

# Manga Vocabulometer, A new support system for extensive reading with Japanese manga translated into English

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**Abstract.** Extensive Reading, called “Tadoku” in Japan, is a method of learning a second language to improve reading speed and fluency. Japanese comics translated into English is used as one of the materials for extensive reading, where Japanese comics are called manga. Using manga to learn English is considered to be a good way to learn English because the content can be inferred from the pictures. However, some learners cannot memorize and learn all the words when they read many books. Therefore, if there is a function to automatically save unknown words in the books they read or to create flashcards, they can learn English more efficiently.

In this paper, we introduce Manga Vocabulometer, the support system for extensive reading. It is a web-based system that allows students to choose their favorite manga to read. It is also able to check for unknown words, so the system can present flashcards to learners. To confirm the advantage of the proposed system, we compare two memorization methods: one is the memorization method using Manga Vocabulometer and the other is the traditional simple memorization method.

**Keywords:** Education · Learning System · Web Application · Extensive Reading · Comic computing.

## 1 Introduction

Japanese comics called manga has been translated into a variety of languages and is widely read around the world. The manga translated into English are not only read by foreign people but also by Japanese people for learning English. The merits of using manga to learn English are that they are familiar to Japanese people and that they are easy to read in English because they provide the situation of a scene as pictures. This paper focuses on extensive reading with manga translated into English. Extensive reading is the method of learning foreign languages by enjoying reading books that are easy to understand. In this manner, the improve reading speed and the difficulty of books are gradually

improved. As a general rule in extensive reading, learners should not refer to a dictionary, but skip over the unfamiliar parts of the book, and stop reading if it is not attractive. In learning to read a lot of books within these rules, learners will be more efficient if they are able to store the words of the books they read. If learners can save the words in the book, learners can pick up the unknown words to make flashcards and recommend books based on the learner's vocabulary. So if we can create a system that can do this, we can make learning more efficient.

As a tool to support extensive reading of text-based documents, Augereau[1] developed Vocabulometer, which analyzes the difficulty level of a document and the vocabulary read by learners using their eye gaze information during reading. It is a web-platform application that aims to contribute to the development of learning system. Using an eye tracker that tracks the user's eye gaze position on the screen, the system can detect which words in a document the user is reading in real-time and store them by the paragraph in the database. It also has a function to recommend suitable documents for a learner's English skills based on the accumulated vocabulary. Yamaguchi et al. proposed Mobile Vocabulometer which is implemented as the app on smartphones [2]. Their experimental results found that Mobile Vocabulometer was more effective in memorization than standard flashcards for many participants. However, Mobile Vocabulometer was not effective for some participants. We assume that some participants cannot concentrate to read English texts because they are not familiar to English texts.

In this paper, we propose Manga Vocabulometer, a new support system for extensive reading to learn English with manga translated into English. By changing the learning materials from text to manga, it is expected that learners can easily grasp the content through pictures and do not get bored. The system extracts and presents English words in the manga according to the learner's English level. In this way, the system can be adapted to the learner's English level. We conducted an experiment to compare memorization learning using Manga Vocabulometer with flashcards at a similar level of unknown words.

The rest of this paper is organized as follows: Section 2 describes the related work of learning English. Section 3 describes the structure of Manga Vocabulometer and how to learn with it. Section 4 describes our experiments and evaluation of learning English with Manga Vocabulometer. Section 5 presents our result and discussion of experiments. Section 6 presents our conclusions.

## 2 Related Work

Yamaguchi et al. developed the text-based Vocabulometer on smartphones[2]. The application had the advantage of allowing users to learn English anytime, anywhere. The experimental results confirmed that it is more useful than flashcards. However, their research is text-based, which makes it difficult to maintain motivation. Hosler et al compared scores for learning with and without manga in the sciences[9]. This experiment found that manga as learning materials can help learners learn in science. This predicts that the use of cartoons in learning will increase the effectiveness of learning. Researchers have debated the effec-

tiveness of context in helping learners acquire vocabulary, but the results have been mixed[5][6]. For example, Webb et al[7]. found that there was no significant difference between the scores of subjects who encountered the target word in a single sentence and those who learned a pair of words. This suggests that the context of a single glossy sentence may have little effect on vocabulary knowledge. However, Hidi et al[8]. showed that learners' interest and comprehension were correlated.

