PROCEEDINGS 01 117–122
March 2008

The Impact on Academic Ability of Using of an E-Learning System in Elementary School Students: An Evaluation Based on a Panel Survey

Ge WANG, Michiko KUMAGAI,
Yoshiko SAWAI, Akira SAKAMOTO

Global COE Program
"Science of Human Development for Restructuring the 'Gap-Widening Society'"
Ochanomizu University

PROCEEDINGS 01 117–122
March 2008

The Impact on Academic Ability of Using of an E-Learning System in Elementary School Students: An Evaluation Based on a Panel Survey

Ge WANG
Ochanomizu University

Michiko KUMAGAI
Ochanomizu University

Yoshiko SAWAI
Ochanomizu University

Akira SAKAMOTO
Ochanomizu University

Abstract

The internet has widely been used in schools, as have learning support systems that make use of the internet. In Japan, however, few empirical studies have so far been conducted to find out the effect of using such e-learning systems on students' academic ability. In this study, therefore, we have tried to investigate if the use of an e-learning system could improve students' academic ability.

In MITAKA Third Elementary School, a drill e-learning system called "e-school MITAKA Model" has been introduced to fourth, fifth and sixth grade's students. About 150 students used it every week for several months to learn Japanese (language) and arithmetic.

We designied a two-wave survey in order to investigate whether there are any causal relations between the use of the system and academic ability. A panel survey is a method used to establish causal relations by giving an identical questionnaire to the same subjects at several different points in time. In this study, we measured the amount of use of the e-learning system for both Japanese and arithmetic, and the performance scores of the subjects for both disciplines at two time points. The assumption is that if use of the e-learning system can truly improve academic ability, the students who frequently used this system then will show higher academic performance at the second time point, compared with the students who used the system only infrequently at the first time point.

We ran a multiple linear regression analysis using SPSS (ver. 11). The students' sex, grade, the amount of e-learning system use, and academic performance measured at the first time point were taken as independent variables and their academic performance as measured at the second time point as a dependent variable. The results showed that the use of the e-learning system did improve students' academic performance in both Japanese and arithmetic.

Finally, we discussed the limitations of the current study from three view points, and pointed out that this study is meaningful in that it presents empirical findings on the effects of e-learning systems to the Japanese field of research on these systems.

Key words : E-Learning Systems, Academic Ability, Elementary School Students, Panel Survey, "e-Project"

1. Introduction

In recent years, the use of the internet in schools has become increasingly common, and this has led to advances in the use of learning support systems which make use of the internet.

Up until now, a great volume of empirical studies have been carried out, with the purpose of investigating the effect of these e-learning support systems on so-called 'new academic abilities,' such as on the ability of children to utilize information, on their international understanding, and on their capacity for independent learning. Moreover, many of these studies have shown the positive effects of these learning systems (Takahira et al, 2002, Suzuki et al, 2001).

By contrast, there appears to be scant empirical knowledge on the effect of e-learning systems on traditional academic ability - in other words, academic ability within conventional disciplines, such as Japanese and arithmetic.

As such, this study is an attempt to investigate and evaluate the effects of a drill e-learning system, based on the results of a practical trial of the system at MITAKA Third Elementary School in Tokyo, Japan.

1.1 Use of the System at MITAKA Third Elementary School

The e-learning system with which this study is concerned was introduced to the MITAKA Third Elementary School (hereinafter, MITAKA Third) between 2002 and 2003 academic year, as part of the "e! Project" overseen by the Ministry of Internal Affairs and Communications (MIC). The purpose of the "e! Project" was to "create and operate an infrastructure which will make experimental use of cutting-edge technology in order to effectively communicate to Japanese citizens the image of Japan as a global leader in IT." MITAKA City was selected to take part within the field of education, and their project was dubbed the "e! school MITAKA Model."

As part of this project, fourth, fifth and sixth grade students were each provided with a notebook computer, use of which was permitted in classroom during the homeroom classes and break and lunch times. Moreover, a wireless LAN internet service was available in each classroom, meaning that students were able to access the internet with using their notebook computers.

