Optimizing the Efficiency of L2 Grammar Learning in Secondary Schools:
Paper-based DDL and Paper+Web-based DDL

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中学校におけるL2文法学習の効率の最適化：
ペーパー版DDLとペーパー＋ウェブベースDDL

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　Introduced by Johns in 1991, data-driven learning（DDL）empowers learners to independently explore linguistic patterns using corpus tools, transitioning from traditional teacher-led methods to a more student-centered method. This paper evaluates the efficiency of L2 grammar learning in secondary schools using DDL, comparing paper-based DDL with a hybrid of paper+web-based DDL. The research conducted in two junior high schools investigates whether different DDL methods affect grammar learning outcomes and how they perform across different English proficiency levels. The findings reveal no significant differences between the two DDL methods, suggesting both are effective for grammar instruction at the beginner level. The study highlights the benefits of paper-based DDL, particularly for environments with limited digital resources, suggesting it as a practical method that avoids overwhelming students with too much information and maximizes classroom time for productive language learning.

　1991年にJohnsによって提唱されたDDL（data-driven learning，データ駆動型学習）は，学習者がコーパスツールを使って言語パターンを自分の力で探求することを可能にし，従来の教師主導の文法学習を生徒中心の学習へと変化させた。本研究は，中学校におけるデータ駆動型学習（data-driven learning, DDL）を用いたL2文法学習の効果について，ペーパー版DDLとペーパー＋ウェブ版のハイブリッドDDLを比較した。本研究には，異なる２校の中学校から，初級レベル英語学習者である123名の中学２年生と56名の中学３年生が参加した。生徒たちは，初級者に適していると言われるペーパー版DDL，あるいは，ペーパー版DDLにウェブ版DDLの強みを加えたペーパー＋ウェブ版DDLを利用して英文法を学習した。指導効果を文法テストにより検証した結果，ペーパー版DDLとペーパー＋ウェブ版DDLの２つのDDL学習の方法はどちらも文法指導に効果があり，これら２つの学習方法の指導効果には有意差はなかった。その結果，ペーパー版ＤＤＬとペーパー＋ウェブ版DDLはどちらも初級レベル学習者の文法指導に有効であることが確認された。

1. Background

　DDL（data-driven learning）was proposed by Johns（1991）. It is defined as "the use of corpus tools and techniques for pedagogical purposes in a foreign/second language"（Boulton & Vyatkina, 2021, p. 68）. It is a learner-centered method in which students use corpus analysis tools to search an extensive database of language data（corpus）. An example of a globally known corpus analysis tool is shown in Figure 1. By analyzing the search results, learners autonomously discover linguistic patterns and rules. This method shifts the traditional model of teacher-led instruction, where teachers deliver explanations unilaterally, to one

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Series . For Winds and Percussion . Teachers Guide .	Book	1 and 2 , revised ed . (Chicago : GIA ,
did hold their attention long enough to get thru a Redwall	book	a few months ago . # Strewing can be tricky . We
to operate . I need you over here ! Jerry ,	book	a room ! Charging to 200 . Clear ! - Still in
book about my mother . Ms-HUTT: No. Ms-A-STEWART: It 's a	book	about growing up and learning to live with what happened or what
what they 've done right or wrong . I finished the	book	actually feeling better about my chances of " making it " ,
is a writer in addition to being a producer . The	book	affords him the opportunity to re-present the story in a
so far . And that Bill , having perhaps read the	book	already , is already there . # Or not . # Anyway
73571 Customers who bought this	book	also bought : # The Demonstrations of Aphrahat , the Persian
" Oracle Bones " (book #2) . This third	book	and book #2 in particular have helped me understand so much
. Then she told me Looking for Mr. Good-bar , the	book	and film about a woman murdered during a one-night stand , was
trail , even hiking the trail alone -- that and the	book	and Reese Witherspoon movie , " Wild , " about a lone
photos produced by 10 full-time journalists . Oyster says they	book	and stay anonymously at each property . Founder Elie Seidman
reconvene for a whole class meeting . We recommend rereading the	book	and stopping at the appropriate places to discuss the essential
. " Look at this . " She opened the spiral-bound	book	and tapped the rough sketch of her halo cake . " Would
Tavis , I want to ask you a question about your	book	and -- and this lead in the water in Flint , Michigan
. See this selectivity in the dating methods in Lubenow 's	book	appendix cited in footnote 41 . See also Woodmorrappe (1999)
be able to sleep until I had exposed everything in this	book	as a scam. " - Peter
better works to come from her pen . # Would this	book	be published if it were n't for the name on the cover
has been more beneficial than the account connected to my	book	because my personal account has more flexibility in terms of

