Evaluation of Course Design and Student Comprehension in the International Learning Environment: A Panel Data Analysis

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Abstract

We evaluated the effectiveness of learning and teaching processes by focusing on the course design and students' learning performance. The case study analyzed here was a distance learning project, in which Thai and Japanese grade 10 students studied how to use MX Flash, a software application used for the creation of animations, from the introductory use to the ability to make a short animation. In designing the course prior to implementation, the theoretical frameworks such as Constructivism theory and Bloom's taxonomy were examined and discussed. From these perspectives, effective learning-teaching methods were determined by course content, conditions of teaching and learning processes, and media usage. The whole course was divided into learning processes and the pedagogical goals in the learning processes were classified, with the following three learning processes determined: (1) a traditional lecture; (2) self-learning; and (3) collaborative learning. At the end of each class, the students were asked to evaluate the course with regard to the three domains of (1) comprehension, (2) cognitive load, and (3) motivation, using a 4-point Likert scale. Based on their responses, a panel data analysis was adopted to verify the appropriateness of the course design and to examine factors promoting or obstructing students' learning performance.

Key words: learning effectiveness, course design, Constructivism theory, Bloom's taxonomy, panel data analysis.

1. Introduction

Thanks to the broad development of Information and Communication Technologies (ICT) related to distance learning for higher education, efforts to improve learning and teaching quality using ICT support have been reshaping traditional learning environments for school education.

It is commonly believed that distance learning using ICT enhances learning quality and lowers the costs of education. Computers are the most common ICT tool for distance learning. As part of global strategies to cope with increasing competition, many prominent universities in the U.S. and Europe have already established campuses in Asian countries and offer the same lectures though the Internet and some countries have promoted the transfer educational know-how to developing countries. Developing countries, on the other hand, are looking for ways to overcome insufficient educational infrastructure and teaching staff as a means of coping with growing demand for higher education. International distance learning thus meets the desires of both developing and developed counties, and clearly enhances international exchange not only in education but also in other areas such as in the sciences and engineering.

1.1. Previous studies

Distance learning offers a range of research topics. With regard to technological development, [5] attempted to develop a lecture environment at the university level by designing the technological support system with a focus on reliability, stability and interactivity. He found that restrictions in technology, such as in image and sound quality, as well as network delays, greatly affected learning difficulty. Adapting the limitations of distance learning technology to actual classroom environments requires further studies, particularly with regard to variations in learner characteristics.

In case of international distance learning, students usually have different backgrounds, in terms of in culture and language. Many innovative educators have investigated practical implementations to raise teaching and learning quality to the level of face-to-face traditional classroom learning. [2], for example, studied communication using e-mail in a social studies class between Japan and Korea, with a focus on course design and problems such as the imbalance in communications among students, the language abilities and student ICT knowledge.

[12] used various ICT media such as a video conference system, school homepage, and web board in teaching Japanese to foreigners. ICT media were used as supplementary sources to traditional teaching, but few students used them. This problem is common in case studies, hampering efforts to identify the determinants of successful usage of ICT.

Most distance learning projects, therefore, seem designed according to the experiences of individual teachers or technology-related experts, rather than based on any vigorous analysis of the effective combination of ICT media aimed at improving student learning performance. Obtaining substantial results of learning effectiveness in case studies is difficult, however; rather, learning effectiveness should be analyzed with due regard to educational concepts and theories.

1.2. Objectives of this paper

These studies have mainly reported on how advanced technologies can be coherently organized with educational purposes or contexts. Nevertheless, a few studies have investigated educational effects by focusing on learners, such as studies of the possibilities and appropriateness of learners receiving knowledge effectively within the limits of technology, variations in learning acquisition methods, students' knowledge background, cultural differences, etc.

From the discussion above, this paper attempts to evaluate the effectiveness of course design by focusing on students' learning performance. In designing the actual course prior to the implementation, the theoretical framework was examined and the Constructivism theory and Bloom's taxonomy were adopted. This paper examines how the original aims of course design were achieved during implementation, or in other words how deeply students acquired knowledge; how smoothly they perceive course contents, instructional methods and media usage; and how they nurtured their creativity in the making an animation. Instead, a rigorous analytical methodology was utilized, namely a panel data analysis, which is now a commonly used methodology in social sciences.