### 3 Application Architecture

In this section, we describe each component of Manga Vocabulometer and the application-based learning in detail.

#### 3.1 Each Component of Manga Vocabulometer

Figure 1 shows the learning flow using Manga Vocabulometer. It is composed of the initial setup and the learning cycle including select, read, and feedback, followed by the review with flashcards. The detail of each component is described at the following paragraphs:

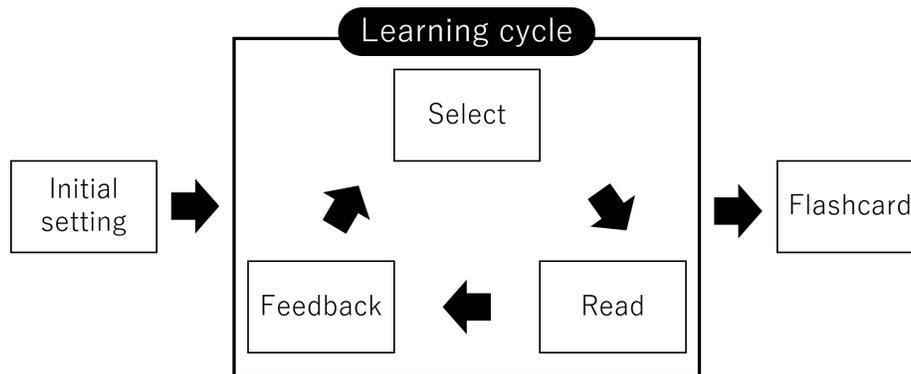


Fig. 1: learning flow

First of all, we explain how to log in. Figure 2 shows login screen. In order to log in, we ask the user to fill out the data required to create his or her account. The user's information is managed on firebase[4]. When users are logged in, users can set up own initial setting. the user registers some topics of their interest and answer the vocabulary questions defined by San Diego Quick Assessment [3] to estimate their English level. Then, the component "initial setting" generates the users' word list based on their estimated vocabulary and the word frequency list. the word frequency list is the list of levels or ranked lists by frequency of occurrence in a particular text. By setting the user's English level, Manga

Vocabulometer can suggest the list of unknown words that match the user's level in the component "feedback".



Fig. 2: login screen

Next, the components "select" and "read" are explained. Figure 3 and Figure 4 show the screens of "select" and "read". In "select," as shown in Fig.3, users can choose the title and episode of manga books. After selecting a manga, they can move to the reading screen shown in Fig.4. The reading screen includes the button to switch between Japanese and English for users to understand the contents conveniently.

Figure 5 shows a feedback screen. After reading, users move to the feedback screen. The unknown words are displayed on the feedback screen, where stop-words such as "a" and "the" are not included in them. Users answer two questionnaires  $Q1$  and  $Q2$  about the interest on five ranks and evaluate the difficulty on three ranks just after reading each episode. The questionnaire  $Q1$  is "How interesting is the episode?" and  $Q2$  is "How long would you like to read more episodes?". The choices of the highest rank (r5) of  $Q1$  and  $Q2$  are "very interesting" and "I want to read now", respectively, while r1 is the lowest rank. In  $Q1$  and  $Q2$ , the middle rank response (r3) is "No strong opinion." Manga Difficulty is evaluated on three ranks: easy, balance, and hard. The above questionnaires will be used for future research in this system. The screen of "feedback" also presents a list of potential unknown words in the manga that are matched to the user's English level and asks the user to select a word they don't know. The selected words are then stored in the database and can be used for learning unknown words with flashcards. The user's unknown word list is updated every time the user answers the questionnaire form. In other words, the system will improve the user's unknown word list every time user reads manga.