Figure 1 An Example of Corpus Search Tool COCA（Corpus of Contemporary American English）

Note. The search result "book" is shown on the monitor.

that fosters student-led exploration and understanding.

DDL actively engages learners in the learning process by having them use corpus search tools to find example sentences related to the learning target, compare these sentences, identify common patterns, and internalize those patterns. Through this inductive method, DDL provides opportunities for students to gain deeper insights into language use while acquiring new knowledge.

Several key features underpin DDL's strengths. First, DDL relies on authentic language data from real-life social contexts, giving learners access to how language is used in everyday situations. Second, it is grounded in constructivist learning theory, which emphasizes a discovery-based process where learners use corpora to identify linguistic patterns and structures, building knowledge from these findings. As a result, DDL can transform traditional teacher-centered instruction into the learner-centered method that is increasingly necessary in modern education.

Moreover, various studies have supported the effectiveness of DDL in language learning. Boulton and Cobb's（2017）meta-analysis highlighted its positive impact on language acquisition, while Mizumoto and Chujo（2015）reported similarly beneficial effects for Japanese learners. In line with these findings, Japan's GIGA School Program, which promotes one-to-one tablet use for students, has facilitated the integration of DDL by providing the necessary digital tools and internet access, creating an environment conducive to its successful implementation.

While DDL is highly beneficial for intermediate and advanced learners because it offers numerous examples to enhance their exposure to the target language, this method may present challenges for beginning-level learners（Crosthwaite, 2020）. The large number of examples, which can be overwhelming, may hinder their ability to focus on essential patterns or rules. Beginning-level learners may need help processing and analyzing the vast array of linguistic data, making it harder to identify critical structures or common usage. Therefore, when using DDL with beginning-level learners, it is crucial to carefully select and limit the number of examples to avoid cognitive overload and to ensure a more manageable learning experience.

An example of controlled language data instruction is McShane's（2018）study, which investigated the effects of paper-based DDL activities on Japanese university EFL learners. According to his research, beginning-level university students who received vocabulary instruction through a combination of paper-based DDL and traditional methods showed significant improvement in the vocabulary items taught via DDL, as evidenced by pre-test and post-test results. In contrast, vocabulary items taught using only traditional methods did not show statistically significant improvement. These results highlight that carefully controlled DDL can enhance language learning for beginning-level learners.

Takahashi and Fujiwara（2016）investigated the impact of a paper-based DDL on elementary school students learning English. The results showed significant improvement in their understanding of plural affix usage, and they retained this knowledge even after a de-

lay. Monoi et al. (2019) also explored the effects of paper-based DDL on English learning in primary school. Grammar tests were conducted and their average test score increased statistically. The participants' comments on their findings about the target grammar frequently mentioned the meaning of words, articles, English orthography, sentence type, and sentence structure. Nishigaki and Kakiba (2023) conducted paper-based DDL and examined how it improved students' grammatical knowledge and how they reached their findings during DDL activities. Seventh-grade students learned about the third-person singular present verb form with DDL. As a result, the students in the DDL class understood the grammar target better than those in the teacher-led class. Mizumoto and Chujo (2016) explored DDL's effectiveness across different learning styles, inductive versus deductive, and language levels. They concluded that guided DDL supported beginning-level learners effectively by providing structured interaction with language data, making DDL more accessible for learners of varied backgrounds.