2. Framwork of distance learning

2.1. Distance Learning Project

An experimental course was conducted during October - December 2005, with participation from 201 grade 10 students of Kyoto University of Education Affiliated High School in Kyoto, Japan and 211 grade 10 Thai students of Chulalongkorn University Demonstration School in Bangkok, Thailand. The course was conducted once a week for about 50 minutes for 3 months, and both Thai and Japanese students shared the same curriculum and learning contents.English was chosen as a common language. Students learned how to use MX Flash, a software application they had not previously used for the creation of original animations. Prior to implementing the distance learning project, special care was taken with regard to teaching software not only by improving the quality of education through the use of technology, namely the computer-based learning system, but also by constructing a proper course design which effectively contributes to students' learning performance.Students were expected to be able to create a short animation (in more detail, see [6] and [7]). In addition, an international distance learning project is a good research object to examine how the different backgrounds of two countries affect their learning performance ([9], [10], and [11]).

2.2. Course Design

The following two theories have become the foundations of this experimental course.

(1) Constructivism

We applied the concept of Constructivism theory suggested by Jonassen et al [1994]. The Constructivism concept emphasizes that knowledge is constructed by learners themselves through two processes, namely (i) connecting new and old information, and (ii) interrelating the learning style and the students' learning

achievements. Based on this concept, the whole course was designed to have three instructional styles, consistent with the content itself and the students' achievements, as shown in Figure 1 and Table 1.

(2) Bloom's Taxonomy

Effective learning requires a clear understanding how well students access desirable knowledge. Bloom's taxonomy offers a promising approach to achieving learning objectives in each step of designing course experiences that promote constructivist understanding to learning. Bloom identified four levels of learning objectives: (i) the first provides students the ability to acquire facts and information, and then to recall them (Recognition); (ii) following this, students should understand the basic use of the acquired knowledge (Understanding); (iii) in the third, they then should apply this knowledge in other situations; that is, students can break down knowledge into its integrated pieces and apply it to other thing (Application); and (iv) at the final stage, students can construct their own new knowledge based on the knowledge and information obtained so far (Analysis).

(3) The course design based theories

Based on the theories discussed above, the course was deivided into segments, depending not only on students' achievements but also teaching and learning technologies, since software is digital content, and ICT technology is easily applied. In the initial stage of the course, students learn what MX Flash is. In the final stage, however, they fully utilize the software and create an animation. The first stage of the course thus aimed to make them understand the software, corresponding to "Recognition" and "Understanding" of Bloom's taxonomy, and the final stage to "Analysis". An important limitation was the length of the course, which was six classes for Thai students and ten for Japanese. Because of this limitation, another stage was added, which we considered to correspond to Bloom's "Application". We set the aim of this second stage as fostering the students' ability to use the software and prepare to create their own animations. These three stages of cources can also be interpreted as Constructivism.

Based on the two theories discussed previously, the following three teaching stages were pedagogically adopted, referred to as: (a) a traditional lecture; (b) self-learning; and (c) collaborative learning. The relationship of these teaching styles to those of Constructivism and Bloom's taxonomy is indicated in Figure 1, and Table 1.
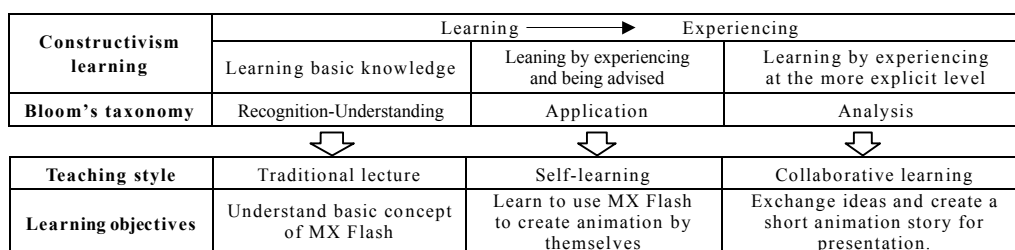
Constructivism learning	Learning ⟶ Experiencing		
	Learning basic knowledge	Leaning by experiencing and being advised	Learning by experiencing at the more explicit level
Bloom's taxonomy	Recognition-Understanding	Application	Analysis
Teaching style	Traditional lecture	Self-learning	Collaborative learning
Learning objectives	Understand basic concept of MX Flash	Learn to use MX Flash to create animation by themselves	Exchange ideas and create a short animation story for presentation.