Fig. 3: manga book selection screen

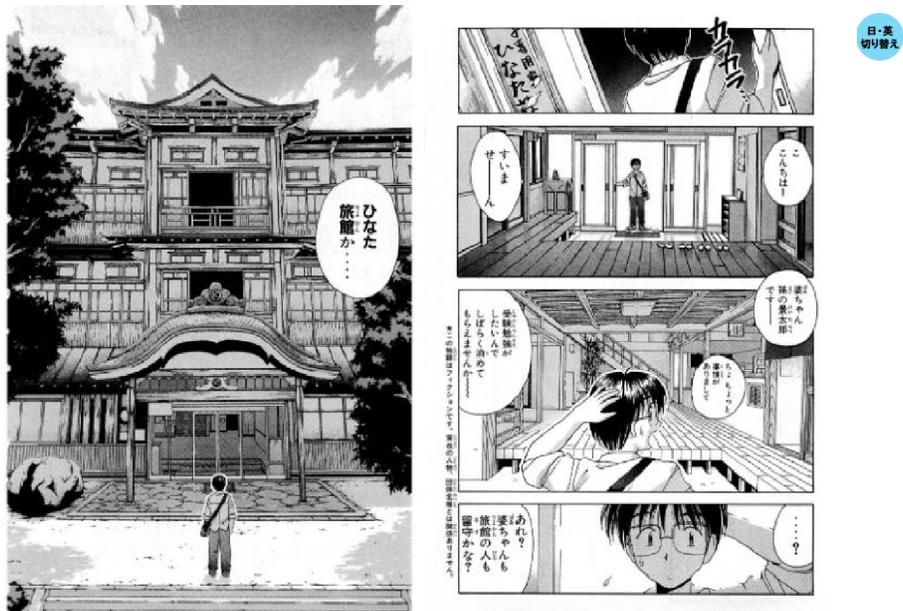


Fig. 4: manga display screen<sup>1</sup>

The screenshot shows a feedback form with three main sections:

- How was this text? Please tell me your review!**: A dropdown menu with "Well Balanced" selected.
- 今のエピソードは面白かったですか?**: A dropdown menu with "どちらともいえない" selected. Below it, a list of options: "とてもおもしろかった", "まあまあ面白かった", "どちらともいえない", "あまり面白くなかった", "まったく面白くなかった".
- 続きのエピソードを見たいと思いますか?**: A dropdown menu with "あまり読みたいと思わない" selected.
- Please check the unknown words**: A list of words with checkboxes: "longtime", "enemy", "opponent", "despite".
- A blue button at the bottom: "GO BACK TO THE TITLE LIST".

Fig. 5: feedback screen

Next, the component “flashcard” is explained. Figure 6 shows flashcard screen. The flashcard screen displays one of the unknown words in user’s word list. There is a function to display the Japanese translation of the word, where it is generated by Google Translate. We used Google Translate for automatic translation instead of manual translation which takes time and effort. We checked the correctness of the translation by random sampling in this experiment.

Moreover, users can move to the manga screen where the word is included for understanding how the word is used in practice.

### 3.2 Learning Material

Users use the pairs of a Japanese manga and the English translated one. Also, to store the words in the database, we should know what words are written in manga. Unfortunately, We cannot use data in Manga109[12] for this experiment, where Manga109 is one of the most famous manga datasets with the annotations of the positions and text information. It is because there is no English manga in Manga109. We prepared the text information in English translated manga in the following manner: Firstly, the regions of English words are detected from English manga page images based on the character detection method proposed by Beak et al. [10].

We applied the method of Smith et al.[11] to obtain text information by cropping images from a single word-by-word region acquired by text detection. We use 22 manga titles in English and Japanese versions for the experiments,

