PAPER

Online Collaborative Kit-Build Concept Map: Learning Effect and Conversation Analysis in Collaborative Learning of English as a Foreign Language Reading Comprehension

Aryo PINANDITO[†*a)], *Nonmember*, Yusuke HAYASHI[††], *and* Tsukasa HIRASHIMA[††], *Members*

SUMMARY Concept map has been widely used as an interactive media to deliver contents in learning. Incorporating concept maps into collaborative learning could promote more interactive and meaningful learning environments. Furthermore, delivering concept maps in a digital form, such as in Kit-Build concept map, could improve learning interaction further. Collaborative learning with Kit-Build concept map has been shown to have positive effects on students' understanding. The way students compose their concept maps while discussing with others is presumed to affect their learning. However, supporting collaborative learning in an online setting is formidable to keep the interaction meaningful and fluid. This study proposed a new approach of real-time collaborative learning with Kit-Build concept map. This study also investigated how concept map recomposition with Kit-Build concept map could help students collaboratively learn EFL reading comprehension from a distance by comparing it with the traditional open-ended concept mapping approach. The learning effect and students' conversation during collaboration with the proposed online Kit-Build concept map system were investigated. Comparative analysis with a traditional collaborative concept mapping approach is also presented. The results suggested that collaborative learning with Kit-Build concept map yielded better outcomes and more meaningful discussion than the traditional open-end concept mapping.

key words: *collaboration, concept map, discussion, EFL, Kit-Build, learning effect, online*

1. Introduction

In learning, knowledge can be shared through a social interaction [1]. Interactive learning through collaboration is considered important as collaborative learning could benefit students socially, psychologically, and academically [2]. Learning in a virtual, online-based learning environment is more challenging than learning in a traditional physical classroom-based learning environment. In an offline classroom, direct face-to-face interactive learning activities are very straightforward and natural. There is no time and space separation to maintain good interaction that involves emo-

tion, empathy, and physical activity. However, technology needs to lessen the time and space separation problems of an online learning environment [3], [4]. The interaction should include students' participation where learning becomes an act of rewriting than merely receiving the contents uncritically; hence, a meaningful learning [5]. When meaningful interaction is developed, students' knowledge and understanding shall improve through the interactions made during learning [6].

As suggested in a study, students need to be presented with interactive learning content to attain an effective and meaningful interaction. The study also suggested that improving students' interaction in such online learning environment helped them enhanced their learning more [7]. Despite the promising benefits of using concept maps in collaborative learning, realizing the ability to interact and discuss using concept maps in online settings is challenging. The technology being used needs to provide a similar interaction style of concept mapping and seamless transition between offline and online; hence, keeping the interaction and discussion natural, thus yields meaningful learning. With the currently available computer and Internet technology, concept maps can be authored in digital forms, distributed, and interactively used online.

A learning framework, namely Kit-Build concept map, uses a recomposition-based concept mapping approach. The students recompose concept maps from a given set of concept node and link components to learn [8]. Kit-Build concept map uses a digital concept mapping tool for teachers and students to compose and interact with concept maps. The set of components for students to recompose can be automatically generated from their teacher's concept map by using the provided tool. Teachers can assess students' understanding by automatically comparing students' concept maps with the teacher's respective concept maps. In other studies, the tool has been extended to support efficient authoring [9], collaborative work [10], [11], and further extensions towards learning activities with Kit-Build [12].

Recently, many education systems were shifting from offline to online. Adoption towards online-based education and learning technologies grew significantly. The interaction style between teachers and students during learning is also transforming. Subsequently, online collaborative learning with Kit-Build concept map requires supports for online use. The concept mapping tool functionality has been

extended in facilitating online and collaborative use of Kit-Build concept map to the extent that students and teachers could collaboratively learn online, work on the same concept map, and have their discussion uninterrupted and conducted in real-time. Hence, removing the offline barrier of current Kit-Build concept map tool while also supporting online collaborative learning with Kit-Build concept map.

In previous studies, Kit-Build concept map has been used to support learning English as a Foreign Language (EFL), especially for reading comprehension. In learning EFL reading comprehension with Kit-Build, students learn, express, and share their understanding by reconstructing concept maps from a set of Kit-Build concept map components. The use of Kit-Build concept map was showed to improve students' comprehension of EFL readings [13], [14]. Previous studies suggested that posing concept maps in collaborative learning could improve students' learning and productivity [15], [16]. Using Kit-Build concept map in collaborative learning also yielded similar benefits towards learning [10], [11]. However, how Kit-Build concept map performed in online collaborative learning has yet to be discovered. This study took the online collaborative Kit-Build concept map tool into a trial to investigate the use of Kit-Build concept map in online collaborative learning of EFL reading comprehension and discover whether it helped the students comprehend the readings better from online discussion and collaborative recomposition of concept maps. Comparative analyses with a traditional online collaborative concept mapping approach were presented in this study regarding the learning effect and students' conversation during collaboration.