Figure 1 Teaching styles and learning objectives based on educational theories

2.3. Three Styles of Learning and Teaching Processes

(1) Traditional lecture

This course was begun using class room style which is the most familiar to the students. The aim of this style was to provide an overview and basic knowledge of the MX Flash animation software. Students were taught by a teacher in a traditional way. To familiarize students with ICT media in the first stage, ICT media such as hyper text on the school's homepage was utilized to supplement lecture.

(2) Self-learning

Students were expected to apply their basic knowledge in practice. Students were told the objective of the module, namely the production of a motion animation, and then studied using WBT (Web-based Training) on the school's homepage. Students were explained about the guidelines required to complete their assignments for about 10 minutes at the beginning of the class, and then had to complete the assignment in the class period by applying the basic knowledge gained from the traditional lecture and the additional knowledge gained from the provided homepage or elsewhere by themselves. The teachers and teaching assistants assisted students individually during the class. Students had to show the achievement of the learning objective by sending their tasks via the school intranet at the end of the class. In this stage, the students were taught how to use ICT media, such as the WBT, and about related information and computer literacy. Students were asked to form teams of about 4 or 5 persons to create short cartoon animations. In preparation, they were informed about collaborative learning which would be conducted later with the foreign students in another school.

(3) Collaborative learning

Students developed their knowledge by learning in a collaborative way. Students were required to exchange their ideas with students' in the same group in their own class but also with the group in the other country. Students formed teams within the class, which were then matched with foreign student teams as team partners.

They had to help one another create an animation under the condition that their completed animation must contain at least one of the techniques for MX Flash software or related idea exchanged with the partner team. Students were required to communicate with one another via a BBS (Bulletin Board System). During the class, students spent their time mainly on creating an animation with their team members. They also had to access the BBS to find comments from the partner teams and undertake a discussion. Students reported their posting of comments to the teacher at the end of each class. In this stage, a TV phone (NTT Phoenix) was also used to support real time communication among students and teachers in the two countries, while in the previous two stages, only asynchronous communications took place.

2.4 Other Factors in Course Design

(1) Learning content and corresponding ICT media

  Learning content was arranged to match the learning goals in each process. However, learning content is not only about academic knowledge or content coverage, but also the acquisition of related skill such as mastering ICT media such as hypertext, WBT (Web-based Training), BBS (Bulletin Board System), etc.

(2) Role of teachers

  In the self-learning style, students are required to take an active role in the learning process, and teacher help is limited to helping the students to develop their own understanding of the content. Practically, however, class-room learning discipline and time limitations in the class-room causes teachers to rush to finish their lecture in passive way. It is therefore necessary to remind both teachers and students to be aware of maintaining an appropriate teaching role, consistent with the characteristic of the particular learning style. Moreover, with regard to the role of the in-class ICT-based learning, a limited time period (50 minutes), variation in teaching style, and the ICT skill of the teacher and the student's familiarity with ICT media were also major quality issues in many case studies. To control these variations, the Thai and Japanese students used the same curriculum and teaching contents, and the courses were conducted in the same time range.

(3) Communication direction

  Management of effective communication, such as the volume or balancing of passive and active direction, is associated with the topic above concerning the role of the teacher. Another key component in generating higher achievement of learning is to identify the direction of communication, and to remind all participants to balance the proportion of communication in each learning style.

(4) Learning media.

  It is important to provide media which suit the learning contents and communication context and assist students to achieve the intended learning outcome. However, students with a lack of ICT skill and unfamiliarity with new learning environment may feel that the utilization of ICT media is inefficient or inadequate. Besides adding ICT usage to learning content, as mentioned above, traditional media such as paper print-outs and oral presentations were utilized simultaneously with ICT media.