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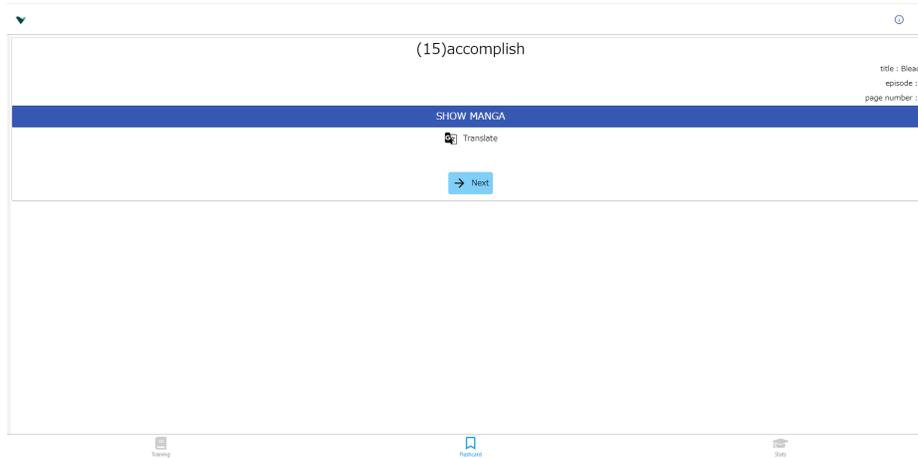


Fig. 6: flashcard screen

where the genres of the manga are various, for example, Fantasy, Sports, Comedy, Suspense, Romance, and so on.

The reason why there are some different genres of manga is to help learners choose manga that match their interests and help them learn.

## 4 Experiment

In this section, we describe our experiments with Manga Vocabulometer. In this experiment, we tested the degree of memorization retention to compare using Manga Vocabulometer with using just flashcard.

### 4.1 Experimental Condition

We conducted an experiment to evaluate the effectiveness of our method. In the experiment, 20 participants learn unknown words with both just memorization and our Manga Vocabulometer. The participants were all Japanese including 9 males and 11 females. They used Manga Vocabulometer as the app working on a desktop PC with a high-speed camera and an eye tracker. The high-speed camera and eye tracker is Blackfly S USB3 and Tobii Eye tracker 4C pro upgrade version, respectively. Figure 7 shows the setup of the experiment. As shown in Fig.7, the eye gaze information, and the video of the participant's face were recorded while the participants read the manga. This data was not used in this evaluation although they will be used for analysing users' reading behaviors.

### 4.2 Details of Experiment

In this subsection, we describe the details and procedures of the experiment. In this experiment, we compared English word memorization using Manga Vocab-

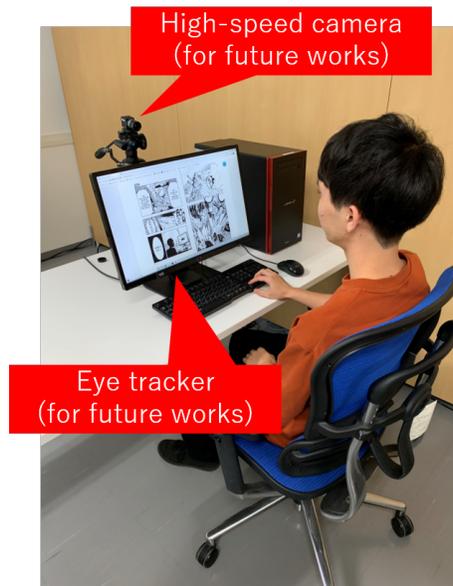


Fig. 7: Setup of experiment

ulometer with simple one just looking at the text. In this experiment, there are two phases: the reading phase and the memorization phase. The reading phase is conducted using the functions in the learning cycle in Fig. 3, and the memorization phase is conducted using the flashcard in Fig. 3.

Firstly, participants freely selected and read English translated manga. After that, they answered questionnaires related to interest and labeled the subjective difficulty and unknown words in each episode. The participants repeated this task until 20 unknown words are collected or one hour. We call these unknown words Wordset A. Then, we selected another 20 words called Wordset B with similar word frequency to the words in Wordset A. The average word-rank is 7430 in Wordset A and 7420 in Wordset B. The smaller this rank, the greater the frequency of the word in the general document. Therefore, Wordset A and B have the similar difficulty each other based on the word frequency. The participants memorized the words in Wordset A using Manga Vocabulometer. They also memorized the words in Wordset B by simply looking at them.