Paper-based DDL is often implemented for beginning-level learners. It offers advantages over digital DDL. First, with paper-based DDL, teachers can select concordance lines appropriate for the learners' language level and learning needs. This treatment ensures that students are exposed to relevant and manageable language examples. Paper-based DDL avoids overwhelming students with input floods. Second, paper-based DDL allows for a more structured learning environment, where the teacher can guide students through specific tasks using the concordances. Teacher's guides can help beginning-level learners build confidence and understanding as they gradually develop the skills needed for exploring corpora and finding language rules, giving them a sense of progression in their learning. Third, paper-based DDL focuses on the specific language patterns the teacher has chosen, helping students target specific grammatical or lexical structures in a controlled manner. For these reasons, beginning-level learners can confidently develop their understanding and progressively develop the skills to explore corpora and find language rules.

When considering teaching in junior high schools, if DDL activities take too much time during English classes, the time for practicing and using English decreases. Therefore, paper-based DDL can reduce the time needed to explore and handle digital devices. However, a paper-based method might reduce the effectiveness of DDL learning. In this study, we aim to examine the differences in the efficacy of two methods: paper-based DDL only and a combination of paper-based and web DDL. We conducted DDL using the following research questions (RQ).

RQ 1: Is there a difference in the learning effectiveness of grammar learning between using paper-based DDL and paper+web-based DDL?

RQ2: Does the grade level of the student or the type of grammar item being studied make a difference in the learning effectiveness of DDL?

This would be a valuable investigation, as it compares the simple and time-saving paper-based DDL method with the more time-consuming blended method of paper-based + web-based DDL, offering insights into how different modalities impact learning outcomes.

2. Research Method

This study involved two different groups of junior high school students: School A and School B. The results of each group will be reported separately.

2.1 School A
2.1.1 Participants

The participants were 56 third-year (9th grade) students from a public junior high school in Chiba Prefecture. Having come from local elementary schools, these students entered the school without taking entrance exams. According to the achievement test results, students' English level was average in the prefecture. The analysis focused on 56 students who completed both the pre-test and post-test. Additionally, only the data from students whose parents or guardians consented to the study were included. Data from students whose parents or guardians did not obtain consent was excluded from the analysis.

One class, with 26 students, learned grammar using paper-based DDL. The other class, with 30 students, learned grammar using paper-based and web-based DDL. Students were willing to study hard because they took these lessons in December, just a few months before the high school entrance exams. Many wanted to review the grammar items they had learned through textbooks to perform better in the entrance examinations.

2.1.2 Learning Schedule

The study was conducted in December 2023 after the students had finished learning all the grammar topics covered in the government-authorized junior high school textbooks. Students took part in eight DDL activities for this study. The learning objectives and contents for each DDL activity are shown in Table 1.

2.1.3 Example of Worksheets

Figure 2 further illustrates an example of the worksheets used in the lessons. The worksheet listed six to nine English sentences, with the Japanese translations

Table 1 The Learning Objectives and Contents for DDL Activities

No.	Objectives	Contents
(1)	Learn to use SVC (be-verb)	Words that follow be-verbs
(2)	Learn to use SVC and SVO structures	Be-verbs and general verbs (1)
(3)	Learn to use question forms of SVC and SVO	Be-verbs and general verbs (2)
(4)	Learn to use negative forms of be-verbs and general verbs	Be-verbs and general verbs (3)
(5)	Learn to use SVC structures	Different general verbs
(6)	Learn to use SVOO structures	Sentences with two objects
(7)	Learn to use SVOC structures	Sentences with an object and a complement (1)
(8)	Learn to use SVOC structures	Sentences with an object and a complement (2)

Figure 2 Sample of Worksheet: School A

provided next to them on the right. DDL tasks were provided on the back of the worksheet. Below is an example of such tasks. The example worksheet shown in Figure 2 focuses on comparing sentences with the "general verbs" and sentences with the "SVOO" sentence structure.

