Multi-media Global PBL with HTML5 and TECHTILE Toolkit for Japanese and Thai Students

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Abstract
This paper describes our new global PBL (gPBL) and discusses its evaluation. We constructed a 6-week project-based-learning class entitling “Design and Implementation of Virtual Space” and conducted it twice a year from 2006. Based on that class, we performed interactive remote teaching trials using a shared virtual space between two universities two times in 2008 and 2010. After these trials, we improved the curriculum by employing tactile information into the virtual space in addition to the existing visual and auditory information. We added a workshop on the tactile device to the class and expanded the interactive remote teaching trials in two directions: sharing tactile information in a common virtual space (hardware) and generalizing the development platform (software). We experimentally confirmed our system between the Shibaura Institute of Technology (SIT) in Japan and the Thai-Nich Institute of Technology (TNI) in Thailand. Based on this background, we began a new gPBL with a tactile device and HTML5 at TNI between SIT and TNI.

Keywords: Global PBL, TECHTILE toolkit, HTML5, TNI, SIT.

1. Introduction
In 2006, we began a course entitled the “Design and Implementation of Virtual Space” on the design and the development of interactive systems for university juniors of the Department of Information Science and Engineering of the Shibaura Institute of Technology (SIT) [1]. Although various courses have attempted to utilize virtual reality [2] [3], teaching design and implementing virtual space en masse were much less common a decade ago. In addition, we conducted an interactive remote teaching trial by shared virtual spaces with Rissho University in Japan in 2008 [4] and with King Mongkut’s University of Technology Thonburi (KMUTT) in Thailand in 2010 [5].

Moreover, we improved our class by employing tactile information in the virtual space in addition to the existing visual and auditory information. In 2011, we added a workshop on a tactile device to the curriculum. We previously described the improvement of our class and confirmation experiment results for the remote sharing of tactile information and platform generalization [6]. We employed the TECHTILE toolkit [7] to provide tactile information and HTML5 for the new platform. Our experiment was conducted between the Shibaura Institute of Technology (SIT) in Japan and the Thai-Nich Institute of Technology (TNI) in Thailand.

Based on this background, we began a new global PBL (gPBL) with the TECHTILE toolkit and HTML5 at TNI. This paper describes the program and evaluates the gPBL.

2. Course Outline
First, we describe the outline of our course: the “Design and Implementation of Virtual Space” [1].
It is held in conjunction with other practicum courses by two other professors for juniors in fall semester. They chose two courses of three courses for its first and second halves. The curriculum in Table 1, which was designed for two half periods of the semester, assumes that the students have taken practicum courses in programming and algorithms using C language. The original program consisted of six classes. To add tactile information to virtual space, from 2011 we added to the fourth class a workshop on a TECHTILE toolkit device [7] that provides tactile information that will be described below.

Virtual Reality Modeling Language (VRML) generates objects in virtual spaces. Since VRML descriptions are text-based by tags, learning is relatively easy for students who are familiar with C language and html. From the third class, students worked in groups and used VRML to generate objects and other software to construct virtual spaces. As software to construct virtual spaces, we used OmegaSpace of Solidray Co., Ltd. [8] until 2015 and in 2016 changed to Unity. At the 6th class (the 7th class from 2011), the students of each group introduced their respective virtual spaces and stereoscopically displayed them on a 100-inch screen with polarized glasses [9] or a stereoscopic projector with LCD shutter glasses [5].

Figures 1 and 2 show examples of the virtual objects made by VRML [4] and virtual worlds constructed using Unity.
Table 1 Curriculum outline

<table>
<thead>
<tr>
<th>Class</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Explanation of VRML and exercises</td>
</tr>
<tr>
<td>2</td>
<td>Presentation of VRML products</td>
</tr>
<tr>
<td>3</td>
<td>Explanation of software for constructing virtual spaces and deciding target spaces to be generated by each group</td>
</tr>
<tr>
<td>(4)</td>
<td>Workshop for TECHTILE toolkit (from 2011)</td>
</tr>
<tr>
<td>4 (5)</td>
<td>Exercises to construct virtual spaces</td>
</tr>
<tr>
<td>5 (6)</td>
<td>Exercises to construct virtual spaces</td>
</tr>
<tr>
<td>6 (7)</td>
<td>Presentation of constructed virtual spaces</td>
</tr>
</tbody>
</table>