Table 1 Course design - three stages of the learning process

Learning style		Traditional lecture	Self-learning	Collaborative learning
Class time	Thailand	1st - 2nd lesson	3rd - 4th lesson	5th - 6th lesson
	Japan	1st - 3rd lesson	4th - 6th lesson	8th - 10th lesson
Learning content and activity		-Baasic usage of MX Flash -ICT media used as online text posted on the school website	-Workshop in making a simple animation using MX Flash -Introduction on how to use WBT/BBS	-Grouping to create a animation -Inter-group communication via BBS
Role of teacher		Instructor	Advisor	Advisor
Communication direction		Teacher to students	Students in the same classroom	Students in the same classroom and in a different classroom
ICT Media		On-line Text	WBT	BBS and TV phone
Type of Distance learning		Asynchronous	Asynchronous	Asynchronous and synchronous
Other media		Oral, Print-out	Oral, Print-out	Oral, Print-out

2.4 Preparation to undertake international cooperative and collaborative learning

  The different in their background is a great advantage and enabled them to produce better work and assignments. All students, however, included mental and learning skill preparation before embaking on new learning style of self learning and collaborative learning. It is important for both Thai and Japanese classroom to engage each stage of learning style in propriate timely manner. This will ensure that both countries carry on their leanring at the same pace.After the learning styles were determined, Thai and Japanese teacher brainstroms to arrange details of suitable content for each class. This content and activities was not only matched to students' characteristic, but it also possibly conducts appropriately to timing of school activities. In Thailand, during this semester students has many school activites such a sport day and exchange academic activities with other schools. It caused classtime decrease about 4 times comparing to Japanese. Due to a fewer class time, the class of this computer subject was move to the last period of the day, so students have some more extra time to use computer and consult with teacher.

3. Learning feedback and evaluation

3.1. Evaluation of the Course

The purpose of this study is to identify the effect of the course design on the learning performance of students. According to Chandler and Sweller ([3]), high cognitive performance which promotes effective learning outcomes is related to the following three factors: (i) comprehension; (ii) cognitive load; and (iii) motivation. We adopted these three factors to evaluate the course.

(1) Comprehension

Comprehension is the capacity and quality of an individual student in identifying how much they have developed their knowledge, which corresponds to Question 1 in the questionnaire (from 1: not at all, to 4: understand quite well).

(2) Cognitive load

Cognitive load refers to the load placed on working memory during the learning process. It is natural that people learn items better and faster if they have been previously exposed to them. On the other hand, the more unfamiliar the item, the longer the time they need to understanding them. A low cognitive load can therefore enhance student understanding.

Our present survey consisted of the two factors for cognitive load: (1) cognitive load in the learning content; and (2) cognitive load in the learning method. The first, cognitive load in the learning content is related to the difficulty in learning the subject contents, which in the present study was a software application for creating MX Flash animations. Question 2 below is related to this factor. The second, cognitive load in the learning method is concerened with the perceived difficulty of the teaching and learning process for each period of the class, which is asked in Question 3(from 1: quite difficult to 4: not difficult at all).

(3) Motivation

"Motivation" is another important factor in achieving learning outcomes. In ICT-based distance learning environments, it is necessary to ensure that students exert sufficient effort to sharing what they are learning and pass on their knowledge to other participants. Students were therefore asked their motivation in "learning contents" and "the media and information literacy," as asked in Question 4 and 5 (from 1: not at all to 4: actually want to do more).

3.2. Propriety of Questions

Referring to the principle of instructional design by [8], improvement in "Comprehension" in learning requires that "Cognitive load" be diminished and "Motivation" be maximized. We adopted this concept as a main hypothesis of this study. The reasons why only five questions were used in the evaluation of the course design and students' learning performance is as follow. (i) As already mentioned, students were asked to fill the questions right after each class in short time. We were afraid the reliability of their replies, since lengthy and many questions made them to rush to answer in an ambiguous way. (ii) There is another rationale behind simple questions for the course evaluation, which is referred to as "Classroom-Assessment-Techniques (CATs)"and "Minute Paper Test," which has been implementing at numerous educational institutions in many countries (see [4], for example). (iii) A rigorous analytical methodology is adopted in this study to evaluate course design and students' comprehension, approximately 1,700 responses, which will be extensively discussed in the next chapter. The students were asked to respond to the questionnaire at the end of each class.

4. Results of regression analysis

In this section, we present multiple regression models to evaluate how "Comprehension" was affected by the two concepts of "Cognitive load" and "Motivation" under the different learning styles: traditional, self-learning and collaborative. Specifically, comprehension was set as a dependant variable, while cognitive load with regard to learning contents, cognitive load with regard to learning methods, motivation towards learning contents, and motivation towards media information literacy were independent variables.

4.1. Simple Observations

The mean of Comprehension scores for each stage is more than 2.50 (mean value), which shows both groups of students in general have understood well, althought those points were higher for Japanese students than Thai students. It is also interesting to note that mean values decrease from the traditional face-to-face to self-learning and to collaborative learning style. This trend appears consistent with realty, since comprehension becomes more difficult in collabotive learning than in a traditional lecture. Means of variables are more diverse in Japanese than Thai students.

