Research Note

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Comparing Computer-based and Paper-based DDL in the Beginner Level English Classroom[1]

Kiyomi CHUJO, Kathryn OGHIGIAN** and Asako UCHIBORI****

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Abstract

To shed light on the relative merits of direct computer access data-driven learning (DDL) and paper-based DDL used at the beginner level and how each approach might affect learning outcomes, pre-test and post-test scores were compared, and student feedback was collected in this study.

Keywords: Data-driven Learning, Concordancing, Computer-based DDL, Paper-based DDL, Beginner Level

1. Introduction

Although there have been advances in the use of corpora in L2 classrooms (Thomas & Boulton, 2012; Boulton, 2013)[1),2)], there is an on-going discussion about, and a lack of empirical studies on, whether or not computer-based data-driven learning (DDL) can be effective at the beginner level, meaning, with the learner having control of the learning process by direct access to corpora, or if the use of paper-based DDL might be just as or more effective.

We know already from the literature that there are advantages for each approach (Stevens, 1995; Leech, 1997; Tomlinson, 1998)[3),4),5)], and we confirmed the computer-based advantages in our earlier studies. Chujo & Oghigian (2008)[6)], Chujo, Anthony & Oghigian (2009)[7)], and Oghigian & Chujo (2010)[8)] demonstrated that computer-based DDL using a parallel corpus and a blend of teacher- and learner-centered learning can be effective at the beginner level. With direct computer access, students can discover patterns in the language. Keying search terms into the computer themselves helps them to remember and build vocabulary, and they learn to use a valuable tool for future queries. In contrast, paper-based DDL can cover more material in less time so it saves time, teachers can limit the tasks to narrow the focus which is particularly important for beginner level learners, and both the computer and software are taken out of the equation, eliminating IT problems. Not all schools have facilities for computer-based learning, and not all teachers and students are comfortable with technology-based instruction.

Since both approaches have clear advantages, we were curious to understand if the same curricular goals (identifying and producing noun and verb phrases) could be achieved with one or the other approach, or if one approach enabled students to make greater gains.

In this study, the pre- and post-test gains between a group using computer-based DDL and another using

*Professor, Department of Liberal Arts and Basic Sciences, College of Industrial Technology, Nihon University
**Adjunct Lecturer, Center for English Language Education for Science and Engineering, Waseda University
***Associate Professor, Department of Liberal Arts and Basic Sciences, College of Industrial Technology, Nihon University

paper-based DDL were compared. This study hopes to shed light on the relative merits of direct computer access and paper-based approaches, and how these might affect student learning outcomes.

2 . Nihon University DDL Study

In Japan, students and employees typically take TOEIC (Test of English for International Communication) tests to measure English proficiency. Chujo (2003)[9] and Uchibori, Chujo & Hasegawa (2006)[10] identified the vocabulary and grammar that typically appears in TOEIC tests and investigated how this compares to the vocabulary and grammar taught in Japanese junior and senior high schools. They found, not surprisingly, that there was a gap, and what we now call the Nihon University study was implemented to teach this vocabulary and grammar to beginner level university students. By beginner level, we mean students who score about 70 out of 100 on the TOEIC Bridge Test. This is similar to a TOEIC 324 -350 range.

The goals are developing basic vocabulary for communication and understanding the basic concept of noun phrases (NPs) and verb phrases (VPs) through DDL. Students are using a Japanese-English parallel corpus tool (Paraconc, Barlow, 2004)[11], a bilingual newspaper corpus (Utiyama & Isahara, 2003)[12], and carefully constructed worksheets.

As shown in **Table 1**, we have been using this DDL program for several years. Beginning in 2005, a four week pilot study focused on TOEIC vocabulary. In 2006, we added grammar and expanded to ten weeks. In each year since, the program has been run for twenty weeks. We have made various pedagogical modifications each year.

We continued each year because of positive feedback from students, as well as seeing gains they have made each year in identifying and producing NPs and VPs. In 2010, we introduced paper-based DDL. In this current paper, we compare the results of 2009 computer-based lessons and 2010 paper-based lessons.