In addition, for terms 1 through 3 of the 2003 academic school year, a drill e-learning support system was introduced, and students used this to study Japanese and arithmetic. This system included the following features : (1) questions are shown automatically on the screen, and after the student scoring more than a certain mark in a drill, the system moves to a more difficult drill; (2) by contrast, if a certain mark is not achieved in a drill, the system moves to an easier drill; (3) students are able to retry questions that were answered incorrectly; (4) students are provided with explanation where necessary; (5) performance is marked automatically, and marks are recorded in a study log, which students can review; (6) the study log is transmitted to the central server, allowing the teacher to review the logs and incorporate them into teaching; (7) teachers can upload original teaching materials on the server, which will then be sent automatically to the students.

Fourth, fifth and sixth grade students used the system for one day each week to learn Japanese, and for one day each week to learn arithmetic, making the total frequency of use two days per week. The system would be used for 15 minutes at a time, in the mornings.

1.2 Panel Survey

We carried out a panel survey in order to determine the effect of using this e-learning support system had on academic ability in Japanese and arithmetic. A panel survey is a method used to establish casual relations, by invesgating same items from giving an identical questionnaire to the same subjects at several different points in time.

There is, in fact, an Experimental technique which has traditionally been used to investigate the effects of learning support systems. In this method, students are randomly separated into multiple groups. One group (experimental group) is then assigned to use the learning system, whilst another group (control group) is assigned not to use the system, or to use learning instead by another kind of method. Then after a period the ability of these two groups will be compared.

However, using this method the students in the control group are not given as much opportunity to learn as the experimental group, and furthermore are being required to learn in a manner which the researcher has assumed to be ineffective. As such, this method is currently meeting with some difficulties, from the dual perspectives of human rights and research ethics.

A panel survey, by contrast, is not burdened by such problems, and is, as such, highly expedient. Many of the evaluative studies that have been carried out on the effect of e-learning systems in recent years have made use of the panel survey method (Takahira et al, 2002, Suzuki et al, 2001).

2. Method

2.1 Subjects

We surveyed 150 students (76 boys, 74 girls in 5 classes) in the fourth, fifth and sixth grades at MITAKA Third. Broken down in school grade, this represented 85 fourth grade students (3 classes, 43 boys, 42 girls), 27 fifth grade students (1 class, 13 boys, 14 girls), and 38 sixth grade students (1 class, 20 boys, 18 girls). A total of 7 classes took part in the practical e-learning experiment, with one extra class from both the fifth and sixth grade, but data on system usage that could be used in our analysis was received from the 5 classes listed above, and it is these, therefore, that form the subject of this study.

Data collectings were carried out during the second and third terms of the 2003 academic year, and the first term of the 2004 academic year. However, whilst the fourth and fifth grade students were able to take part in all three data collectings, the sixth grade students had graduated to junior high school by the time of the third data collecting time. Moreover, data collecting was not carried out in the first term of the 2003 academic year because the system was still in an experimental usage stage.

2.2 Measures

2 sets of variables were measured, namely : (1) the level of use of the learning system for each academic disciplines and (2) academic ability for each discipline.

Level of use : Records of usage were taken each time students used the system. The students filled in details of his or her grade, the discipline, the unit, the name of the learning unit, the date, the frequency, the level and marks achieved , in a log sheet. The supervising teacher collected up the log sheets after each session, and checked whether the details had been filled in correctly.

Data of levels of usage used in this study was gleaned from these log sheets. Specifically, total learning frequencies for each discipline, at each academic term, were accounted every time when the students studied a unit by assuming that each time a unit was completed represented one incident of usage. Levels of usage in Japanese and arithmetic for the second and third terms of the 2003 academic year were used in our analysis.

Academic ability : This study used data on scores from academic tests (for Japanese and arithmetic) carried out in the second and third terms of the 2003 academic year, and the first terms of the 2004 academic years. The CRT standard academic achievement tests set by the academic publisher Toshobunka Ltd. were used in the second term of 2003, the national standard CDT-II achievement tests in the third term of 2003, and the NRT achievement tests in the first term of 2004.

The first two tests represented tests adapted to the required levels for students in each relevant academic grade. The third test was conducted after the students advancing to the next academic grade, although the contents were still about what they have learned at the last academic grade, however, was of a standard required by students in the academic grade below. This is because at the time of this third test, namely in the first term of the academic year, students will still not have covered most of the relevant curriculum. For all three tests, all questions covering areas of the curriculum not yet studied were removed.