The time for the memorization was fixed for 2 hours so that the participants can learn the total 40 words by heart. We conducted four confirmation tests at the intervals of 1, 2, 4, and 8 days after they had memorized all the words. The confirmation test consists of 5 words in Wordset A and 5 words in Wordset B, for a total of 10 words. For the 17th participant (P17), the experiment was conducted with 12 words both in Wordset A and B because P17 collected only 12 unknown words in Wordset A. Then, we selected another 12 words called

Wordset B with similar word frequency to the words in Wordset A for P17. The confirmation test for P17 consists of 3 words in Wordset A and 3 words in Wordset B, for a total of 12 words.

## 5 Result and Discussion

Figure 8 shows the results of the confirmation test. The horizontal axis in Fig. 8 represents the difference of scores for Wordset A and B, where a score means the number of correct answers. Therefore, positive values in the horizontal axis means that Manga Vocabulometer is effective in the memorization of words. The vertical axis in Fig. 8 represents the number of participants which is corresponding to each score. As shown in Figure 8, 17 out of 20 users scored better on the confirmation test of Wordset A than Wordset B. Due to the small memorized words, the statistical comparison of the test per user is limited and the order of the tests is not taken into account, so it is difficult to infer much from the sum of the differences.

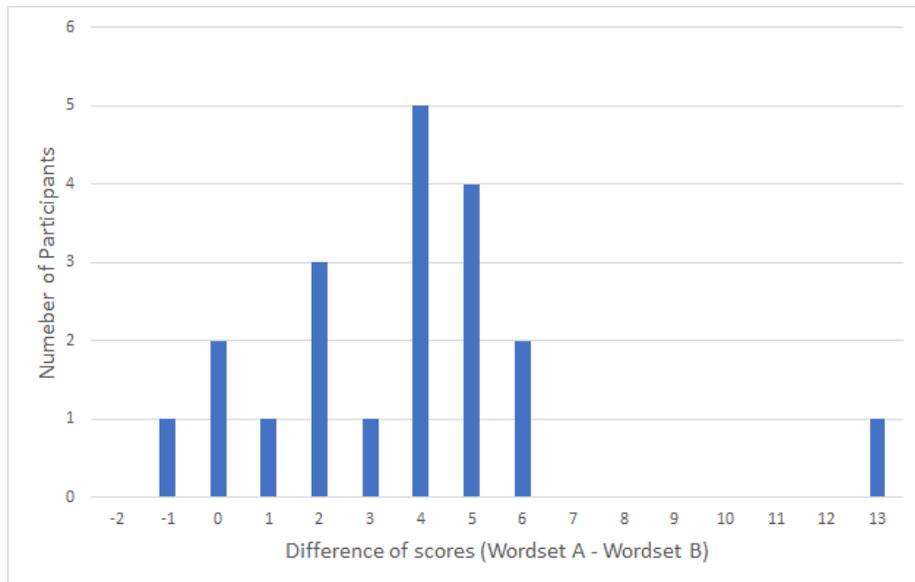


Fig. 8: Results of confirmation tests based on the difference between the numbers of correct answers for Wordset A and B.

To confirm the performance, we introduced a two-tailed Wilcoxon-Pratt Signed-Rank test[13] which is a non-parametric statistical hypothesis test. This test uses the pairs of dependent data for a non-parametric distribution. For using the test, we calculated the mean and standard deviation of the percentages of

participants' correct answers for Wordset A and Wordset B. Table 1 shows the calculated mean and standard deviation for Wordset A and B. As shown in Tab. 1, we can find that the means in Wordset A are greater than those in Wordset B for all test days. The difference in Wordset's performance appears to be greater the more remote the day of the test, suggesting that the proposed method has better long-term retention. Table 2 shows the results of the Wilcoxon-Pratt signed-rank test. The reason why p-values in "Test Day 1" and "Test Day 2" are undefined is because there is not much difference between the results of the tests which means that many of them are tied. In general, if p-value is less than 0.05, the result of the test is effective. The results in Tab. 2 indicate that Manga Vocabulometer is effective for inducing better English vocabulary retention.

Table 1: Mean and standard deviation of the percentages of correct answers for Wordset A and B.