・Read the English sentences aloud together with the teacher.
・Circle the verbs in each English sentence.
・Circle the Japanese equivalent you circled in the English sentences above.
・Look at List 2. What kind of words come after the verbs? Group the similar ones together.
・What are the characteristics of each group?
・Summarize what we learned in today's lesson at the end of class.

2.1.4 Effectiveness Verification

We conducted a pre-test and a post-test as grammar tests. The test consisted of 11 questions in which students had to translate sentences from Japanese to English. For example, students saw the Japanese sentence, "彼女はネコが好きではありません。" and translated it into English as "She doesn't like cats." The same questions were used in both the pre-test and the post-test but the order of the questions was changed in the post-test. The post-test was administered one week after the instruction ended. After the pre-test, no answers or explanations were given, and students were not informed in advance that there would be a post-test.

The test assessed whether students understood the five basic sentence patterns and the difference between the be-verbs and general verbs. Therefore, spelling mistakes were not penalized. Additionally, answers like "She don't like cats." "She doesn't like cat," "She don't likes cat." were judged as correct answers because, in this question, the choice of be verbs and general verbs was target. Therefore, "She isn't like cats." was marked as incorrect because students did not choose between be verbs and general verbs correctly.

2.2 School B

This section describes the details of the DDL lessons conducted at School B.

Table 2　Nine Classes that Make Up One Program: School B

Class	Textbook	Learning Content
1	Scenes 1	Understanding and practicing the present perfect（completion, affirmative sentences）
2	Scenes 2	Understanding and practicing the present perfect（completion, negative/interrogative sentences）
3	Scenes 3	Understanding and practicing the present perfect（experience）
4	Think 1	Understanding a dialogue about Japanese pop culture
5	Think 2	Understanding a dialogue about Japanese pop culture
6	Think 3	Understanding a speech about Japanese pop culture
7	Retell	Activity to communicate the overview of the 4th to 6th periods in English with a partner
8	Interact	Production activities using the language materials learned
9	Summary	Writing a report based on questions and observations

Table 3　Flow and Contents of a 50-minute Class Session: School B

Time	Contents of Class Session		
0〜10	Greetings, Daily activities, Review, etc.		
10〜15	Confirmation of new vocabulary and expressions		
15〜20	[Textbook] Meaning-based introduction of grammar item		
20〜37	**[Paper-based DDL]**	20〜28	**[Paper-based DDL]**
28〜37	**[Web-based DDL]**	28〜38	[Textbook] Listen [Textbook] Speak & Write
37〜45	[Textbook] Listen [Textbook] Speak & Write	38〜45	Output activities
45〜50	Reflection		

Note. The gray areas indicate where the content differed between paper-based DDL and paper + web DDL.

2.2.1 Participants

The participants were 123 second-year students（8th grade）from a junior high school affiliated with a national university's education faculty. Since this junior high school is a research school for the university's faculty of education, consent was obtained from the students' parents and guardians at enrollment, agreeing to their children's participation in research and collecting and analyzing research data.

2.2.2 Learning Schedule

In this study, the textbook used by the students was *Sunshine English Course 2*（Kairyudo）, covering Program 7 and Program 8. The present perfect and the present perfect continuous were the grammar targets of these programs. Both grammar points are included in the government's junior high school English educational guidelines. As shown in Table 2, both programs consisted of nine lessons. In the ninth class, as an end-of-unit activity, each student took up a question that arose throughout the program and wrote their original inquiry report.
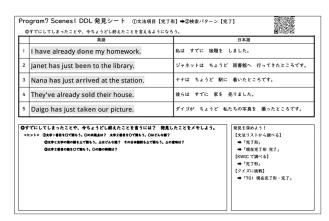
Table 3 shows the flow and content of a 50-minute

Figure 3　An Example of Worksheet: School B

class session. In the table, paper-based DDL and web-based DDL are indicated in bold. Additionally, the shaded columns show the web-based DDL activity was conducted in the web-based DDL, while output activities were carried out in the paper-based DDL.