This study surveys the same subjects a number of times. As such, the same questions cannot be used. Were identical questions to be used, the results of tests could be greatly affected by that if the students have reviewed the previous tests and then the results of the survey could be significantly disturbed by the influence of the individual difference brought about by, for example, whether or not the subject revised the questions from the previous questionnaire. Meanwhile, we could not find any publishers which provided more than three versions of standardized tests, and as such we used tests from several different publishing companies.

Tests from differing publishers cannot, of course, be described as identical, nor can this even be claimed for the CRT and NRT tests, despite both being from the same publisher. However, all the tests were produced to assess standard levels of knowledge, and can be considered as evaluating academic ability in each discipline, based on the systematic checking of the contents of each relevant textbook, in an unbiased and highly appropriate manner. As such, we considered there to be little risk of any significant discrepancy in terms of the contents of the tests and the academic ability the tests were designed to evaluate.

Moreover, the learning contents of the e-learning system considered by this study were drawn up so as to cover the entire learning curriculum for both subject disciplines comprehensively and systemically. For these reasons, we determined that it would be possible to evaluate the effects of learning supported by the e-learning system by using the tests chosen.

2.3 Procedure

In terms of the levels of usage of the e-learning support system, we used data obtained from log sheets that were completed by the students between the second and third terms of the 2003 academic year. In term of academic ability, we look the score for each of the tests conducted at the mid-period of the second term, the third term of the 2003 academic year and the first term of 2004 academic year.

In terms of the analysis of the effect that the e-learning system had on academic ability, we used the model shown in figure 1. The usage levels and academic ability measured at time of the first test were taken as independent variables, and the academic ability shown at the time of the second test as a dependent variable. By carrying out a multiple linear regression analysis based on this structure, we should be able to provide a solution to this model. The first time was considered to be either the second or third term of 2003, and the second time be either the third term of 2003 or the first term of 2004, respectively, and in doing so we were able

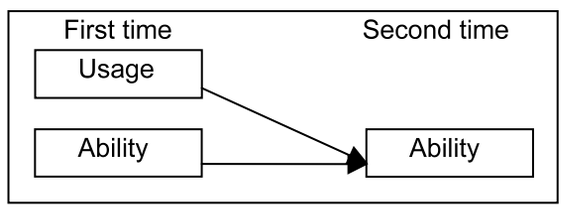

Figure 1. Analysis Model.

to establish solutions for the respective periods. If the use of an e-learning system really is able to improve academic ability, then students with high levels of system usage during the first period should show, by the second time, a greater increase in academic ability than those students who did not use the system as much. This can be displayed by looking at the levels of usage shown for the first time through the multiple linear regression analysis. The analytical software used in this study was SPSS (ver. 11).

3. Results

3.1 Simple tabulation

Firstly, we calculated the average level of e-learning system usage for the different school grades, for the second and third terms of 2003 (see Table 1). On conducting an F test on the average levels for each grade, we saw that the usage levels were different throughout the grades. Table 1 also shows the results of a multiple comparison test.

As the maximum possible marks for the tests used in each school term differed, the figures analyzed were the marks for each term divided by the maximum possible test score. We calculated the average figure for each grade for the second and third terms of 2003, and the first term of 2004, and these are summarized in table 1. Also examination differed throughout each grade and it would be irrelevant to make inter-grade comparison. This is why we have not conducted such comparison.

3.2 Effect of usage

Firstly, in order to investigate the effect of the e-learning system used in the second term of 2003 on academic ability as shown in the third term of 2003, a multiple linear regression analysis was carried out, with the level of usage and academic ability (test scores) in the second term 2003 taken as independent variables, and the academic ability in the third term of 2003 as a dependent variable.

It should also be mentioned that differences in classes could lead to an overevaluation of the effect of levels of system usage. For example, the supervising teacher of one class may be more enthusiastic than teachers of other classes, having the students use the e-learning system more than others. He or she may also be exceptionally gifted as a teacher, which itself may be a factor in increasing academic ability amongst his or her students. In such a case, the effect of usage of the e-learning system, as shown from the multiple linear regression analysis, may in part be due to the enthusiasm and talent of the teacher.

There is, therefore, a need to eliminate the influence of these factors, which may lead to overevaluation. As well as differences in classes, gender is also an important variable, and it is standard practice to eliminate the influence of gender on test results. Moreover, it can be said that removing the differences in classes can also be adapted to remove differences in school grades.