4.2. Estimation Results by OLS

Let us briefly summarize the results of the estimation presented by [7], which utilized OLS (Ordinal Least Squares) in order to estimate the relationship between dependent and independent variables at each learning style separately. In most of learning stages, four dependent variables (Q2, Q3, Q4 and Q5) contributed significantly to students' comprehension.

In particular, two concepts of cognitive load have significant positive confidence, which is more than those for motivations. The only exception is the comprehension of Japanese students in the self-learning style; Q5 "Motivation towards media and information literacy" has a significant negative coefficient that Japanese students showed less interest in related technology for learning, such as computer skills in this learning style, and this led to a decrease in comprehension for this lesson.

According to the above results, OLS estimation seems to have shown that almost all variables promote student comprehension in each stage; that is, the efficiency of course contents, teaching method, media selection, etc. on student's comprehension, but it failes to identify which variables are essential. Moreover, this estimation does not prove the appropriateness of the three styles of course design at all. A more rigorous analysis is required to explore these issues.

4.3. Eastimation Method

(1) Equation for estimation

In this distance learning course, each Japanese student participated in ten classes and submitted responses to the questions, while Thai students participated in six classes. This difference is due to the class schedules of two high schools. At each stage, their respnses form cross-section data, while for each student, they constitute time-series data. Panel data analysis is an estimation method which integrates two kinds of data in estimation. This analysis has become popular in social sciences and has extensively expanded the scope of analysis, but few studies have used this method in educational evaluation.

At first, to verify the appropriateness of course design in terms of comprehension, we add comprehension variable of the previous learning stage as independent variables. More concretely, in estimating comprehension in the self-learning stage in addition to cognitive load and motivation, the average value of comprehension with the traditional lecture of each student is used. The estimation equation of the self-learning style can be expressed in the following way:

$$Comprehension_i = {}_0 + {}_1 x_{i1} + {}_2 x_{2i} + {}_3 x_{i3} + {}_4 x_{i4} + {}_5 x_{i5} + u_i \quad (1)$$

where i denotes a particular student and x_{ij}s are variables at the self-learning style:
x_{i1}: Cognitive load with regard to learning contents, x_{i2}: Cognitive load with regard to learning methods,
x_{i3}: Motivation towards learning contents, x_{i4}: Motivation towards media and information literacy

In addition, x_{i5} denotes the average value of comprehension of i student in the traditional lecture style. If ${}_5$ is positively significant, then we can conclude that course design is appropriate and effective, since comprehension at the last stage promotes that at the current stage. The estimation equation of the collaborative learning stage can be expressed in a similar manner.

$$Comprehension_i = {}_0 + {}_1 x_{i1} + {}_2 x_{i2} + {}_3 x_{i3} + {}_4 x_{i4} + {}_5 x_{i5} + {}_6 x_{i6} + u_i \quad (2)$$

All variables except x_{i5} and x_{i6} are those of the collaborative learning stage similarly to equation (1), and x_{i5} and x_{i6} are the average values of the traditional lecture and self-learning stages of i student, respectively.

(2) Results of estimation by OLS

As for the results of estimation at the traditional lecture stage, this stage does not have a prior stage, and the estimation is exactly the same as [7].

Thai students reported a relatively high socre in Q2 "Cognitive load in learning contents," which indicates that Thai students understand better when learning contents are easy to understand. This in turn suggests that courses aimed at Thai students should be designed with close attention to the level and volume of contents of each session.

With regard to the Q2 of Japanese students, this factor is not significant; this implies that the difficulty of contents was irrelevant to their "Comprehension". For these students, the teacher's lecturing and communication skills were more important in the traditional lecture style teaching.

Motivation asked in Q5 is not significant for both Janapese and Thai students, and this means that students were less motivated to study computer skills further using this stage.

(3) Verification of course design by panel data analysis

(a) Self-learning

Let us examine the results of estimation according to equation (1), in which comprehension in the traditional lecture stage is included as an independent variable. The results show an interesting contrast between Japanese and Thai students, as for Japanese students, comprehension at the previous stage affect that of the self-learning

stage at the 1% significance level, whereas for Thai students this is not significant. In the traditional and self-learning styles, it can be said that the course was more properly designed for Japanese than Thai students.

