Computer vs. Paper: Which works best for language learning?

Computer vs. Paper: Which works best for language learning?

*LEIS Adrian and **ERMANOV Davron

Abstract

In this study, we investigate the benefits of using computer technology to assist language learning in a Japanese university English as a foreign language (EFL) classroom. Lessons were conducted introducing the conditional forms of English grammar (i.e., *if* clauses) to two groups: one taught using the traditional paper and the chalkboard and the other using computer presentation software without the use of any paper. Statistical analyses were conducted in order to discover whether there were any salient advantages to using paper-based materials in the lesson. Although statistically significant differences were observed between the pre- and posttests for both the group being taught in the traditional manner ($t(22) = 2.25$, $p = .04$, $d = .62$) and the group being taught using presentation software ($t(15) = 3.15$, $p < .01$, $d = 1.07$), no significant differences were observed between the two groups at the posttest stage, $t(37) = .45$, $p = .65$. The authors conclude that there seem to be no clear advantages to using paper-based materials in language instruction, and the use of computer presentation software allows more interaction between teachers and students, creating a more personalized learning atmosphere, which may lead to greater improvements in such environments over a longer period of time.

Key words：Computer-assisted language learning （CALL）（コンピューター支援語学学習）
Educational technology（教育工学）
EFL in Japan（日本における英語教育）
University students（大学生）

Introduction

Since the introduction of language laboratories in the late 1950s, the use of electronic devices in education, especially language learning, has seen several changes and transitions. The increased affordability of computers for members of the general public in the 1980s and revolutionary changes in operating systems such as Windows 95, Windows 98, and Windows Millennium Edition in the 1990s and turn of the century played major roles in changing the approach toward education by both teachers and students alike. Whereas in the past, lecture notes, for example, would have to be copied by hand or photocopied, with the increased availability of computers, data could be easily transferred onto floppy disks or sent by email. Since the first decade of the 21st Century, an increase in the use of smartphones and tablet computers has been seen, especially since the release of the iPad in 2010, which in turn has also resulted in many educators using these devices in their

＊ Department of English Education
＊＊ Academic Lyceum under the University of World Economy and Diplomacy

classrooms and researchers conducting studies to investigate whether there were any salient advantages in using such devices in learning.

In the present paper, we aim to give a further contribution to the field of computer-assisted language learning (CALL) by reporting a quasi-experimental study conducted with Japanese university students to compare their understanding of a grammatical feature of the English language and whether there were any distinct benefits in using paper-based materials in language learning.

Literature Review

Several researchers have investigated the use of computers in education in comparison to paper-based classes. Early studies argued that paper-based materials were favorable for increasing students' proficiency and understanding in their chosen fields. Wayne (2003), for example, suggested that the comprehension scores of university students working in self-study were significantly higher for those reading printed material than

Table1　Literature Comparing Learning Centered on Digital Materials and Paper Materials

Author/s	Year	Paper / Digital	Summary
Wayne	2003	Paper	Reading printed materials resulted in higher comprehension than reading material on a computer screen
Wästlund, Reinikka, Norlander, & Archer	2005	Paper	Using computers for presentations resulted in weaker performances and higher accuracy
Kenning	2007	Paper	Mobile phones were viewed as distractions by students when studying
Leis	2014	Both	Students with lower motivation tended to view mobile phones as devices for fun, not education, however students with higher motivation enjoyed using such tools for learning
Koyama & Takeuchi	2004	Both	Although students appeared to make more effort when using electronic dictionaries, no statistically significant differences could be observed in vocabulary tests
Hassaskhah, Barekat, & Farhang Asa	2014	Both	Paper material seemed to lead to higher reading comprehension, however, digital technology provides many functions that should be embraced by instructors
Ashcroft & Cvitkovic	2015	Both	Digital methods were effective for vocabulary acquisition in lower proficiency learners, but both paper and digital brought benefits for those with high proficiency
Teich	1991	Digital	Using computers improved learning while also allowing instructors to use time more efficiently
Warner	1996	Digital	Using digital materials improved the efficiency with which students work
Thornton & Houser	2005	Digital	Students showed a preference for mobile technology for learning vocabulary compared to paper-based materials
Chu, Hwang, Tsai, & Tseng	2010	Digital	Using mobile technology increased students' learning motivation
Dziemianko	2010	Digital	Using electronic dictionaries resulted in higher vocabulary acquisition in both receptive and productive tasks compared to paper dictionaries
Hwang & Chang	2011	Digital	Using mobile technology provided a more authentic environment for learning
Gitsaki & Robby	2014	Digital	The use of tablet computers in EFL classrooms brought about positive effects on exam results, second language learning motivation, and more active participation in class
Leis, Tohei, & Cooke	2015	Digital	Students encouraged to use smartphones for educational purposes showed more signs of autonomy in comparison to students in classes in which digital technology was not used

