**Supplementary materials**

1. **Participants’ scores on the TOEIC and Vocabulary Tests**

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| --- | --- | --- | --- |
| Students | Reading scores(TOEIC) | Linggle (Vocabulary Test 1)accuracy rates (%) | Linggle (Vocabulary Test 2)accuracy rates (%) |
| S1 | 485 | 82.8 | 87.9 |
| S2 | 450 | 45.9 | 91.4 |
| S3 | 435 | 84.5 | 93.1 |
| S4 | 320 | 77.6 | 86.0 |
| S5 | 320 | 48.3 | 82.8 |
| S6 | 290 | 82.8 | 94.8 |
| S7 | 260 | 75.9 | 93.1 |
| S8 | 260 | 67.2 | 84.5 |
| S9 | 245 | 74.1 | 86.2 |
| S10 | 230 | 74.1 | 89.7 |
| S11 | 215 | 62.1 | 77.6 |
| S12 | 205 | 70.7 | 91.4 |
| S13 | 175 | 58.6 | 84.5 |
| S14 | 160 | 72.4 | 72.4 |
| S15 | 160 | 48.3 | 72.4 |
| S16 | 155 | 56.9 | 87.9 |
| S17 | 155 | 75.9 | 84.5 |
| S18 | 140 | 58.6 | 63.8 |
| S19 | 130 | 77.6 | 87.9 |
| S20 | 125 | 65.5 | 82.8 |
| S21 | 105 | 62.1 | 72.4 |
| S22 | 115 | 81.0 | 89.7 |
| S23 | 115 | 63.8 | 74.1 |
| S24 | 105 | 36.2 | 53.4 |
| S25 | 95 | 46.6 | 65.5 |
| S26 | 90 | 56.9 | 56.9 |
| S27 | 70 | 36.2 | 56.9 |
| S28 | 70 | 43.1 | 50.0 |
| S29 | 70 | 36.2 | 48.3 |
| S30 | 60 | 53.4 | 58.6 |
| S31 | 70 | 39.7 | 62.1 |
| S32 | 25 | 50.0 | 67.2 |

1. **Participants’ background (for section 2.1)**

The backgrounds of the participants (27 freshmen and five sophomores) were similar. Of the 32 students, four were overseas students (S1, S2, S4, and S5) – two were from Indonesia and two were from Malaysia – who completed high school in their home countries and came to Taiwan for university education. The other 28 students had learned English as a foreign language, from elementary school up to college.

Regarding the students’ previous experience in using vocabulary tools, they were familiar with online dictionaries and translation tools such as Google Translate, and most of them had previously downloaded a bilingual dictionary app such as Erudite on their smartphone for ease of use to help them solve vocabulary problems.

1. **Syntax commands and functions of Linggle (for section 1.5)**

|  |  |  |
| --- | --- | --- |
| Commands | Functions | Examples |
| \* | Search for any word | *make a \* mistake* |
| Part of speech | Search for words with a part of speech (e.g. adj., adv., n., prep.) | *to v. knowledge**a adj. computer* |
| / | Whether A or B is used more often | *to achieve/reach agreement* |
| \_ | Search for any word (one word) | *make a \_ mistake* |
| ~ | Search for a word similar to the word *w* | *~academic research* |
| ? | Check whether the word *w* is needed | *discuss ?about the issue* |

1. **Three reference tools used in the study (for section 2.3.1)**

|  |  |  |
| --- | --- | --- |
| Tools | Features | Output |
| Linggle | Monolingual | English phrases, patterns and common combinations, with example sentences |
| Yahoo! Kimo Dictionary | Bilingual | Chinese definitions, with bilingual example sentences |
| Oxford Advanced Learner’s Dictionary | Monolingual | English definitions, with English examples |

1. **Detailed description of the Vocabulary Test (for section 2.3.2)**

Part 1 featured a short article from BBC News to test whether the students could correctly identify the parts of speech of eight highlighted words and their meanings. The successful use of Linggle required them to identify the parts of speech of the searched words so they could assign the correct search commands. This intended to measure whether the students had prerequisite knowledge of identifying the part of speech of a word in a sentence.