2. Literature Review

2.1 Collaborative Learning of EFL Learners with Kit-Build Concept Map

Kit-Build concept map is a learning framework that uses concept maps as its learning strategy. The framework incorporates a computer-supported concept mapping tool that allows teachers to assess students' understanding by comparing teacher and students' concept maps more efficiently [17]. Kit-Build concept map primarily adopts a closed-end concept map approach where students' concept maps are limited to the provided components [8]. In Kit-Build concept map, a set of concept map components from which the students will recompose is called a kit.

In composing a closed-end concept map, the students cannot freely compose their concept maps with their own words or ideas as opposed to composing an open-end concept map from scratch. The concept map recomposition activity of a Kit-Build kit is referred to as kit-building. The kit, from which students compose their concept maps, can be obtained from the teacher's concept map decomposition. The decomposition of teacher's concept maps can be performed automatically by the Kit-Build concept map tool or manually by the teachers. As the students compose their

concept map using the same components as their teacher's concept map components, the comparison can be automatically carried out by the concept mapping tool [8]. Thus, their misunderstanding or misconception can be inferred from the different parts between teacher and students' concept maps.

Learning the EFL reading comprehension with Kit-Build concept map was shown to be one beneficial learning strategy to learn with concept maps. One practical use of Kit-Build concept map is supporting the learning of EFL reading comprehension. Practising with many readings is a common way to improve learner's language skills. Collaboratively learning with others has also been known to more beneficial than learning individually. Collaborative learning promoted active learning, knowledge-sharing, and self-discovery of learners due to the interaction during the collaboration process [18]. Therefore, in the context of collaborative learning of EFL reading comprehension, one understanding of a reading text can be shared through the interaction and discussion during collaboration, hence improved comprehension [1].

The nature of interaction varies in different learning environments and settings, either in a direct—face-to-face learning environment or in an online class at a distance. Regardless of the settings, the environment needs to stimulate learners' curiosity to promote meaningful collaborative learning; hence more productive activities and improved learning [19]. Therefore, to support collaborative learning with Kit-Build concept map and also supporting distance communication, the Kit-Build concept map tool has been extended with real-time synchronization of concept mapping capability and text-based communication features. This study tries to discover whether composing concept maps with Kit-Build concept map helps students better understand the reading than composing concept maps from scratch in an online collaborative learning environment.

2.2 The Use of Kit-Build Concept Map Authoring Tool in Collaborative Learning

In learning with the current Kit-Build concept map tool, a single user can only create or compose one concept map at a time. Even though the tool has been applied in collaborative learning, it cannot be operated by more than one student to work on the same concept map at the same time [10], [11]. Moreover, it was impossible to use the current tool to collaboratively work on a single concept map from two different computers simultaneously. As the need for a collaborative Kit-Build concept mapping arises, an extension to the existing Kit-Build concept map tool that supported collaborative work was implemented.

The new implementation of Kit-Build concept map tool allowed multiple users to work with a concept map from different computers collaboratively and simultaneously. Any changes over one drawing canvas will immediately be reflected to the other participating users; hence, a real-time collaborative concept mapping environment is created. A
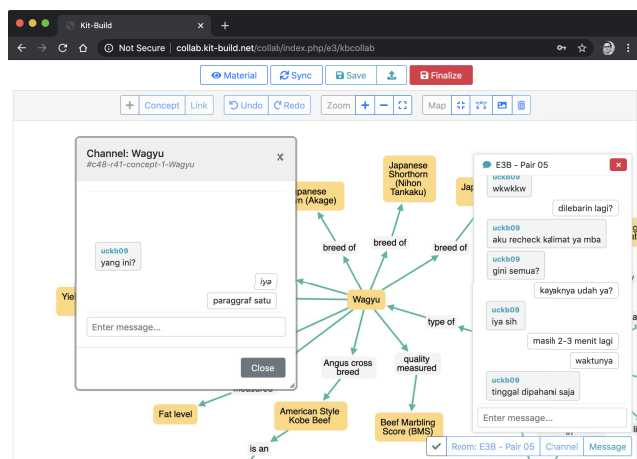
Fig. 1 Communication in online collaborative Kit-Build concept map tool

similar concept mapping tool has been developed in another study [20]. The tool also allows several users to compose a concept map at the same time collaboratively. However, the tool does not support the recomposition of concept maps, and it has no comparison analysis features as in this study new collaborative Kit-Build concept map authoring tool.