those reading texts presented on computer screens. In a similar way, Wästlund, Reinikka, Norlander, and Archer (2005) reported through a study conducted with university students in Sweden that the use of computer technology for presentations weakened performance as well as increasing anxiety felt by participants. More recently, however, with the increasing availability of computers, and especially smartphones and computer tablets, the pattern of results has changed with some studies promoting the use of computer technology in learning. For example, Chu, Hwang, Tsai, and Tseng (2010) gave evidence to support an approach using mobile technology with elementary school students discussing that mobile devices brought about favorable effects for improving students' motivation to learn as well as in their scholastic achievements. The results of Hwang and Chang's (2011) study strengthened these findings, concluding that the use of mobile devices in the classroom were favorable for reinforcing "the learning achievements of the students when they are situated to learn in a real-world environment" (Hwang & Chang, 2011, p. 1029). Table 1 displays examples of literature comparing learning centered on digital materials and paper materials.

Although Table 1 suggests the majority of literature encourages the use of computers and electronic devices for educational purposes, from the authors' observations of general classes, a large majority of instructors appear to still prefer paper for teaching. Therefore, in the present study, we aim to gain a deeper understanding to the following research question:

Does teaching using paper lead to higher understanding of grammatical features of language?

The Study

Participants

A total of 39 first-year Japanese university students (i.e., average age = 18.62) participated in the present study, of which 32 were female and seven were male. All participants majored in education with specialist fields of Early Childhood (i.e., 9 students), Children and Culture (i.e., 7 students), Pedagogy (i.e., 12 students), and Educational Psychology (i.e., 11 students). Because students were in their first year of university, they had all experienced six years of compulsory English education at junior and senior high school. None of the participants had lived abroad for longer than six weeks and their average score on the TOEIC test was 432.95 (SD = 108.40) suggesting their English proficiency to be low-intermediate to intermediate.

Procedure

The present study followed a pretest-posttest design. In the first week of the experiment, all participants were required to take an English proficiency test created by the authors. The test was conducted online using the free software Google Forms® and marking application, Flubaroo® to ensure accurate marking. The test consisted of 40 multiple-choice items, including 20 distractors and 20 items focused on conditionals (i.e., *if* clauses). Conditionals were focused upon in the present study as several researchers have previously discussed these as difficult grammatical forms for Japanese learners of English (e.g., Suzuki, Leis, & Itagaki, 2014). Two groups (i.e., Computer Group and Paper Group) were created based on participants' scores on the conditional items in the pretest. The students were instructed to attend class at the designated time set by the authors. Due to some students being unable to attend certain set times, the group numbers were slightly unbalanced with the Computer Group (i.e., 16 students) having

Table 2　Statistical Descriptions of the Computer and Paper Groups

Group	Number	Age	TOEIC Score	Pretest Score
Computer	16	18.69 (1.08)	440.63 (119.27)	8.22 (2.56)
Paper	23	18.57 (.79)	427.61 (102.59)	8.31 (2.70)

Note. Standard deviations are shown in parentheses.

less participants than the Paper Group (i.e., 23 students). The two groups were statistically balanced for both scores in the pretest (p = .91) and their English proficiency according to the TOEIC Test (p = .72). Table 2 displays the statistical descriptions for the two groups.