Test Day	Wordset A Mean	Wordset A STDEV	Wordset B Mean	Wordset B STDEV
1	4.8125	0.5266	4.1176	0.8455
2	4.5625	0.8638	4.0657	1.3448
4	4.1250	1.2183	3.6769	1.2686
8	4.0000	1.1726	2.3610	1.5995

Table 2: Results of Wilcoxon-Pratt signed-rank test between Wordset A and B.

Test Day	Z-Score	p-value
1	-2.6656	-
2	-1.9548	-
4	-2.4318	0.0151
8	-2.9396	0.0033

Then, we analyse the experimental results for each user. Figure 9a and 9b show the number of correct answers for each user, Wordset, and test day. As shown in Fig. 9a and Fig. 9b, the number of correct answers of some participants (P05, P07, and P08) in Wordset B was zero at the test day 8. On the other hand, the number of correct answers in Word Set A were not zero for all participants at the test day 8. Moreover, the numbers of correct answers in Wordset A were higher than or equal to those in Wordset B except for P03. Therefore, the experimental results confirmed that the memorization method using Manga Vocabulometer was effective for retention in some results. Here we describe the considerations from the results we obtained with the component "feedback". We also found in this experiment that there was no correlation between the difficulty of the manga perceived by the reader and memory retention. In other words, the

memorization method using Manga Vocabulometer does not correlate well with the difficulty of the manga when reading, since the reader associates the picture with the content. Furthermore, the results of the questionnaire on interest level revealed that extensive reading using Manga Vocabulometer was easy to maintain motivation.

We compare Manga Vocabulometer with Mobile Vocabulometer proposed by Yamaguchi et al. which is a smartphone app for learning English with texts. In the experiment for Mobile Vocabulometer, they compared memorization using the Mobile Vocabulometer with flashcard memorization. It is similar to our experiment, however, they used 32 words while we used 20 words. Table 3 shows the mean and standard deviation of the percentages of correct answers for Wordset A and B in their experiments cited from their paper[2], where the setting of Wordset A and B is same as our setting except for the replacement of Manga Vocabulometer with Mobile Vocabulometer. As shown in Table 3, it is shown that learning with Mobile Vocabulometer is effective. Therefore, it was found that manga and text-based learning materials were more effective than flashcards, depending on the participant.

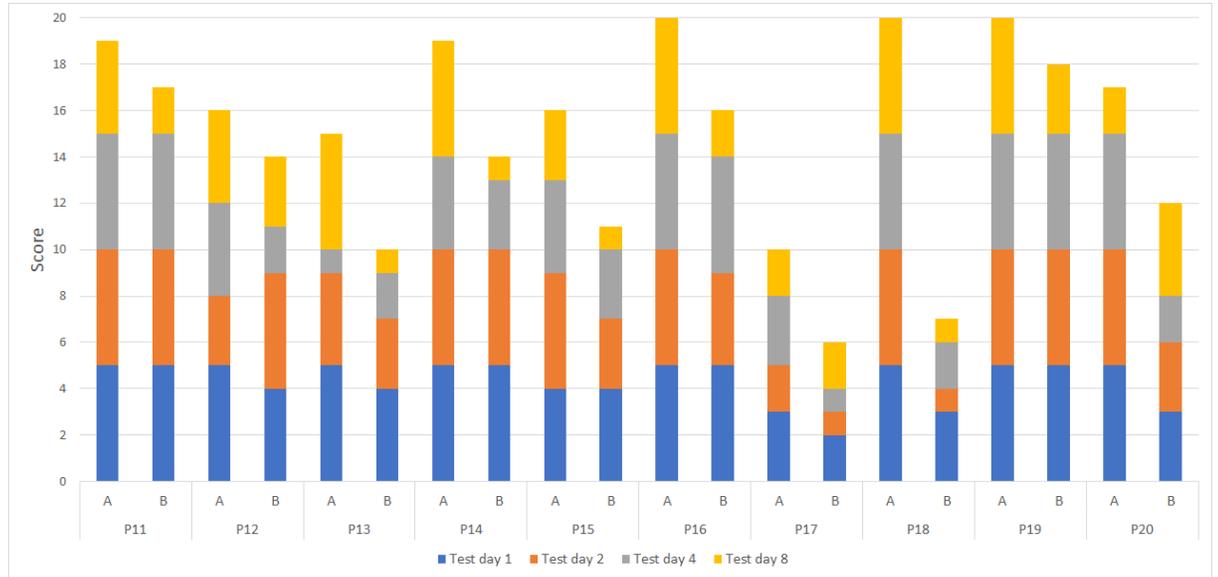
Table 3: Mean and standard deviation of the percentages of correct answers for Wordset A and Wordset B of Testing in Yamaguchi’s experiment