3 . Case Study

3.1 Participants

In both 2009 and 2010, the participants were beginner level engineering students. The average TOEIC Bridge Test score of 2009 was 69 points out of 100 and that of 2010 was 73 points.

The main difference between the two groups was the 2009 group used computer-based DDL (hereafter computer-based DDL group) and the 2010 group used paper-based DDL (hereafter paper-based DDL group). For both groups, classes met weekly for ninety minutes in a CALL classroom for a total of twenty weeks. Both groups followed the same syllabus and same procedure except that the computer-based DDL students worked on computers and the paper-based DDL students worked on paper printouts of computer screens. Each group had twenty-five students. Both groups studied the same vocabulary using a CALL program.

We were curious about how computer-based DDL students would respond to paper-based DDL exercises, and vice versa. Thus for the computer-based DDL group, ten tasks in the second term were given as paper-based tasks. For the paper-based group, ten tasks in the first two lessons were computer-based, and eighteen subsequent lessons were paper-based. We measured gains with the same pre- and post-tests for both groups and collected student feedback about both approaches.

Table 1 Nihon University DDL Study

Year	Development	Length
2005	Pilot study : vocabulary DDL lessons	4 weeks
2006	Pilot study : vocabulary+grammar DDL lessons	10 weeks
2007	Pedagogical modifications	20 weeks
2008	Continued modifications	20 weeks
2009	Computer-based DDL lessons	20 weeks
2010	Paper-based DDL lessons	20 weeks

3.2 Syllabus

Table 2 shows the DDL syllabus. Starting with lexical-based concepts, such as identifying word classes and derivations, then we teach noun phrases in the spring and verb phrases in the fall term. The vocabulary taught in previous lessons is used as the DDL search terms in each current lesson. Students begin with vocabulary, so vocabulary is always taught first and is spiraled through the curriculum. Just as the grammatical structures are grouped by category, the vocabulary is also grouped by topic, such as business, personnel, travel, time, and daily life.

3.3 Teaching Procedure

In each ninety minute class, students start with vocabulary. This vocabulary activity lasts thirty minutes. Students learn twenty new words in each class. This CALL program is based on the TOEIC vocabulary study mentioned earlier (Chujo, 2003)[13]. The same vocabulary is used in the grammar exercises, for example, seven of the twenty words are used in the grammar-based DDL exercises. Both the computer-based and paper-based groups use this same CALL program.

Both groups follow the same 4-step procedure shown in **Table 3**. First they explore seven of the twenty vocabulary words in a specific grammar context with DDL. The teacher then explains the grammar so students can confirm or correct the hypotheses they made about the grammar. In Step 3, they do practice and consolidation as homework. In Step 4, they do production work also as their homework. In the next section, these steps are explained in more detail.

3.3.1 Step 1 DDL Exercises

For the computer-based group, students are working in pairs, sitting in front of computers. They each have a worksheet that has a list of very specific tasks. They type in a search term into the computer software and then examine the results. They make a hypothesis about the grammar, and then go to the

Table 2 DDL Syllabus

Week	Spring Semester		Fall Semester	
	Grammar	Vocabulary	Grammar	Vocabulary
1	(Pre-test)			Vocabulary [11]
2		Vocabulary [1]	VP : intransitive & transitive	Vocabulary [12]
3	Word classes	Vocabulary [2]	VP : transitive SVOO	Vocabulary [13]
4	Derivations and inflections	Vocabulary [3]	VP : gerunds and infinitives	Vocabulary [14]
5	Non-count nouns	Vocabulary [4]	VP : *that* clause	Vocabulary [15]
6	NP : article+adjective+noun	Vocabulary [5]	VP : *wh*-clause.	Vocabulary [16]
·	·	·	·	·
10	NP : followed by *to*	Vocabulary [9]	VP : *remain/seem*	Vocabulary [20]
11	NP followed by *-ed*, *-ing*	Vocabulary [10]	VP : agreement	
12	NP followed by *who*, *which*, *that*		(Post-test)	

Table 3 Grammar Teaching Procedure

Step 1	Hypothesis formation through inductive DDL exercises
Step 2	Explicit explanations from the teacher to confirm or correct these hypotheses
Step 3	Hypothesis testing through follow-up exercises (homework) and teacher feedback for the homework
Step 4	Production through follow-up exercises (homework) and teacher feedback on homework

next task. The paper-based students follow the same procedure, working in pairs, but they are looking at printed concordance lines on a paper. They do not use a computer ; they are not typing any words or sorting any results.