As for variables (Q2, Q3, Q4, and Q5) at the same self-learning stage, Q2 "Cognitive load of the learning contents" is not significant for Japanese students, while both cognitive load items are significant for Thai students. This implies again that learning contents and teaching methods are more suitable to Thai students. Motivation towards media and information literacy is not significant for either group of students, which is similar to the results in the previous traditional lecture stage.

(b) Collaborative learning

Collaborative learning is estimated by equation (2), in which comprehension at not only the previous self-learning stage but also two stages prior, (i.e. traditional lecture stage) are included in the right hand side of the equation. For Japanese students, only comprehension at the previous self-learning stage affects that of the collaborative learning stage at the 10% level; while for Thai students, that of the traditional lecture stage is at the 1% significance level.

Thai students' comprehension at the first traditional lecture stage provided a positive effect at the 1% significant level, which indicates that course contents at the traditional lecture stage are better suited to Thai students' comprehension in the final collaborative learning stage. From these results, it shows that course design divided into three stages from introductory use to the advanced use to make a short animation is better suited to Japanese than Thai students.

Regarding the four factors (Q2, Q3, Q4 and Q5) at the collaborative learning stage contributing to comprehension at the same stage, Thai students' cognitive load in learning contents and Japanese students' cognitive load in teaching method are found to be significantly different.

4.4. Effect of cognitive load and motivation

In the previous section, we examined how effectively the distance learning course is designed by introducing the variable of comprehension at the previous learning stages into the estimation equation. Since comprehension in this model is defined as the mean value of comprehension scores of classes at the same learning stage, this provides no information on how the four factors of cognitive load (Q2 and Q3) and motivation (Q4 and Q5) of the same or different learning stages promote comprehension in the particular learning stage. In order to examine this issue, an additional estimation model is prepared.

(1) Equation for estimation

The objective of this estimation is to examine how four factors namely cognitive load and motivation of not only the same learning stage but also different leaning stages affect comprehension in the particular learning style. The equation takes the following form:

$$Comprehension_i = {}_0 + {}_1x_{i1} + {}_2x_{2i} + {}_3x_{i3} + {}_4x_{i4} + {}_5y_{i1} + {}_6y_{2i} + {}_7y_{i3} + {}_8y_{i4} + u_i \quad (3)$$

where x_{ij}s are the same as the previous section and y_{ij}s are cognitive load and motivation of the previous stage; in the case of the self-learning stage, these are variables in the traditional stage, and in the case of the collaborative learning stage, these are the variables of the self-learning stage as well as those of the traditional stage. In this model, we attempted to identify which cognitive load or motivation contributes to student comprehension of the same and different learning stages.

(2) Estimation results by panel data analysis

(a) Self-learning

The results show that for Japanese students, among variables at the previous traditional lecture style, only Q4 "Motivation towards teaching contents" is significant at the 5% level, but has a negative sign, indicating that this variable is an obstacle and reduces Japanese students' comprehension at the self-learning stage. For Thai students, there is no significant variable in the previous learning style, and this estimation thus cannot identify any factors in promoting comprehension of the self-learning style.

As for variables in the same self-learning style, Q2 "Cognitive load of learning contents" and Q3 "Cognitive load of teaching method" of Thai students are significant at the 1% and 5% significant level, respectively. For Japanese students, although Q3 and Q4 are significant at the 1% level, again Q5 "Motivation towards media and information literacy" has a negative sign at the 5% significance level, which shows that this motivation reduces the level of comprehension. For Thai students, on the other hand, motivations (Q4 and Q5) are not significant at all, which is the same result in the previous section.

(b) Collaborative learning

The collaborative learning stage has two prior stages and thus there are 12 independent variables in the equation. For Thai students, among variables in the traditional lecture style, none is significant, while in the self-learning style, there are two significant variables at the 5% level, namely Q2 "Cognitive load of learning contents" and Q4 "Motivation towards learning contents". The latter, however, has a negative sign, which implies that it is an obstacle promoting comprehension of the collaborative learning stage.

For Japanese students, on the other hand, there are two negative factors, namely Q4 in the traditional learning stage and Q2 in the self-learning stage, both at the 10% significance level. These are obstacles in comprehension at the collaborative learning stage. Q3 in the self-learning and coefficients of Q2 and Q4 at the collaborative learning stage are positively significant.