![Examples of objects made by VRML](image1)

Figure 1 Examples of objects made by VRML [4]

![Examples of virtual spaces constructed using Unity](image2)

Figure 2 Examples of virtual spaces constructed using Unity

3. Improvements of Curriculum by Adding Tactile Information

As mentioned above, from 2011, we employed tactile information and both visual and auditory information in the virtual space using the TECHTILE toolkit [7]. The TECHTILE toolkit (Figure 3) is composed of a haptic recorder (a microphone), a haptic display (small vibrators), and a signal amplifier that is optimized to present not only the audibility zone (20-20000 Hz) but also low-frequency (1-20 Hz) vibrations [10]. We changed the curriculum to include the device workshop (Table 1).

![TECHTILE toolkit](image3)

Figure 3 TECHTILE toolkit and workshop scene
4. Platform Improvements for Development

We employed Skype and HTML5 to generalize remote collaborative teaching. We experimented between the SIT and the TNI locations to confirm the sharing of content created by HTML5 and remote collaboration using Skype connections in March 2016 [11]. Figure 4 shows experimental scenes from the SIT side. A note PC display, its speaker, and a TECHTILE toolkit vibrator were used for showing the content created by the TNI side. We also used an iPhone for communication.

Figure 4 Experimental scenes from the SIT side

5. Conducting Global PBL at TNI

Based on this preparation, ten SIT juniors who took the practicum course and ten TNI juniors who took a HTML5 class participated the global PBL at TNI. The gPBL schedule held on March 2017 is shown in Table 2.

Table 2 gPBL schedule

<table>
<thead>
<tr>
<th>Date</th>
<th>Morning</th>
<th>Afternoon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar. 4</td>
<td>Leave from Haneda International Airport (SIT)</td>
<td>Arrive at Suvarnabhumi International Airport (SIT)</td>
</tr>
<tr>
<td>Mar. 5</td>
<td>Field trip in Bangkok to temples (SIT)</td>
<td>Cultural exchange</td>
</tr>
<tr>
<td>Mar. 6</td>
<td>Introduction and TNI tour</td>
<td>HTML5 lecture mainly for SIT students</td>
</tr>
<tr>
<td>Mar. 7</td>
<td>Group work</td>
<td>Group work</td>
</tr>
<tr>
<td>Mar. 8</td>
<td>Group work</td>
<td>Group work and Intermediate presentation</td>
</tr>
<tr>
<td>Mar. 9</td>
<td>Group work</td>
<td>Factory visit (SIT)</td>
</tr>
<tr>
<td>Mar. 10</td>
<td>Group work</td>
<td>Cultural exchange (making Thai sweets)</td>
</tr>
<tr>
<td>Mar. 11</td>
<td>Group work</td>
<td>Final presentation and closing</td>
</tr>
<tr>
<td>Mar. 12</td>
<td>Cultural exchange</td>
<td>Cultural exchange and departure from Bangkok (SIT)</td>
</tr>
<tr>
<td>Mar. 13</td>
<td>Arrive at Tokyo (SIT)</td>
<td></td>
</tr>
</tbody>
</table>

This program had five groups, each of which consisted of two SIT students and two TNI students. English was used for communication in the group work and cultural exchange. Each group had internal discussion for deciding a target system to create with HTML5 and the TECHTILE toolkit. After groups introduced their plans for the target systems at their intermediate presentations, they began to develop their systems. At the final presentation, the five groups introduced their developed systems and the best group was honored. Figure 5 shows group work scenes and presentations. Figure5(h) shows the members of the best group.

Each SIT student submitted daily and final reports. In addition, nine students out of ten answered questionnaires to compare their attitudes before and after attending the gPBL. The following are some report and questionnaire results:

- For four students, this gPBL was their first experience to go abroad.
- No students had spent more than one month abroad.
- All students recognized the importance of learning English as a communication tool.
- All students expressed motivation to embrace a wider vision of the world.