Fig. 1 shows a sample of a computer-based

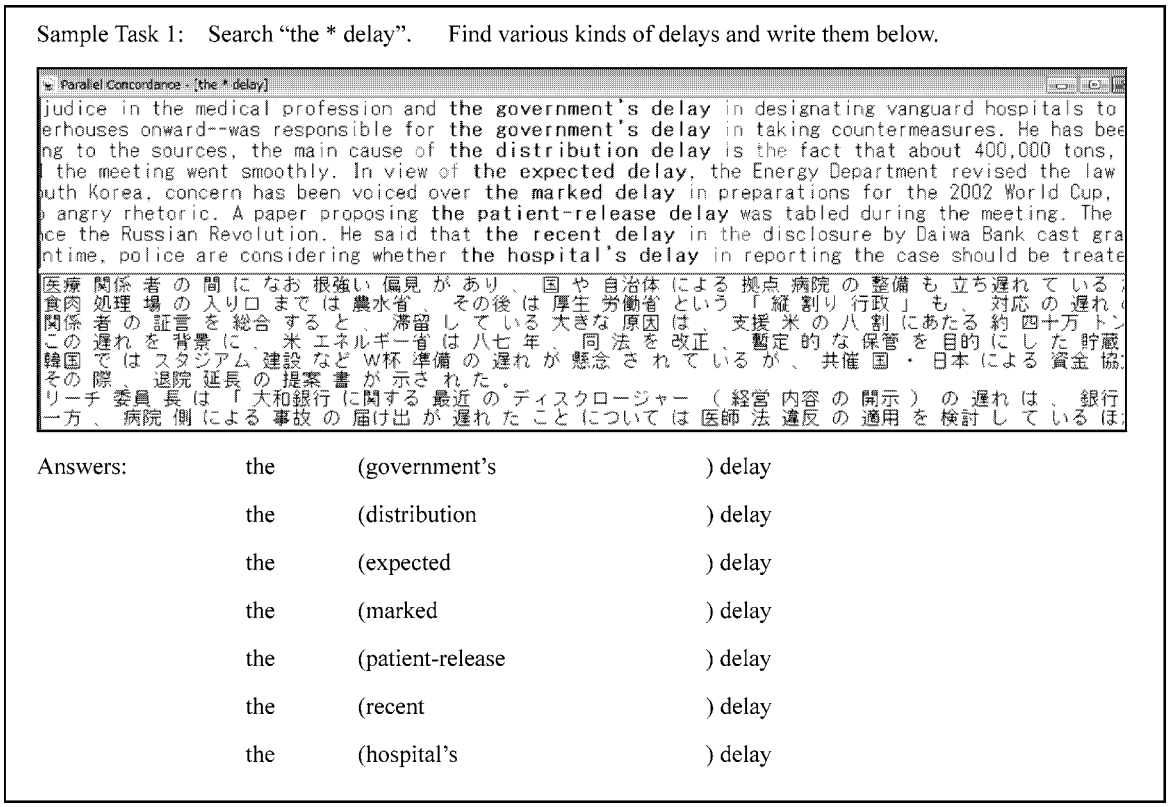

Fig. 1 Computer-based Guided Grammar Exercise

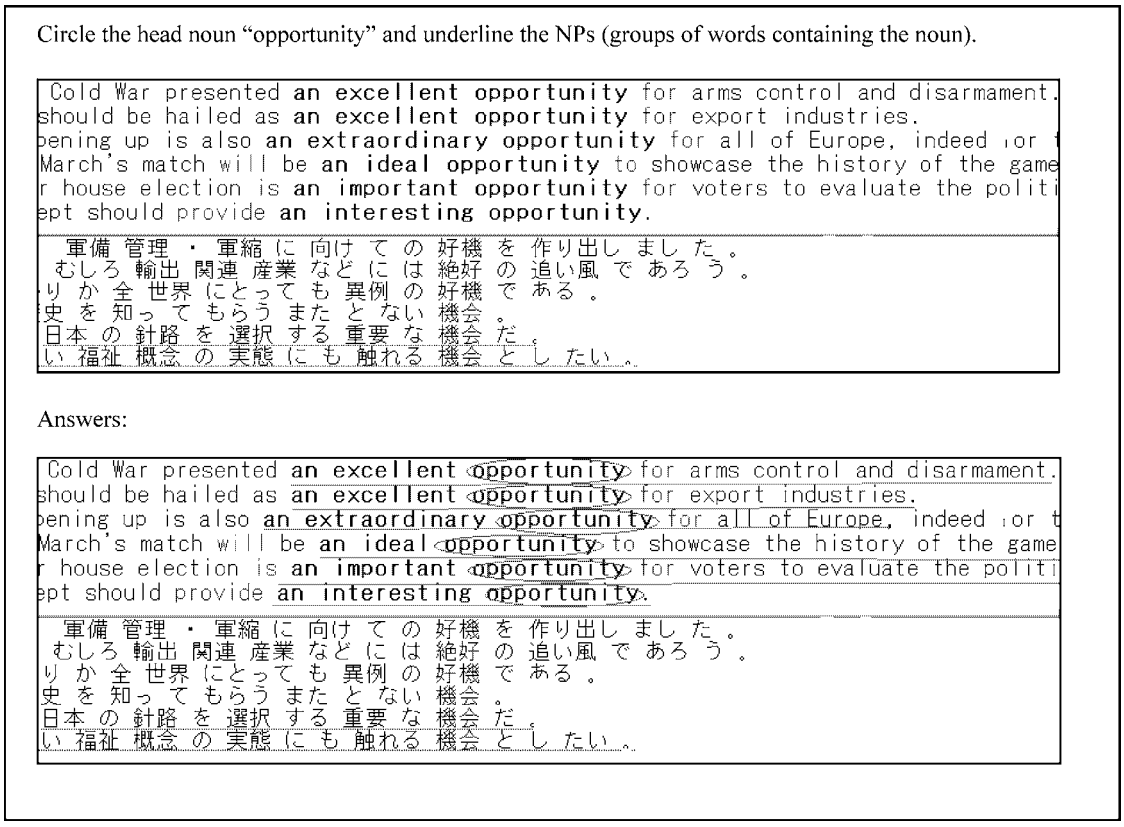

Fig. 2 Paper-based Guided Grammar Exercise

exercise. Students are given five or six similar tasks in one DDL lesson. In this example, students type in "the 〈wildcard〉 delay" and they see the concordance lines on a computer screen. This task is to find types of delays, and they write answers such as the *government's* delay, the *distribution* delay, the *expected* delay, and the *marked* delay. From this and other similar tasks, they hypothesize that the structure of these NPs is "article＋premodifier＋noun" and that various premodifiers such as possessive *'s*, noun, *-ed* and adjective appear between the article and the head noun. We focus on premodifiers in this task, and a sample task of postmodifiers is shown in the next paper-based exercise. The answers are provided for the reader and are not included on the student version.

Fig. 2 looks very similar to Fig. 1, but for this paper-based task, there is no computer. Students using paper-based DDL follow exactly the same classroom procedure but are looking at concordance screenshots fitted onto a worksheet, not a computer screen, and they are not interacting with the corpus. The concordance lines are in color. They are from the same Japanese-English newspaper parallel corpus. Some concordances were given with Japanese translations and others were not. In this sample task, taking one step ahead, students are asked to circle the head noun and underline the NP containing the word "opportunity" with both premodifiers and postmodifiers. In this case, they are looking at various adjectives modifying the head noun and postmodifiers such as prepositional phrases and to-infinitives.

3.3.2 Step 2 Grammar Explanation

When students finish all tasks on their worksheets, the teacher gives an explanation of the grammar so

[NP	(Determiner)	(Premodifier)	Head Noun	(Postmodifier)]
	article	adjective		prepositional phrase
	quantifier	-ing		-ing/-ed
	numeral	-ed		relative clauses

Fig. 3 Grammar Explanation Used for Introducing the General Structure of the NP

Unit 12　　Personnel 1　VP (Transitive SVOO)　　**Answers**

Task 1　Match the phrases on the left with the best phrases from the word bank on the right.