One week after the pretest, students participated in either a class in which conditionals were taught using only a paper handout and the chalkboard or via a PowerPoint® presentation without any paper being given to students. A detailed description of the lessons is provided in the Intervention section below. Immediately after the lessons, students were once again given the same English proficiency test conducted at the pretest stage of the study. Results were analyzed using SPSS Version 22 to check for any statistically significant differences in the posttest scores between the two groups.

Intervention

Two varieties of lessons were taught in the present study. Each lesson focused on three varieties of conditional sentences, the first conditional (e.g., If you go to Australia next December, it will be very hot), the second conditional (e.g., If you went to Australia next December, it would be very hot), and the third conditional (e.g., If you had gone to Australia last December it would have been very hot). Both 40-minute lessons were conducted using the exact same procedure by one of the authors who was not the students' regular English teacher. The lessons began with a simple introduction of the instructor, followed by explanations of the three varieties of conditionals and interaction between the teacher and students to confirm understanding of lesson content. The lessons concluded with a summary of the main points of the three varieties of conditionals.

The main difference between the two lessons was at the explanation stage. In the first lesson, which was taught to the Paper Group, the instructor used the chalkboard to show the different usages of conditionals (see Figure 1). Students were also given handouts on paper with several example sentences and cloze tests to confirm students' understanding of the conditional form. An advantage of using the chalkboard was that the teacher's notes remained on the board while he was explaining other varieties of conditional clauses. This meant that students were able to compare the three forms, increasing the possibility of a clearer understanding of the differences. However, the authors also hypothesized that weaknesses would also be found with using the chalkboard. For example, the teacher's writing may not be clear or large enough and, due to the time taken to write on the chalkboard, explanations may need to be done hastily in order to finish the class within the designated time.

Figure 1. Teaching varieties of conditionals to the Paper Group.

In the class conducted with the Computer Group (see Figure 2), on the other hand, explanations were conducted only using presentation software (i.e., PowerPoint®). Unlike the Paper Group, example sentences and cloze test items to confirm understanding were not distributed to students. The authors hypothesized that the advantage of this approach would be that, due to the example sentences and explanations already being prepared in the presentation slideshow, the instructor would have more time to spend teaching detailed points of each conditional clause. Thus, a more salient understanding on behalf of the students would be achieved. However, because in a presentation slideshow previous slides are no longer visible for students to compare the varieties of conditionals, students may become confused when trying to recall the main points of the lesson later on.

Students in both groups were required to complete the posttest immediately after their lessons had been completed.

Figure 2. Teaching varieties of conditionals to the Computer Group.

Results

In the research question in the present study, the authors ask whether there is any statistically significant advantage for students studying grammatical features of language using a chalkboard and paper. The authors predict that although using the chalkboard and paper does bring some advantages as discussed above, the ability to use animation through presentation software and such an approach saving time for the teacher both before and during class would result in better understanding for the Computer Group thus significantly higher scores in the posttest.

First, paired-samples t tests were conducted to compare the pre- and posttest results for each group to measure whether participants were able to make significant progress in their understanding of conditionals. Table 3 displays the statistical descriptions of these analyses. The tests were significant, with the Computer Group being significantly higher at the posttest stage (M = 11.38, SD = 2.90) in comparison to the pretest (M = 8.31, SD = 2.70), $t(15) = 3.15$, $p = .007$, $d = 1.067$ and the Paper Group at the posttest stage (M = 10.74, SD = 5.04) also being significantly higher than the pretest stage (M = 8.27, SD = 2.56), $t(22) = 2.25$, $p = .035$, $d = .618$. Although the tests were significant, overlaps were observed in the 95% Confidence Intervals of both groups.

