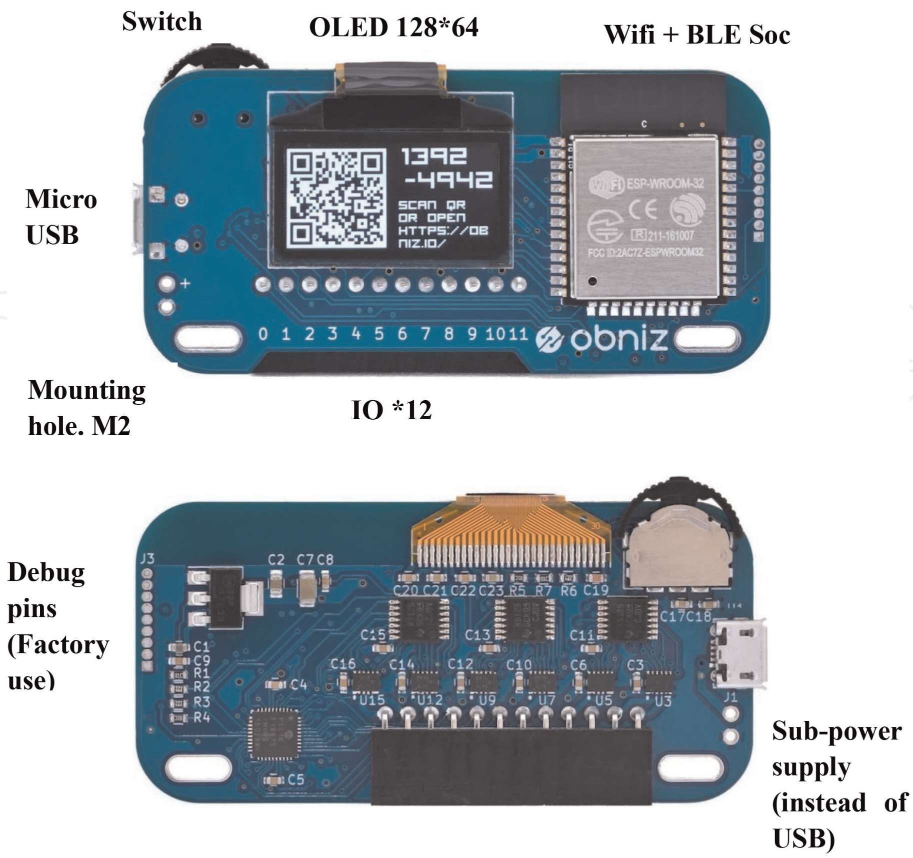

Figure 4.
Various devices and functions are arranged on the obniz board [8].

environment that can build IoT systems in a browser environment *via* Wi-Fi. By programming the electronic parts connected to the Mounting Holes in the obniz Board shown in **Figure 4**, it is possible not only to operate them with the keyboard of the PC but also to use mobile phones through obniz Cloud. JavaScript can be used as a development language. As with Microsoft's program editor MakeCode mentioned above, block programming that does not require programming knowledge can also be used.

In "2. IoT and platform service: obniz" in **Table 4**, the attendance confirmation system is explained below. In the attendance confirmation system, both LEDs were inserted into the appropriate positions of the mounting holes, so that the green LED blinked when the person was away and the red LED blinked when the person was present (**Figure 5**). Furthermore, to detect the presence of humans using the distance sensor, the terminals of the sensor were connected to the appropriate positions of the mounting holes.

For the algorithm to confirm people's presence in seats, if the value of the distance sensor (variable name "range") detected an object within 300 m, the seat was considered filled (assuming that a person was seated); otherwise, the seat was considered empty. An example of block programming according to this algorithm is shown in **Figure 6**.

5.4 Metaverse experience: spatial platform

Spatial, as a US start-up company, provides the Spatial platform that allows users to create their own VR/AR spaces. Multiple users as avatars (up to 25 to 30 users) in