1)	May I offer	you a drink?
2)	Would you give	me your phone number?
3)	I emailed	the message to you.
4)	Taro showed	some photos to Wendy.
5)	The CEO promised	a high salary to the employees.
6)	Please bring me	a glass of beer.

Task 2　Circle the verb and underline the verb phrase.

7) I will email a copy of the ad to you.

8) The manager gave advice to the new employees.

9) John bought Patty a book.

10) The company offers good benefits to the employees.

Task 3　Complete the sentences.

11) I gave (her a cat) yesterday.　　私は昨日彼女にネコをあげた。

12) I gave (a CD to her) two years ago.　　私は 2 年前 CD を彼女にあげた。

Fig. 4 Sample Follow-up Tasks for Practice and Production

that students can confirm or correct their hypotheses. An example is shown in **Fig. 3**. The discussion on explicit grammar explanation is found in Chujo & Oghigian (2008) and Uchibori & Chujo (2010)[14),15)].

3.3.3 Steps 3 & 4 Practice and Production

In Step 3, students do practice and consolidation for hypothesis testing using the follow-up worksheet given as homework. It contains tasks aimed at consolidating comprehension by providing practice and encouraging production using the targeted grammar. Sample tasks are shown in **Fig. 4**, where students complete a sentence by choosing or filling in the correct phrase, and underline verbs and verb complements. The answers are provided for the reader and are not included on the student version.

4. Students' Gains

4.1 Pre- and Post-tests

We used four different types of test questions for NPs and VPs. Sample questions and answers used for the pre- and post-test are shown in **Table 4**. Each question was controlled by word level (high frequency words [hereafter HFW] or TOEIC-level words [hereafter TOEIC words]), sentence length, and structural pattern.

In total, there were sixty NP questions, made up of the following four types of NP subtests; (1) identifying an NP (HFW), (2) identifying an NP (TOEIC words), (3) producing an NP (HFW), and (4) understanding an TOEIC-type NP. Each NP subtest consisted of fifteen questions composed of the following three NP patterns, respectively; "determiner+adjective+noun," "noun+prepositional phrase," and "noun + *to*/*-ing*/*-ed*." Average sentence length was 9.1 words.

In total, there were eighty VP questions, made up of the following four types of VP subtests; (1) identifying a VP (HFW), (2) identifying a VP (TOEIC words), (3) producing a VP (HFW), and (4) understanding a TOEIC-type VP. Each VP subtest consists of twenty questions composed of two questions of the following ten VP categories, respectively: agreement, double objects, the passive, adverbs, infinitives, predicate, gerunds, *that* clause, "*be*+adjective," and *remain*/*seem*. Average sentence length was 9.2 words.

In the beginning of the spring semester, the pre-test

Table 4 Sample Pre-test and Post-test Questions for Noun Phrases and Verb Phrases

NP	(1)	Identifying NP (HFW)	*Underline all the noun phrases.* A famous writer wrote these comic books.
	(2)	Identifying NP (TOEIC words)	*Underline all the noun phrases.* The secretary ordered some expensive paper.
	(3)	Producing NP (HFW)	*Complete the sentence.* （あの背の高い人は私たちのクラスの新入生です。） (That tall boy) is a new student in our class.
	(4)	Understanding TOEIC-type NP	*Choose the best answer.* I appreciate your (generosity, generous, generously, generousness) offer.
VP	(1)	Identifying VP (HFW)	*Underline all the verb phrases.* David will give his girlfriend a nice dress.
	(2)	Identifying VP (TOEIC words)	*Underline all the verb phrases.* The personnel department offered me a promotion.
	(3)	Producing VP (HFW)	*Complete the sentence.* （彼の弟は昨日トムにプレゼントをあげた。） His younger brother (gave Tom a present) yesterday.
	(4)	Understanding TOEIC-type VP	*Choose the best answer.* The government (offers, supplies, advises, explains) parents a wider selection of schools.

was given and at the end of the fall semester, the post-test was given. The same tests were used for pre- and post-test but the order of the questions was changed. The students were not told they would be given tests, and they were not given the answers at any time.