Second, to test the hypothesis made by the authors at the beginning of this section, an independent-samples t test was conducted in order

Table 3 Statistical Descriptions for the Pre- and Posttests

		Pretest		Posttest	
Group	Number	Mean	95%CI	Mean	95%CI
Computer	16	8.31 (2.70)	[6.89, 9.75]	11.38 (2.90)	[9.17, 13.57]
Paper	23	8.27 (2.56)	[7.11, 9.32]	10.74 (5.04)	[8.91, 12.58]

Note. Standard deviations are displayed in parentheses; 95%CI: 95% Confidence Intervals.

to confirm any statistically significant differences at the posttest stage of the study. The test was not significant, $t(37) = .45$, $p = .65$, with a wide overlapping range of 95% confidence intervals suggesting that there were no clear statistical differences between the two groups at the posttest stage. In order to confirm a type II error (i.e., reporting no statistically significant differences when in fact they may exist) had not been made, a post hoc power analysis was conducted using Faul and Erdfelder's (1992) software package G*Power. The results revealed there was more than sufficient power (i.e., $1 - \beta = .88$) to conclude that no such error existed and there was indeed no statically significant difference in the posttest scores of the two groups.

Discussion

The purpose of this study was to compare English grammar lessons taught to EFL students by either using a chalkboard and paper or presentation software, in order to develop a deeper understanding of whether either of these approaches shows a salient advantage over the other from the perspective of effectiveness for learning. The results suggest that, on the basis of one 40-minute lesson, there were no statistically significant differences between the two groups at the posttest stage of the study. Several topics of discussion can be raised based on the results and observations during the intervention.

First, the length of the study may have been too short. Several previous studies (e.g., Sasaki, 2011) suggest that in order for significant developments to be seen in students' motivation and proficiency in English writing, an intervention of at least one university semester (i.e., three months) would be required. Therefore, in order for a clear gap to become apparent in the levels of understanding due to studying in a traditional learning environment or a paperless one making use of digital technology, a longer time frame will be necessary for future studies.

Furthermore, although there were no significant differences between the two groups at the posttest stage of the study, the levels of significance and effect sizes of the difference between the pre- and posttests were much greater for the Computer Group than the Paper Group. With a longer time span, not only of the study itself, but the actual lessons as well (e.g., 90 minutes rather than 40 minutes as was the case in the present study), significant improvements at the posttest stage may be seen for the Computer Group.

Second, based on observations of the lesson by the authors, the instructor appeared to have more time to give personalized instruction for the Computer Group. Keefe (2007) defines the philosophy of personalization as "learner-centered －the learner must be involved" (p. 221) and a personalized learning environment as one that is "designed to foster collaboration and reflective conversation" (p. 221). In the lessons conducted in the present study, much time was wasted with the instructor writing examples on the chalkboard for the Paper Group. This resulted in chunks of silence in which students were waiting for the instructor to finish writing. As a result, the teacher was unable to complete all of the example sentences and quizzes he had prepared and had to rush through the explanation of the third conditional due to lack of teaching time. On the other hand, in the Computer Group, because the example sentences had already been prepared on presentation software, students were allowed more time to practice all the example sentences and quizzes as well as receive a thorough explanation of the third conditional. The extra time in the class conducted with the Computer Group allowed the instructor to give more personalized instruction, answering the call of researchers such as Keefe to increase this vital aspect of education.

Third, because the Computer Group was taught

in a paperless environment, the preparation on the teacher's behalf was limited to preparing the presentation slides. In the case of the Paper Group, more time was required in order make the paper handouts for students. Although electronic handouts were not distributed to the Computer Group in the present study, it would be possible for this to be done by using classroom management applications (e.g., Google Classroom). Such applications would allow instructors to either distribute the handouts to students via email or provide links for students to download the handouts at their discretion. A simple observation of a typical Japanese university classroom makes it clear that a great majority of students now own smartphones. Because students are able to access the electronic handouts anytime they have their smartphones on hand, there are increased opportunities for learning.

Conclusions

The question of whether using computer technology is beneficial for learning in an EFL environment has received much attention over the past number of years. Whereas some teachers prefer a traditional approach, using the chalkboard to display main points and providing paper handouts to students, others tend to adopt a more modern approach, using presentation software with some of these teachers distributing electronic handouts via email or classroom management applications. In the present study, although no significant differences were observed in the posttest between the two groups, it has been discussed that using presentation software helps the instructor prepare for class in a more efficient way and provides students with opportunities to access the class notes any time they wish.