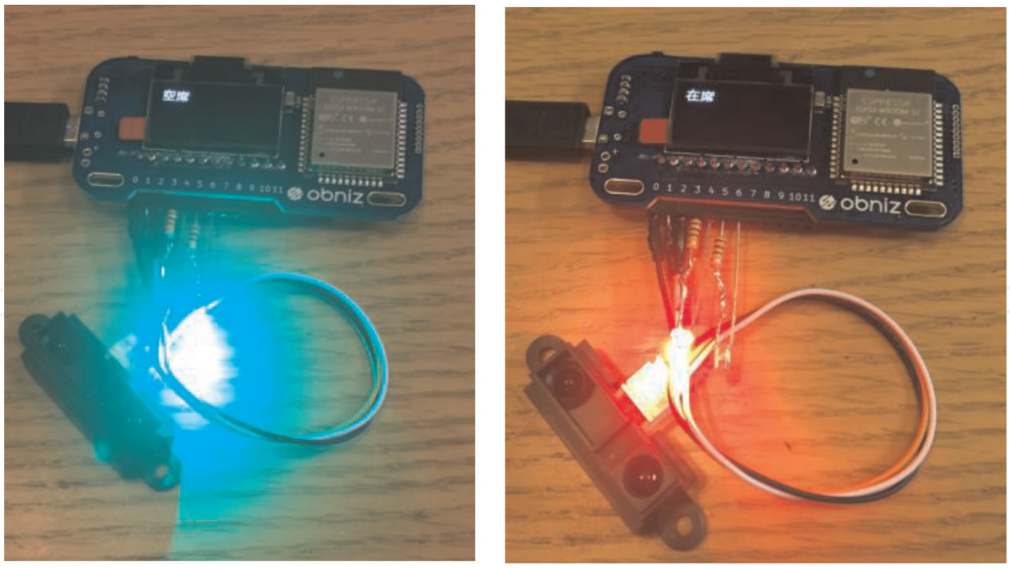

Figure 5.
LEDs (blue: vacant, red: occupied) and distance sensor connected to the mounting holes of obniz (Source: *Yoshiyuki Ono*).

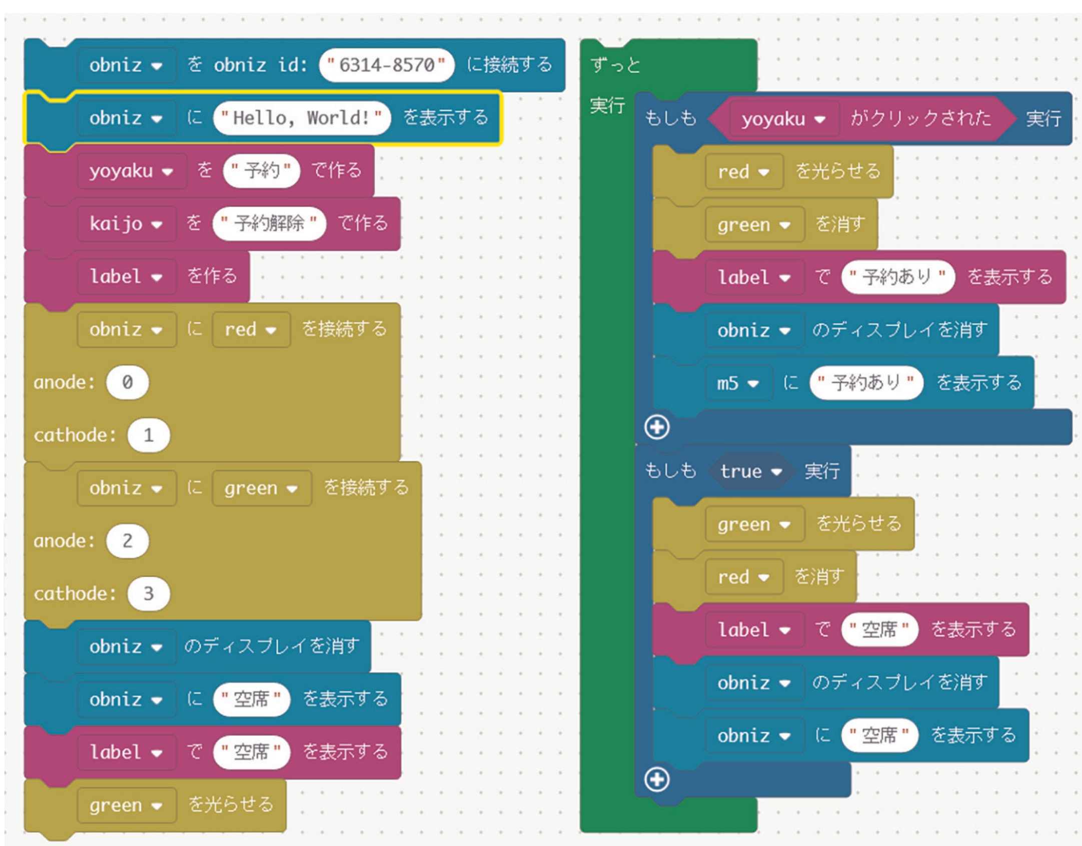

Figure 6.
Example of block programming and the seat confirmation system algorithm (Source: *created by Yoshiyuki Ono*).

different locations can participate in the same VR/AR spaces, such as virtual galleries, virtual tours, virtual facilities, and communicate with each other.