The gender variable is a dichotomous variable, and if this is included in the multiple linear regression analysis as an independent variable, then the influence of gender upon results can be eliminated. Differences in school class, however, represent a five leveled nominal variable, and cannot in general be factored into the multiple linear regression analysis. As such, before carrying out the multiple linear regression analysis, we centeralizedered the data for both usage levels and academic ability so that the average for each class became 0, and thus were able to eliminate much of the influence that class difference might have had.

The results of the multiple linear regression analysis, with gender included into the parameters as an independent variable, showed that, with regard to Japanese, the levels of usage of the e-learning system in

Table 1. Levels of e-learning system usage and academic test scores

		Level of usage							Test score					
		Grade 4		Grade 5		Grade 6			Grade 4		Grade 5		Grade 6	
Subject	Term	*n*	Mean	*n*	Mean	*n*	Mean	*F*	*n*	Mean	*n*	Mean	*n*	Mean
Japanese	2	78	17.01[a]	15	25.27[b]	37	7.24[c]	21.96**	84	.79	25	.78	37	.80
	3	78	13.63[a]	13	19.08[b]	37	2.81[c]	41.54**	82	.80	27	.76	36	.83
	1	—	—	—	—	—	—	—	75	.77	25	.75	—	—
Arithmetic	2	78	15.62[a]	15	21.33[ab]	37	22.78[b]	4.79*	85	.81	26	.74	37	.70
	3	78	8.86[a]	13	22.85[b]	37	2.92[c]	63.56**	83	.86	27	.83	36	.69
	1	—	—	—	—	—	—	—	75	.79	25	.60	—	—

Note : *p<.05, **p<.01. The letters at the top right of the figures shown above indicate the results of the Tukey multiple comparison test. Figures showing the same letters indicate that there is no significant difference. [n] indicates the valid data numbers, excluding missing values, and these are less than the total original number of questionnaire subjects.

the second term of 2003 had a significant effect on academic ability in Japanese in the third term of 2003 (β = .19, df=121, p<.01). Moreover, with regard to arithmetic also, levels of usage of the e-learning system in the second term of 2003 had a significant effect on academic ability in arithmetic in the third term of 2003 (β =.14, df =123, p<.05).

However, the analysis of difference between the third term of 2003 and the first term of 2004 showed that levels of usage in the third term of 2003 had no effect on academic ability in either discipline in the first term of 2004. We also analyzed the differences between the second terms of 2003 and the first term of 2004, but this also showed no effect of the levels of e-learning system usage.

4. Discussions

This study shows that the use of the e-learning system in the second term of 2003 had a significant effect on academic ability in the third term of the same year. Students who used the Japanese language learning system frequently showed improved marks in Japanese, and students who used the arithmetic learning system frequently showed improved marks in arithmetic. This means that the e-learning support system has the ability to improve academic ability. We would like to make the following three points about the knowledge gleaned by this study.

Our first observation is about the limitation of the effect. The results of this study show that use of the Japanese and arithmetic systems served to improve ability only in Japanese and arithmetic respectively. This implies that, although the systems do appear to have the ability to improve academic ability, it still cannot be said that the systems improve overall capability or motivation that transcends the specific learning content.

Moreover, the results show that usage of the systems in the second and third terms of 2003 had no influence on academic ability in the first term of 2004. This seems to suggest that, since usage of the system ended at the close of the third term in 2003, academic ability was influenced by various learning after usage ended, and, as a result, the effect of system usage weakened. This implies that whilst learning with the system may have an effect on that specific learning, it does not have a more general effect on improving academic ability outside of its specific parameters.

This localization of effect may be a result of the e-learning system considered in this study being a drill-based learning system. In the future, in order to investigate this possibility, and to consider how best to improve overall ability and motivation, there should be further examination of how best to use learning support systems and information technologies within schools.

The second point is concerned with the relationship with the effects of computer-aided instruction (CAI). Studies on the effects of CAI learning have been carried out, particularly in the USA, since its introduction, and the positive effects of CAI have been thus proven. In Japan, however, it cannot yet be said that the effects of CAI have been fully substantiated. It is certainly hard to argue that evaluative studies into learning effects have been the main focus of CAI studies in Japan (Kondoh, Nagahata, Imada, 1996), nor can it be said that substantial research has been carried out on this issue. Moreover, it has often been suggested that the methods applied in this kind of research are problematic (Kimura, Yamamoto, Nojima, 1977), and as far as we are aware, there has been no research that can be said to have shown statistical evidence of the effects of CAI.