Whether the traditional approach or the digital approach is more advantageous for students' learning is still up for debate and further research is necessary. The authors wish to emphasize, however, that in our opinion, computer technology, such as the presentation software described in the present study, should not be the center of the lesson, but simply an aide to allow teachers to give more individualized instruction to their students. When technology becomes the focus of lessons, students can become distracted, disturbing their capability to learn. With the appropriate use of technology, therefore, we believe a classroom environment can be established that promotes learning in ways that meet the needs and learning styles of each individual student.

Acknowledgements

The authors wish to thank the students who participated in the experiment.

References

Ashcroft R. J. & Cvitkovic, R. (2015, June). *Digital flashcards: Quizlet versus paper.* Paper presented at the annual meeting of JALTCALL, Fukuoka, Japan.

Chu, H. C., Hwang, G. J., Tsai, C. C., & Tseng, J. C. (2010). A two-tier test approach to developing location-aware mobile learning systems for natural science courses. *Computers & Education, 55*(4), 1618-1627.

Dziemianko, A. (2010). Paper or electronic? The role of dictionary form in language reception, production and the retention of meaning and collocations. *International Journal of Lexicography,* 57-60.

Faul, F., & Erdfelder, E. (1992). GPOWER: A priori, post-hoc, and compromise power analyses for MS-DOS [Computer program]. *Bonn, FRG: Bonn University, Department of Psychology.*

Gitsaki, C., & Robby, M. A. (2014). Post-Secondary Students Using the iPad to Learn English: An Impact Study. *International Journal of Mobile and Blended Learning (IJMBL), 6*(4), 53-74.

Hassaskhah, J., Barekat, B., & Farhang Asa, N. (2014). Reading performance of Iranian EFL learners in paper and digital texts. *The Journal of Teaching Language Skills, 6*(1), 1-21.

Hwang, G. J., & Chang, H. F. (2011). A formative assessment-based mobile learning approach to improving the learning attitudes and achievements of students. *Computers & Education, 56*(4), 1023-1031.

Keefe, J. W. (2007). What is personalization? *Phi Delta Kappan, 89*(3), 217-223.

Kenning, M. M. (2007). *ICT and language learning: From print to the mobile phone.* Pagrave MacMillan.

Koyama, T., & Takeuchi, O. (2004). How look-up frequency affects EFL learning?: An empirical study on the use of handheld-electronic dictionaries. *Proceedings of the CLaSIC 2004 Conference,* 1018-1024.

Leis, A. (2014). Encouraging autonomy through the use of a social networking system. *JALTCALL Journal 10*(1), 69-80.

Leis, A., Tohei, A., & Cooke, S. (2015). Smartphone assisted language learning and autonomy. *International Journal of Computer-Assisted Language Learning and Teaching 5*(3), 75-88.

Sasaki, M. (2011). Effects of various lengths of study-abroad experience on Japanese EFL students' L2 writing ability and motivation: A longitudinal study. *TESOL Quarterly, 45*(1), 81-105.

Suzuki, W., Leis, A., & Itagaki, N. (2014). An investigation into effects of feedback through grammar explanation and direct correction in second language writing. *Annual Review of English Language Education in Japan, 25,* 49-63.

Teich, P. F. (1991). How effective is computer-assisted instruction? An evaluation for legal educators. *Journal of Legal Education, 41*(3/4), 489-501.

Thornton, P., & Houser, C. (2005). Using mobile phones in English Education in Japan. *Journal of Computer Assisted Learning, 21,* 217-228.

Warner, R. (1996). Teaching Electronically: The Chicago-Kent Experiment. *Seattle U. L. Rev., 20,* 383-400.

Wästlund, E., Reinikka, H., Norlander, T., & Archer, T. (2005). Effects of VDT and paper presentation on consumption and production of information: Psychological and physiological factors. *Computers in human behavior, 21*(2), 377-394.

Wayne, J. C. (2003). *Relationship between text display method and college student short-term knowledge retention during self-study* (Doctoral dissertation, Dissertation. East Tennessee State University).

（平成27年 9 月30日受理）