2.2.3 Example Worksheet

Figure 3 shows an example of the worksheet used by the students. The worksheet included five sentenc-

es carefully selected by the teacher to help students discover the grammatical rules the teacher expected them to notice. Expressly, the sentences were limited to short ones with simple vocabulary to ensure easy understanding.

In addition, to help students who struggle to notice the necessary points, the teacher provided scaffolding hints such as "circle the first bold word with a square" and "circle the second bold word with a circle." Figure 3 shows the result of students marking the concordance lines according to these hints. The figure shows that the students used scaffolding to grasp the English sentences. In addition, to help students who struggle to notice the necessary points, we provided scaffolding hints such as "circle the first red (bold) word with a square" and "circle the second bold word with a circle." Figure 3 shows the result of students marking the concordance lines according to these hints. The figure shows that the students used scaffolding to grasp the English sentences.

2.2.4 Effectiveness Verification

The effectiveness was evaluated through a grammar test. The grammar test consisted of (1) error correction in English sentences and (2) fill-in-the-blank questions, administered via Google Forms. In (1) error correction, students marked ◯ if the sentence was correct and ✕ if it was incorrect. If they marked ✕, they were required to explain the reason for the mistake. In (2) fill-in-the-blank questions, students read a Japanese sentence and filled in the appropriate words in the blanks of the English sentence to match the meaning. The number of blanks was limited to a maximum of two. The same questions were used in the pre-test, the post-test, and the delayed test, but the order of the questions was changed in the three tests. The post-test was administered one week after the instruction ended, and the delayed test was conducted four weeks after the instruction ended. After the pre-test and post-test, no answers or explanations were given, and students were not informed in advance that

there would be a post-test and delayed test. Mistakes in uppercase and lowercase letters were marked as correct during grading.

3. Results and Discussion

3.1 Grammar Test Results of School A

The descriptive statistics for the grammar test results are shown in Table 4. In the class that utilized paper-based DDL, the average score rose from 6.42 to 7.50, and in the class that used paper+web-based DDL, it increased from 5.70 to 7.13.

Two-way ANOVA revealed a significant main effect of the test ($F(1, 54) = 27.682$, $p < .001$, $\eta^2 = .031$). Multiple comparisons showed that the paper-based and paper+web-based DDL classes demonstrated statistically significant differences with a large effect size. However, the main effect of the teaching method ($F(1, 54) = 0.355$, $p = .554$, $\eta^2 = .006$) and the interaction between the test and the teaching method ($F(1, 54) = 0.558$, $p = .458$, $\eta^2 = 6.339 \times 10^{-4}$) were not significant. The effect size was "large" for both methods.

Although there was no statistically significant difference between the teaching methods for the pre-test and post-test, the scores of both the paper-based and the paper+web-based classes significantly improved from the pre-test to the post-test.

3.2 Grammar Test Results of School B

A survey conducted after the DDL classes showed whether students had already learned the grammar through cram school or self-study before taking the lesson using DDL. Although few students were learning it for the first time, the pre-test results showed that the knowledge of those who had studied it in advance was not solid.

・Students who understood the present perfect tense before the lesson: 33.5%
・Students who somewhat understood the present perfect tense before the lesson: 48.9%
・Students learning the present perfect tense for the

Table 4　Descriptive Statistics for the Grammar Test Results: School A

Methods	Tests	M [95%CI]	SD	Min	Max	skew-ness	kur-tosi	α
Paper	Pre-test	6.42 [5.09-7.76]	3.30	0	11	− .56	− .68	.88
	Post-test	7.50 [6.22:8.78]	3.17	0	11	− 1.01	− .04	.81
Paper + Web	Pre-test	5.70 [4.31:7.09]	3.72	0	11	− .09	1.50	.82
	Post-test	7.13 [5.72:8.55]	3.79	0	11	− .61	− 1.19	.86