Test Day	Wordset A Mean	Wordset A STDEV	Wordset B Mean	Wordset B STDEV
1	5.2380	1.0910	4.2380	1.5134
2	5.0000	1.2247	3.7619	1.5461
4	4.2380	1.3380	3.5238	1.6917
8	4.1428	1.6212	2.7142	1.4540

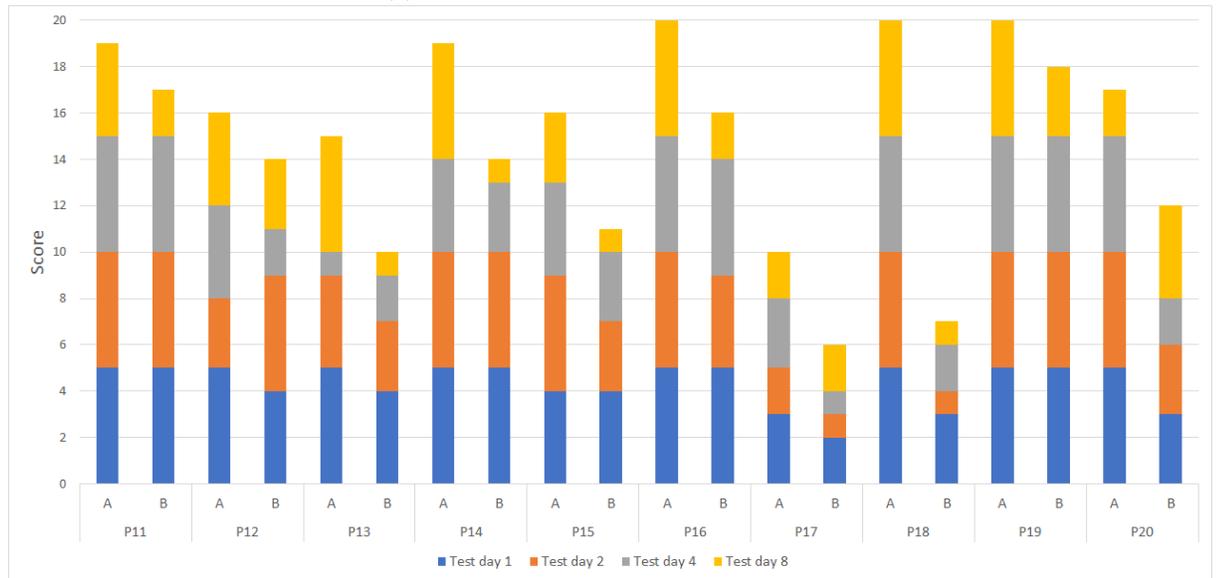
## 6 Conclusion and Future Work

In this paper, we proposed Manga Vocabulometer, the new support system for extensive reading. This system allows users to generate flashcards that are matched to their English skills. In our experiment, the participants memorized 40 unknown words with Manga Vocabulometer and normal flashcards. The experimental results confirmed that Manga Vocabulometer has a positive impact on learning effectiveness based on p-values obtained by Wilcoxon-Pratt signed-rank test.

In the current Manga Vocabulometer, learners are required to choose the manga by themselves. This means that they won’t know if the manga they are reading is appropriate for their English level until they actually read it. It is the future work to add the function of recommending manga appropriate to the learner’s English level and interests.



(a) P01 to P10.



(b) P11 to P20.

Fig. 9: Number of correct answers for each user, Wordset, and interval

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