Parts 2 and 3 included items on both lexical and grammatical collocations (Benson et al., 1986). Part 2 included 10 collocations in different combinations, such as V + N, V + Prep and Prep + N. For each question, the students had to choose one correct answer between two choices. The distractors used in this section were those that might cause confusion in the students’ L1, for example, *I don’t think we should (do/make) a decision now. Let’s wait until tomorrow*, which sounds similar in the students’ L1.

Part 3 was a bit more challenging than Part 2. The students had to fill in the correct words according to the Chinese clues at the end of each sentence, for example, *I really liked to* \_\_\_\_\_\_ *kites when I was a kid*. (放風箏). This measured productive versus perceptive use.

Part 4 tested whether the students could find synonymous words, such as adjectives, adverbs, and verbs, to fill in the blanks to complete the sentences correctly, taking context into consideration. For example, for the three sentences *He did a good job*, *He did a great job*,and *He did a decent job*, the students were asked tofill in the blanks with three more adjectives that could be used to admire people who did a good job*.*

Part 5 required the students to perform 12 error corrections in a short article, with underlined problematic phrases or words as a clue, for example, *… they cared about each other and they rely in each other …* and *He got very depressed about this…. He then got addicted in alcohol*.

**Summary of the tasks on the vocabulary test**

|  |  |  |
| --- | --- | --- |
|  | Tasks | Question types |
| Part 1 | Read a short news article and identify the parts of speech and the meanings of the underlined words. | 8 underlined words for parts of speech The same 8 underlined words for meaning |
| Part 2 | Choose the correct collocation between two distractors. | 10 multiple-choice questions  |
| Part 3 | Fill in the missing words using the Chinese clues. | 10 fill-in-the-blank questions |
| Part 4 | Fill in the blanks with synonymous words.  | 10 fill-in-the-blank questions |
| Part 5 | Correct 12 collocation errors in a short article. | 12 error corrections |

1. **Complete patterns of cross-referencing in Part 3 (for Table 6)**

|  |  |  |  |
| --- | --- | --- | --- |
| Patterns | Combination of tools | Frequency | Accuracy rates (%) |
| 1 | Linggle | 76  | 88 |
| 2 | Linggle + Yahoo! | 40 | 75 |
| 3 | Yahoo! + Linggle | 35 | 86 |
| 4 | Linggle + Oxford | 5 | 100 |
| 5 | Oxford + Linggle | 2 | 100 |
| 6 | Yahoo! + Linggle + Oxford | 2 | 100 |
| 7 | Yahoo! + Linggle + Yahoo! | 2 | 50 |
| 8 | Linggle + Yahoo! + Oxford | 2 | 100 |
| 9 | Yahoo! + Oxford + Linggle | 1 | 100 |
| 10 | Oxford + Yahoo! + Linggle | 1 | 100 |

1. **Complete types of Linggle syntax commands the students used in Part 4 (for Table 8)**

|  |  |
| --- | --- |
| Syntax | Syntax & frequency |
| Question 1 | Question 2 | Question 3 |
| Part of speech | did a adj. job (13)do a adj. job (4)a adj. job (3)adj. job (1) | It is adv. ridiculous (12)adv. ridiculous (5) | v. your goal (12); v. goal (10); v. your goal soon (1); can v. your goal (1); can v. goal soon (1); can v. goal (1); You can v. your goal soon (1); You can v. your goal (1); You can v. goal (1) |
| Wildcard \* | did a \* job (6)He did a \* job (3) | It is \* ridiculous (2)\*ridiculous (1) | Can \* your goal (1)\* your goal (1) |
| Underscore \_ | He did a \_ job (1) | It is \_ ridiculous (2) | Can \_ your goal (1)\_ your goal (1) |
| ~ | No use of the syntax | No use of the syntax | ~accomplish goal (1) |

*Note*. The numbers in parentheses represent the frequency of uses of the syntax commands.