Based on rigorous panel data analyses, we examine the appropriateness of course design and identify factors that play significantly positive or negative roles in this distance learning project. In the next section, we will summarize the results obtained in these analyses.

4.5. Appropriateness of Course Design

In order to discuss the appropriateness of course design indicated in Figure 1 and Table 1, let us begin with the three styles of course design. The results are summarized in Table 2. As mentioned earlier, in estimating the effect of comprehension of the previous stage(s), Thai students' comprehension at the collaborative learning stage is affected only by that of the two prior stages, while in the self-learning stage, comprehension at the previous learning stage is not significant. For Japanese students, at the self-learning stage as well as collaborative learning stage, comprehension of the previous style is positively significant; while that of two prior stages is not significant.These findings indicate that course designs which consist of three learning stages are better suited to Japanese students.

Table 2: Appropriateness of course design comparing to the prior learning stage

	Thai students		Japanese students	
	Self-learning	Traditional	Self-learning	Traditional
Self-learning				***
Collaborative learning		***	*	

Note: ***, ** and * indicate 1%, 5% and 10% significance level, respectively

4.6. Factors Promoting or Obstructing Comprehension

Factors (Q2, Q3, Q4 and Q5) which promote or obstruct student comprehension are summarized in Table 3, which shows interesting contrasts between Japanese and Thai students. In the table, "direct effect" implies how factors at each learning stage provide a significant effect on comprehension at the same stage, while "indirect effect" refers to those from different learning stage. Regarding the direct effect, for Thai students, two kinds of cognitive load are found significant commonly at all three stages, while two motivations are not significant except Q4 at the traditional learning stage. Thai students gain their understanding better through lecture contents and teaching methods throughout the course, but that motivation had less influence.

Table 3: Factors promoting or obstructing comprehension

	Direct effect			Indirect effect		
				From one previous stage		From two previous stage
Japanese students	T: N	S: N	C: N	T	S	T
Q2 Cognitive load in teaching contents		***	***		[*]	
Q3 Cognitive load in teaching method	***	**	*		*	
Q4 Motivation towards teaching contents	***	***	***	[**]		[*]
Q5 Motivation towards media and information literacy		[**]				
Thai students	T: N	S: N	C: N	T	S	T
Q2 Cognitive load in teaching contents	***	***	***		**	
Q3 Cognitive load in teaching method	***	***	***			
Q4 Motivation towards teaching contents	**	***		[**]		
Q5 Motivation towards media and information literacy	**					

Note 1: ***, ** and * indicate 1%, 5% and 10% significance level, respectively
Note 2: T, S and C stand for Traditional lecture, Self learning and Collaborative learning, respectively.
Note 3: [ ] indicates negatively significant
Note 4: N indicates tables shown Tables 2 and 3 in Natcha [7].

For Japanese students, Q3 are found to be significant at three learning stages, Q4 at the traditional and the self-learning stages, and Q2 only at the collaborative stage. From these, it can be said that the particular teaching method and motivation to learn more about contents promotes their comprehension. However, Q5 is negatively related to comprehension in self-learning, which should have been taken care at the beginning.

Regarding the indirect effect, however, the course design does not promote students' comprehension at three stages for both groups of students, since there are only few significant factors, but also they have negative signs. In particular, Q4 "Motivation towards learning contents" is found to be an obstacle for understanding for both groups of students, although it contributes to comprehension at the same learning stage. Care should be taken for designing courses and selecting contents which are underrated at the next learning stages.

5. Conclusions

In course design, Constructivism theory provided a learning architecture which promoted a more interactive acquisition of knowledge through experiences such as self-learning or collaborative learning. The obstacles to international distance education included timing, language, learning background, knowledge of ICT media accumulated to date, etc. Bloom taxonomy was therefore adopted not only to manage appropriate learning targets and intended learning outcome, but in actual practice, it also helped teachers to estimate student readiness at each step of the new ICT international teaching and learning environment and to rapidly validate the appropriateness of the teaching methods, such as subject content arrangement and instructional strategies.

By utilizing panel data analyses, this study successfully identified not only which parts of course design are appropriate for students' comprehension and which parts are not, but also which factors of cognitive load and motivation enhance or obstruct students' understanding. From the results, we realized complex relashionships of learning perception and respective learning stages. These empirical results indicate that in the same learning environment, Thai and Japanese students had different perceptions of the effect of learning processes and contents on their comprehension. The variation is strengthened in a more complex setting, such as self-learning and collaborative learning.