Table 5　Results of Descriptive Analysis and Grammar Test: School B

Method	Tests	M [95%CI]	SD	Min	Max	skew-ness	kur-tosi	α
Paper	Pre-test	8.92 [7.45-10.40]	5.94	1	23	0.57	−0.61	.82
	Post-test	18.78 [17.16-20.41]	6.55	2	28	−0.75	−0.06	.85
	Delayed-test	18.83 [17.06-20.61]	7.16	3	30	−0.43	−0.78	.79
Paper + web	Pre-test	7.43 [5.87-8.99]	5.94	1	28	1.38	1.64	.84
	Post-test	18.91 [17.37-20.46	5.88	3	28	−0.73	0.09	.81
	Delayed-test	20.45 [18.71-22.18]	6.60	2	30	−1.17	1.28	.80

first time: 17.7%

Table 5 shows the descriptive statistics for the grammar test results of the classes taught using the simplified and regular teaching methods. In the paper-based class, the average score on the pre-test was 8.92 (95% CI [7.45, 10.40]), but this increased to 18.78 (95% CI [17.16, 20.41]) on the post-test, and the delayed post-test score was 18.83 (95% CI [17.06, 20.61]). A similar trend was observed in the paper+web class, where the average score increased from 7.43 (95% CI [5.87, 8.99]) on the pre-test to 18.91 (95% CI [17.37, 20.46]) on the post-test and reached 20.45 (95% CI [18.71, 22.18]) on the delayed post-test.

As a normal distribution was not achieved, a non-parametric test was conducted. First, when comparing the effects between the paper-based class and the paper+web based class, the results revealed no statistically significant difference in scores between the two classes.

The results showed a statistically significant difference between the tests. Multiple comparisons with Holm's correction confirmed substantial differences between the pre-test and post-test and between the pre-test and delayed post-test. However, no significant difference was found between the post-test and the delayed post-test. This indicates that because of learning with DDL, scores increased between the pre-test and post-test, and the learning effect was maintained even after about one month.

The effect sizes were "large" for both methods. ($d=$ −1.58, $d=1.94$.)

4. Conclusion

DDL is a learning method that allows students to explore language patterns through corpus analysis and encourages more exploratory, individualized, and independent discovery than traditional instruction. Expanding opportunities for input, DDL is effective for intermediate and advanced learners. In contrast, beginning-level English learners are often overwhelmed by the volume of data in DDL and unable to make discoveries. Therefore, using paper-based DDL worksheets with carefully selected information and structured teacher guidance is effective for beginning-level learners.

The answer to RQ1, "Is there a difference in the learning effectiveness of grammar learning between using paper-based DDL and paper+web-based DDL? was "No." Paper-based DDL and paper+web-based DDL were effective in learning grammar in both School A and School B, and there was no difference in the effect size. The answer to RQ 2, "Does the student's grade level or the type of grammar item being studied make a difference in the learning effectiveness of DDL?" was also "No." Both paper-based DDL and paper+web-based DDL were effective in grammar learning for students at different English proficiency levels, and there was no difference in the effect size. These confirm that paper-based DDL has the same effect as paper+web-based DDL.

Paper-based DDL saves time in exploratory activities because the teacher presents the linguistic data in an informative and focused manner, and the saved time can be used for production activities. Thus, paper-based DDL solves the problem of DDL being time-consuming. Using paper-based DDL saves time exploring language rules and makes integrating DDL into regular English classes easier. The introductory steps in DDL learning include: 1) using the paper-based DDL with teacher guidance to familiarize students with the exploratory approach to grammar learning. As students become accustomed to the exploratory approach, we can 2) reduce the teacher's ad-

vice and move to the web-based version of DDL, which takes less time for exploration. DDL can be integrated as a part of regular classes.

5. Acknowledgment

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