4.2 Group Gains

Table 5 shows the results for the NP+VP (hereafter NP/VP) pre- and post-tests. Each test is expressed as a percentage. In this table, we marked sixty NP questions on the basis of 50 points, and eighty VP questions on the basis of 50 points, so that the total score of NP/VP equaled 100 points. We applied the paired *t*-test to each pre- and post-test score for both groups. Both DDL groups made gains in all types of NP/VP questions with a difference significant at the 1% level. We can see that there was a substantial average increase in both computer-based and paper-based DDL and both DDL approaches were efficient for teaching the four types of NP/VP.

4.3 TOEIC Bridge Test Gains

We also collected and compared TOEIC Bridge test scores in **Table 6**. The pre-test was administered in April and the post-test was given in January. The highest score was 100. We applied the paired *t*-test to each pre- and post-test score for both groups. We can see that the computer-based group made gains for the total score of the TOEIC Bridge test with a difference significant at the 5% level. Looking at the paper-based group, students made gains in the reading section with a difference significant at the 5% level.

Table 5 Group Gains (NP/VP)

	Computer-based DDL Group			Paper-based DDL Group		
	Pre-test	Post-test	Gain	Pre-test	Post-test	Gain
Identifying NP/VP (HFW)	44.2	82.6	38.4**	42.7	76.4	33.8**
Identifying NP/VP (TOEIC words)	42.3	87.6	45.3**	41.0	77.0	36.0**
Producing NP/VP	61.8	78.0	16.2**	69.2	78.0	8.7**
TOEIC-type NP/VP	54.5	65.2	10.7**	54.0	62.6	8.5**
Average	50.7	78.3	27.6	51.7	73.5	21.8

**p<.01

Table 6 TOEIC Bridge Test Gains

	Computer-based DDL Group			Paper-based DDL Group		
	Pre-test	Post-test	Gain	Pre-test	Post-test	Gain
Listening Section	33.8	35.6	1.8*	37.7	38.4	0.7
Reading Section	35.1	36.6	1.5	35.5	37.4	1.9*
Total	69.0	72.2	3.2*	73.2	75.8	2.6

*p<.05

Table 7 Average Test Scores of Computer-based and Paper-based DDL Groups

	Computer-based DDL Group		Paper-based DDL Group	
	Pre-test	Post-test	Pre-test	Post-test
Number of Students	25	25	25	25
Average of 4 types of NP/VP total	50.7	78.3	51.7	73.5
SD	13.5	5.6	11.1	12.8

4.4 Pre-test and Post-test Score Difference

Next, we investigated the pre- and post-test score difference between a group using computer-based DDL and another using paper-based DDL. **Table 7** shows the average pre- and post-test scores and standard deviations (SDs) of the computer-based and paper-based groups. In this table, the total score of NP/VP equals 100 points. As can be seen from this table, pre-test scores of both groups are almost the same, whereas the post-test score of the computer-based group is a little higher than paper-based group.

We performed a two-way ANOVA statistical test (two-factor ANOVA with repeated measures on one factor). The result was that the DDL exercise effect represented by the pre- and post-test scores was highly significant with a p-value less than 0.001 ($F(1, 48)=214.1$, $p<.001$). On the other hand, there was no significant difference between computer- and paper-based exercises with the p-value of 0.489 ($F(1, 48)=0.487$, *n.s.*). The interaction between pre-post-test and exercises is marginally significant ($F(1, 48)=3.211$, $0.05<p<0.1$).

These conclusions from the ANOVA are in agreement with the *Welch's t* test on the post-test scores of computer-based and paper-based groups intended for use with two samples having possibly unequal variances ($t(33)=1.72$, $0.05<p<0.1$). The two-tailed p-value was given as 0.094, which was between .05 and .10. The result of the analyses revealed that we could say there is a "marginally" significant difference between the DDL exercise types, but we did not really get the significant results. This could mean that computer-based DDL might have a tendency to have a slightly higher efficacy in teaching the four types of NPs/VPs compared to paper-based DDL, or that there is no real difference between the two groups from which the post-test scores are drawn.