The Spatial platform enables the communication between different devices (cross-device communication) [9]. For example, compatible cross-devices include

MR devices such as Microsoft's HoloLens and Magic Leap's Magic Leap 1, integrated VR headsets such as Meta Quest, tablets, desktop PCs, and smartphones. Our own Tamaki Lab Virtual Museum, especially for "Hands-on training (2)" in **Table 4**, was created using the Spatial platform.

In hands-on training for each group (one group consisting of four learners), each learner first created their own spatial platform account and avatar. After entering the Tamaki Lab Virtual Museum, the individual learner browsed various exhibits while walking around the museum. They attached some digital sticky notes with each learner's name to their interested exhibits (**Figure 7**).

Then, they selected the most popular exhibit by having the four avatars communicate with each other and meet in front of the selected exhibit. After everyone gathered in front of the selected exhibit, they took a virtual commemorative photo. The virtual commemorative photo data were submitted as a group assignment report for hands-on training.

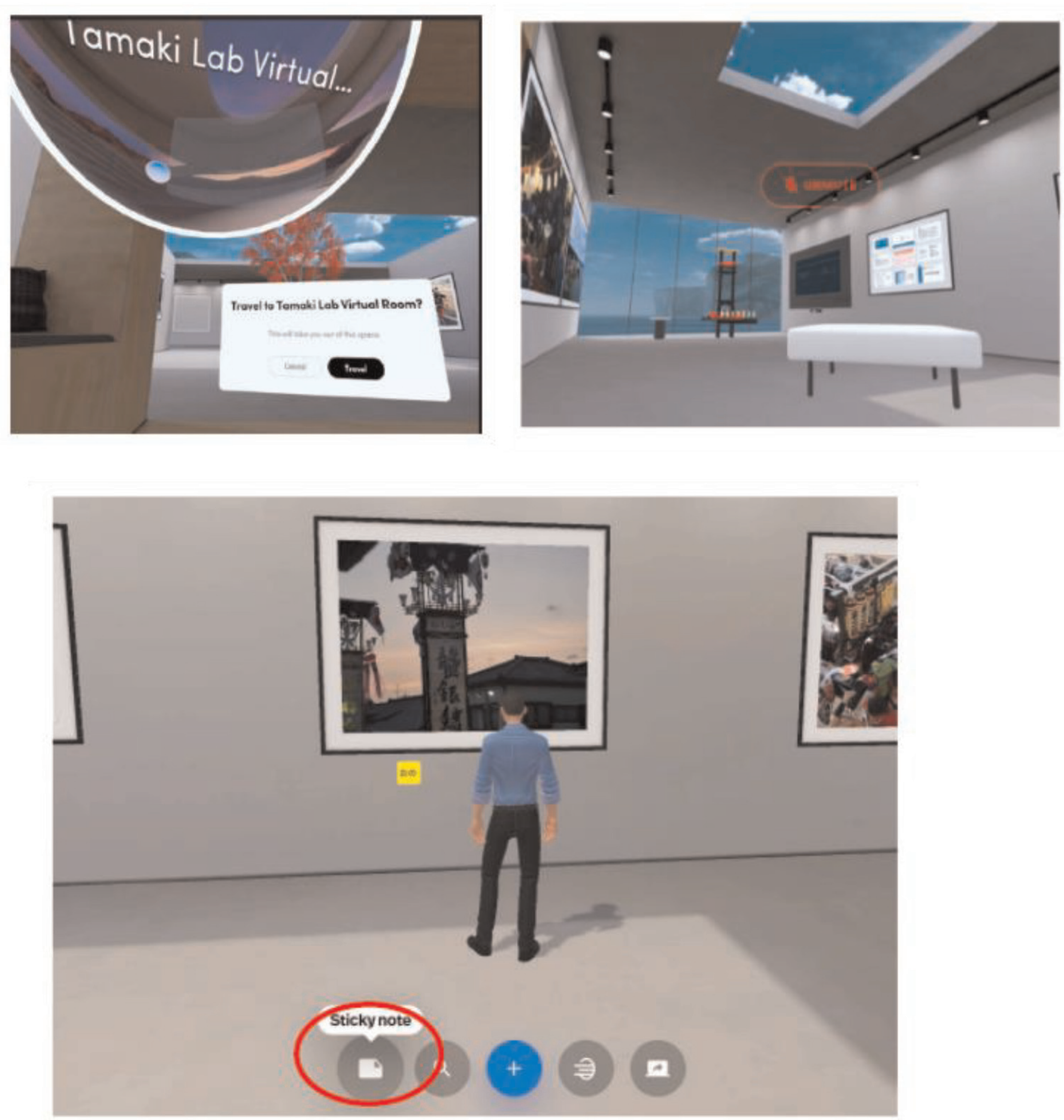

Figure 7.
Tamaki lab virtual museum in spatial (Source: *Yoshiyuki Ono).*

As a group work exercise in preparation for the presentation on the Spatial platform, they planned a new university laboratory design following the virtual visit experience and gave a group presentation and mutual evaluation.

6. Conclusion

In response to social issues that may arise in the future, new human resources who can formulate SDG/CE business scheme documents have become necessary and are referred to as business producers. New educational methods to train business producers to combine both PBL and AL to accommodate hybrid group work by effectively utilizing educational DX technology for a flexible response to the new normal following COVID-19. This chapter discussed curriculum design for hybrid group work exercises combined with PBL and AL and shared digital whiteboards for collaborative learning methods using Google Docs and the miro platform service. Furthermore, it discussed DX learning environment systems corresponding to regular class times and special class times by utilizing LMS and web conferencing systems, digital teaching materials, and learning support.

To address another research issue, the research team of this paper is developing an automatic question-and-answer system for learners in an online environment using an AI chatbot during and after a hybrid group work class. The system was actually incorporated into demonstration classes in 2021, and the system will continue to be improved.

As prerequisites for the four types of human resources who formulated the SDG/CE business schemes, they were taught theories and mechanisms for various advanced technologies and are referred to as "system creators."