The system examined by this study made use of the internet, and differed from conventional CAI in a number of ways. For example, (a) data on learning progress was transmitted to a central server, allowing teachers to make reference to it, and (b) teachers were able to upload original teaching material onto the server, from where it would be sent automatically to the students. We can say, therefore, that it represents a strengthening of traditional CAI functions.

However, it cannot be immediately be concluded that the differences in effect between the system observed in this study and more conventional CAI research are grounded in the differing functions of the two systems. Methods of research in the two areas differ (panel study versus experiment), and as such it is not possible to make a direct comparison. There is a need for further research on this issue.

The third point is concerned with the limitations of a panel study. In examining the effect of system usage on academic ability, this study removed the influence of class and gender difference, but the fact remains that there are innumerable other variables, the influence of which cannot be wholly eliminated from the results. This is an overall weakness of using panel studies to examine causal relations.

At the same time, this study gleaned results that showed that (a) system usage levels for Japanese and arithmetic had a clear and positive influence on

academic ability in Japanese and arithmetic, and (b) the effect of usage had disappeared after the end of system usage, and had no effect on academic ability in the first term of 2004. The results of this study, therefore, clearly imply a reflection of the effects of system usage.

In panel studies, it is important to strengthen the conclusions that can be made about casual relations through supplementary discussion and the accumulation of research-based knowledge. Ideally, future research in this area will examine these issues in greater depth.

Putting these issues aside for a moment, however, this study may be considered meaningful in that it has gleaned a set of results that clearly demonstrate the effect that usage of a learning support system which makes use of the internet can have on traditional academic ability, in the context of empirical research in this area being somewhat lacking.

References

Kimura, S., Yamamoto, M., & Nojima, E. (1977) The development of a CAI drill program on positive/negative values and the examination of its effectiveness in practical use, *National Institute for Education the Development and Research of CAI*, 12 : 1-32.) (originally in Japanese)

Kondoh, I., Nagahata, H., & Imada, S. (1996) The effectiveness of traditional teaching methods and computer-assisted instruction upon four categories of students : Teaching basic information technology, *Japan Journal of Educational Technology* 19 (4) : 197-205.)

Suzuki, K., Sakamoto. A., Adachi, N., Kimura, F., Mori, T., Sakamoto, K., Takahira, M., Kobayashi, K., & Kashibuchi, M. (2001) The effects of the Internet use on international understanding : A panel study of high school students, *Transactions of Japanese Society for Information and Systems in Education* 18 (3 • 4) : 398-409.)

Takahira, M., Sakamoto, A., Kobayashi, K., Kashibuchi, M., Adachi, N., Sakamoto, K., Mori, T., Suzuki, K., Kimura, F., Sakamoto, T. (2002) The effect of Internet use in non-class time on high school students' information literacy, *Transactions of Japanese Society for Information and Systems in Education* 19 (4) : 212-217.)

(Notes)

1 The system introduced was the '*Rainzu e raiburari gakkō intānetto tokubetsu-ban pokettsu* 2' (the Lines E! Library : School Internet Special Edition - Pocket 2)

Acknowledgements

This research was carried out as part of the "e! Project" overseen by the Ministry of Internal Affairs and Communications, contracted to our research group as part of the 2005 "Investigative Research on the Utilization of IT in Education" by NTT Communications. We would like to extend our heartfelt thanks to the principal of the MITAKA Third Elementary School in Tokyo, Mr. Masao Sugiyama, as well as all of the staff. We would also like to thank Mr. Katsumi Oshima, Center Chief of the Mitaka Education Center, for his support.

This article was translated from the Japanese paper whose bibliographical information is : Wang, G., Kumagai, M., Sawai, Y., & Sakamoto, A. (2006) The impact of use of an e-learning system on academic ability in elementary school students : Evaluation based on a panel survey. Japan Journal of Educational Technology, 29 (suppl.), 45-48.

Author Note

Ge WANG
Student of Doctoral Course, Graduate School of Humanities and Sciences, Ochanomizu University
E-mail : g0670323@edu.ocha.ac.jp

Michiko KUMAGAI
Editional staff, Kongo Shuppan, Ltd

Yoshiko SAWAi
Director, Child Labo

Akira SAKAMOTO
Professor of Social Psychology Ph. D, Graduate School of Humanities and Sciences, Ochanomizu University
E-mail : sakamoto.akira@ocha.ac.jp