For Thai students, in contrast, cognitive load (difficulty) was more important than motivation. To decrease cognitive load for Thai students, knowledge checking or controlling the volume of contents in each class during the course should thus be undertaken. In contrast, Japanese students should be provided with teaching content which will promote their eagerness, such as new ideas or challenging activities.

In terms of comprehension among Thai students, cognitive load or difficulty had the strongest influence on comprehension, whereas motivation had the least influence in the same teaching styles with Japanese students. Closer investigation of this interesting result should identify whether the lack of motivation among Thai students is derived from the variation in learning cultures, or from a failure in teaching methods.

Our present results will be of benefit in the development of guidelines for prioritizing learning factors such as contents, processes, materials and ICT media in international learning.

In-school classroom discipline is also one of the important to take more attentention. A class period of 50 minutes seems enough for traditional lecturing classes, but not for self-learning and collaborative learning. Class observation showed that all students experienced difficulty in completing their assignments in time. On several occasions, the teachers of both countries found it difficult to maintain advisory roles in the limited class time and this forced them to return to the traditional style of teaching. Moreover, both Thai and Japanese students lost about 10-15 minutes in transferring to the computer classroom, leaving only 35-40 minutes for the class itself. We therefore recommend the adjustment of times to better match actual in-school classroom conditions, such as by providing a shorter period for each class session and longer term for the whole course.

The combination of various learning methods supported by technology reveals the possibilities of enhancing effective learning in school education. This study found that course design should place a greater emphasis on two-way interactive communication and more real-time. This will assist when teacher manpower in the advisor role is insufficient.

Most students used the WBT and BBS only in the classroom, and only students who were their group representative participated in the BBS. Moreover, the number of teacher as advisors was insufficient, because many of the students required direct advice from teachers. We therefore offer several suggestions which may enhance interaction communication.

- Discussion via the BBS should be made compulsory when interactive communication is considered to be essential, particularly in collaborative learning.
- The interaction of both student-student and teacher-student with technology support in the classroom environment should be more real-time. This will assist when teacher manpower in the advisor role is insufficient.

As an international distance learning, English language for non-native English speaker is one of communication problem. This requirement was to provide students with a good opportunity to integrate their knowledge of English with computer skills. In practice, however, it increased the difficulty in learning. Although an on-line English dictionary or translation software was available, students rarely used it. Observation showed that students of both countries had problems in composing sentences for communication, rather than vocabulary problems. They relied more on the assistance of the teacher assistants in actual classes. Lack of communicative skill seemed a more serious impediment to learning than their actual English level. Promotion of communication skills would therefore be the key to lowering the language barrier.

In addition, An unfamiliarity with teaching methods was a learning obstacle. Although the Japanese students had some experience with technology-enabled distance education, the present study was the first time for the Thai students to experience such a teaching or learning environment. Although the subject

contents were new to all students and their background knowledge level at the beginning of the class was the same, Thai students required the contents with a much lower cognitive load (easier understanding). This in turn suggests that the lower level of experience with ICT teaching or learning environments tended to discourage the adoption of a positive learning attitude. The readiness of students to utilize an ICT-based teaching or learning environment should therefore be considered. Students should be provided with sufficient experience or information by showing a video clip, for instance, of a former class or conducting a trial mock-up.

Regarding to readiness of high school students to self-learning and collaborative learning, Observation showed that if students do not have sufficient self-organization, then self-learning and even collaborative learning may fail in the traditional face-to-face lecture style. Students failed to perform their assigned roles of communication, particularly in the self-learning and collaborative learning styles. They made no effort to confront problems by themselves, but rather waited for the teacher to solve unclear points. Adaptability to self-learning is required. Moreover, in the collaborative learning style, knowledge is acquired through the process of social participation, which is generally experienced in higher education. It appears more difficult for high school students to improve their attitude to learning than for college students, for example. It is thus necessary to acclimate them to collaborative learning methods by using clear assignments and easily understood activities among classmates, such as interactive games or role-play discussion, for example.

Finally, this study attempted to analyze the major potential promoters of learning in practical and consistent manner. However, learning impact is subject the particular characteristics of each country and understanding the actual effects of course design require further studies.

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