The practical hands-on training program was created to cover the following three subjects: (1) Micro:bit and browser-based block programming editor MakeCode, (2) obniz and MakeCode, and (3) metaverse experience: Tamaki Lab Virtual Museum on the Spatial platform. Each group presented individual avatars and evaluated other groups on Spatial.

To improve the educational quality of both programs for business producers and system creators, strengthening the structure and professional human resources of the educational management organizations to continuously maintain the established new educational methods should be enhanced. These organizations should develop new educational methods of instructional design [10], engage in continuous research and development of learning environment platforms, promote faculty development, educate teaching assistants, improve grading evaluation methods, and improve course evaluation methods.

To address future challenges with the DX project activities, it is necessary to systematize and maintain these facilities and ICT systems for new DX education, and numerous computer education devices, software, and platforms should be consolidated into one comprehensive DX education system. To make full use of the comprehensive DX education system, appropriate experiential training programs should be prepared for faculty, expert staff, and TAs engaged in the system's operation and management. Furthermore, digital teaching materials for individual instructors and learners must be developed in practical educational sites.

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References

[1] National Science & Technology Council Committee on STEM Education. Chatting a course for success: America's strategy for STEM education. 2018

[2] Kin'ya T, Tomofumi T, Yoshiki N, Katsuhiro I, Maki A, Zheng Z. Development and implementation of online group work exercise combined with project-based learning and active learning methods. Aoyama Business Review. 2022;**44**:1-28

[3] Kin'ya T, Tomofumi T, Yoshiki N, Maki A. Trends in Japanese university education DX and case study of hybrid group work exercises in 2022: Digital whiteboard, DX learning environment, and AI chatbot systems for hybrid group work exercises. Aoyama Business Review. 2023; **45**:1-39

[4] Google. [Internet]. Google Docs. Available from: https://www.google.com/docs/about/

[5] miro. 2023. Available from: https://miro.com/app/dashboard/

[6] Anthony S. BBC Micro:bit—a free single-board PC for every Year 7 kid in the UK. arstechnica.uk. Retrieved 8 July 2015. Available from: https://arstechnica.com/gadgets/2015/07/bbc-Micro:bit-a-free-single-board-pc-for-every-year-7-kid-in-the-uk/

[7] Microsoft "MakeCode." 2023. Available from: https://www.microsoft.com/ja-jp/makecode/about

[8] obniz. 2023. Available from: https://obniz.com/ja/products/obnizboard

[9] spatial. 2023. Available from: https://www.spatial.io/

[10] Jonassen D. Designing constructivist learning environment (Volume II). In: Reigeluth CM, editor. Instructional-design Theories and Models: A New Paradigm of Instructional Theory. University Park: Pennsylvania State University; 1999. pp. 215-239