Figures 6 and 7 show the results of following questionnaire, provided by JASSO (Japan Student Services Organization) in Japanese, on a 5-point Likert scale:

Q1. I can identify issues to do myself and take initiatives to tackle them.
Q2. I can work with my colleagues and solve the problems with them.
Q3. I can set my own targets and complete them with little fear of failure.
Q4. I can analyze the current situation and concretely focus on its problem points.
Q5. I can consider a solution process for tasks and systematically execute it.
Q6. I can devise proposals and opinions with new ideas on issues without dwelling on the existing ideas.
Q7. I can convey my opinion in an easy-to-understand manner and accurately explain it to others.
Q8. I can create a comfortable discussion environment for others and elicit their opinions.
Q9. I do not stubbornly cling to my opinions and methods, and I can respond flexibly by respecting the opinions and the positions of others.
Q10. When I work in a team, I can understand the relationship between myself and others and the relevant issues.
Q11. According to the rules and procedures, I can properly take my own actions and respond.
Q12. Even if I am placed in stressful situations, I can positively deal with them by defining them as growth opportunities.
Q13. I can assume a leadership role in places and with friends whose cultural backgrounds are different from mine.
Q14. Even though risk exists, I believe in challenging myself.
Q15. Even if I lack foreign language ability, I actively struggle to convey my meanings and communicate.
Q16. I can understand and accept people who have different faiths and cultural backgrounds.
Q17. I welcome exchanges with foreigners, both domestically and overseas.
Q18. I am motivated to study specialized fields.
Q19. I am motivated to study other languages.
Q20. I have knowledge of the society, customs and culture of the foreign country I am staying in.
Q21. I have knowledge and interest in politics, social issues, and international relations.
Q22. I recognize the importance of gender equality in society.
Q23. I have a clear vision for my future direction and path.

Q1 to Q12 are related to the fundamental competencies for working persons, which divided into three parts: “Action,” “Thinking,” and “Teamwork,” as defined by the Japanese Ministry of Economy, Trade and Industry in 2006 [12]. Q1 to Q3 are related to “Action,” Q4 to Q6 are related to “Thinking,” and Q7 to Q12 are related to “Teamwork” in the ATT. In addition, Q15 and Q19 are related to “Language study,” and Q17, Q18, and Q20 are related to “Cross-cultural understanding.” Other items are classified into “Otherwise.” Figure 6 compares the average scores for the questionnaire items before and after attending the gPBL. All of the post-gPBL scores exceeded the pre-gPBL scores. As for the “Language study” items (Q15 and Q19), some “Cross-cultural understanding” items (Q17 and Q20), and some “Otherwise” items (Q13 and Q23), the differences are greater than 1. Figure 7 shows the individual differences of the pre- and post-gPBL scores, where A to I show each student. Q15, Q20, and Q23 show positive differences for all students. On the other hand, some ATT items (Q5, Q8, Q9, Q11, and Q12) and Q22, which is an item in “Otherwise,” but related to “Gender equality,” have individuals whose scores fell. However, because the students whose scores fell differed for each item, and they put higher scores for other items, we believe that all the students improved in various ways through gPBL activities.

6. Conclusion
Based on improvements to our project-based-learning program entitled “Design and Implementation of Virtual Space” at the Shibaura institute of technology (SIT) by employing tactile information in virtual space in addition to existing visual and auditory information, we expanded the program for a global PBL at the Thai-Nich institute of Technology (TNI). Ten SIT juniors who took the practice course and ten TNI juniors who took a HTML5 class participated in the gPBL. From their daily and final reports and questionnaire answers from the SIT students, we confirmed that gPBL was very useful at least for the SIT students to expand their views for their futures. Future work will continue to improve this gPBL.

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References
Figure 5 gPBL scenes
Figure 6 Average scores for each question item

Figure 7 Differences of scores of pre- and post-questionnaire items for each student


Biography
Michiko Ohkura received her B.S. (1976) and M.S. (1978) degrees in Mathematical Engineering and Ph. D. (1995) in Advances Interdisciplinary Studies from the University of Tokyo, Japan. She worked for some companies including Central Research Laboratory, Hitachi Ltd., and is currently a deputy president and a professor of Department of Information Science and Engineering, the Shibaura Institute of Technology, Japan. Her current research interests include human-friendly interactive systems and creation of Kansei values. She is a member of Science Council of Japan, a director of the Japan Society of Kansei Engineering (JSKE), and a member of IEEE, The Institute of Electronics, Information and Communication Engineers (IEICE), Information Processing Society of Japan (IPSJ), The Virtual Reality Society of Japan (VRSJ), and other some academic societies.