4.5 Students Feedback : Computer-based vs. Paper-based DDL

We asked for feedback from the two different groups of students and compared their opinions. Overall, in spite of the difference in contact time with computer or paper-based DDL, they had the same reactions, summarized in **Table** 8.

In short, computer-based DDL was active, they liked searching the corpus themselves, and the learning was "fixed in their memories," while the main disadvantages were that the search itself takes time and sometimes search mistakes caused confusion. The paper-based work was easier and quicker to do, students could write and underline on the paper, and they did not need to worry about search mistakes because the correct results were given to them. Students did not like that the learning was

Table 8 Student Feedback : Computer-based vs. Paper-based DDL

Computer-based	+	● active ; learning was "fixed in our memories" ● can compare two languages ● liked having control ● can see many examples at a time ● can see a sentence to the end ● always can see the translation
	−	● takes time ; initial settings take time ; needs a computer ● mistakes cause confusion ; difficult operation ● can't have results at hand
Paper-based	+	● saves time ; can do tasks instantly ● can do more tasks in the same amount of time ● no search mistakes ● can write and underline on the paper
	−	● passive ● not memorable ● can't see many examples ; sentences are cut off ● sometimes didn't have translation

Table 9 Teacher Perspectives : Computer-based vs. Paper-based DDL

Computer-based	+	● Students are active learners. ● Beginner level students who dislike English are motivated by using the novel concordance tool and are interested in searching the concordance lines. ● Students can learn how to use corpus tools. ● Students are exposed to many English examples. ● Students can learn vocabulary and grammar from a new aspect different from their past experience.
	−	● IT interruptions sometimes reduce students' interest. ● Initial settings and looking at the concordance lines takes time. ● Cannot use at home without a free web parallel concordancer. (The parallel concordancer is expensive.)
Paper-based	+	● The teacher can control the concordance lines, e.g., edit difficult or confusing variations or exceptions. ● Class is more manageable－no interruptions from IT malfunctions or misunderstandings.
	−	● Less interesting than computer-based exercises. ● Students mechanically underline and are not active learners. ● Students are not taught how to use corpus tools.

passive, and not memorable, and they did not like that the sentences were cut off to fit on the paper.

4.6 Teacher Perspectives : Computer-based vs. Paper-based

A teacher perspective on computer-based and paper-based DDL is summarized in **Table 9**. From a teacher's perspective, computer-based lessons took more time and could be more challenging but they were more interesting, motivating and engaging. The advantages of paper-based lessons were that class time could be used to cover more tasks, concordance lines could be edited to control the focus (in other words, teachers can pre-select salient examples and delete variations or exceptions), and the time spent setting up and trouble-shooting computers and software was eliminated. The main disadvantages were that the exercises were not as interesting, powerful and motivating, students tended to mechanically underline target structures rather than become active learners, and they were not taught how to use corpus tools.

5 . Conclusion

Beginner level students showed significant gains in identifying and producing NPs and VPs using both computer-based and paper-based DDL. No significant difference in efficacy exists except for a marginal difference suggesting that computer-based DDL could be more efficient than paper-based. Regarding paper-based exercises, students appreciated the time saved on searching words, while they appreciated computer-based exercises because this learner-centered approach helped them to 'fix the learning firmly in their memories.' Summing up, to benefit from the advantages of both approaches, these are being blended or mixed, meaning combining face-to-face teaching, online work, and off-campus work.

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Notes

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英語初級レベル学習者向けコンピュータ版・ペーパー版 DDL の比較

中條清美，キャサリン・オヒガン，内堀朝子

概　要

コーパスを利用して学習者自らが例文から文法規則を発見するデータ駆動型学習 (Data-driven Learning : DDL) は，帰納的な学習に有効な教材であるため，教育利用の期待が高い。本稿では，パソコンを利用したコーパス直接利用版（コンピュータ版）と普通教室でも指導可能なコーパス画面を載せたプリント利用の間接利用版（ペーパー版）の DDL 教材を開発し，英語初級レベル学習者を対象とした指導実践をおこなった。事前・事後テストを用いた指導効果の測定結果と学習者のフィードバックが報告された。

キーワード：データ駆動型学習，コンコーダンシング，コンピュータ版 DDL，ペーパー版 DDL，初級レベル学習者