The tool has been developed with web technologies, hence accessible from modern web browsers that support HTML5 and Javascript. The tool is expected to run on most computers and mobile devices with access to the Internet despite the requirements that have to be met for a smooth and seamless concept mapping experience. An example of the newly developed online collaborative Kit-Build concept map tool, which shows a student's concept map during collaboration, is shown in Fig. 1.

In supporting communication in collaborative work of concept mapping, the online collaborative Kit-Build concept map tool provided two kinds of text-based communication channels as shown in Fig. 1 for students to communicate and discuss their concept maps with others. The discussion data for analysis were obtained from these channels. One of the communication channels, which is located on the right side of the screen, is a general discussion channel. Messages sent from this channel will be broadcasted to other participants who joined the collaboration. The other type of communication channel is linked to a concept or link node; hence, one communication channel for each concept and link node. The node-linked communication channels were designed to facilitate discussion of a particular idea or relationship attached to the corresponding concept or link nodes. Additionally, notifications and indicators will be displayed over a concept or link node when a new message arrives. These communication features are useful for facilitating communication among users and keeping the discussion in control when discussing many different topics or ideas simultaneously.

3. Methodology

3.1 Research Questions

In answering the research questions, a concept mapping tool, which extends the previous Kit-Build concept map tool, has been designed and developed. The tool now allows teachers and students to collaboratively compose concept maps online. An experiment is designed to evaluate the tool in the context of an online real-time collaborative learning that uses the Kit-Build concept map method. This study targeted the learning of EFL reading comprehension, where students collaboratively compose concept maps with partners.

This study aimed to answer two research questions regarding the online collaborative learning of EFL reading comprehension with Kit-Build concept map. The first research question describes how the use of Kit-Build concept map in an online collaborative learning environment of EFL reading comprehension, which uses concept maps composition as its learning strategy, affects students' comprehension as opposed to the regular open-end concept mapping. The second research question investigates whether there are differences in students' conversation when they collaboratively work on their concept maps with and without Kit-Build.

3.2 Reading Material and Concept Map Kit

The context of this research was the use of the Kit-Build concept map in supporting the online collaborative learning of EFL reading comprehension. The EFL reading comprehension subject used in the experiment was a general English reading text entitled "Wagyu." The reading consisted of 900 English words without any graphics that discussed Wagyu—the Japanese-breed cows. The reading content was obtained from various online sources consisting of factual information, uncommon vocabularies, and several complex linguistic aspects as problems that the students have to overcome to comprehend the content thoroughly.

A concept map (Kit-Build goal map) was specifically composed as a Kit-Build kit. The kit consisted of 20 links and 19 concepts that covered most of the reading's main topics and ideas. The kit was provided only to participants who compose their concept maps with Kit-Build. The type of kit was a set of fully deconstructed components of the goal map; there were no link nodes that have been pre-connected to a concept node, neither entirely nor partially when the kit was given. For the purpose of this study, the goal map and the kit implied the answers to only half the questions of pre-, post-, and delayed-test. As an example, several parts of the kit to be recomposed by the students are shown in Fig. 2.

3.3 Participants

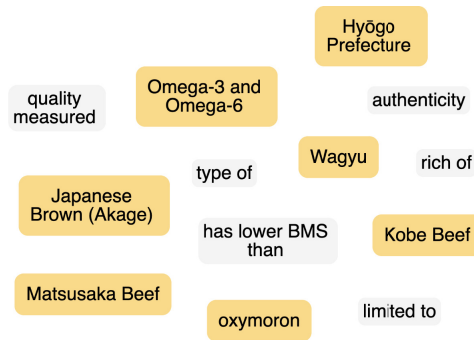The experiment involved 40 international students that consisted of 25 men and 15 women. They were graduate stu-

Fig. 2 Part of the provided kit that implied the answer to several comprehension test questions.

dents studying at Hiroshima University and used English as a foreign language, pursuing master's (60%) and doctoral (40%) degrees in engineering, social science, education, linguistic, finance, and department policy. They originated from Asian countries, and none of them were native English speakers or used English as their second language, i.e., Indonesia (75%), China (20%), and Laos (5%). Their age was in the range of 20–25 (27.5%), 25–30 (37.5%), 30–35 (15%), 35–40 (17.5%), and 40–45 (2.5%). Their ability in English was high enough to adequately understand various learning subjects delivered in English as they have an average equivalent Test of English as a Foreign Language (TOEFL) Paper-Based Test (PBT) score of 557.6 (SD = 41.30).

They were divided into two groups of dyads, i.e., Collaborative Scratch Mapping (CSM) group and Collaborative Kit-Building (CKB) group. The groups solely differ in terms of the concept mapping approach used to create a concept map. During the collaboration, the students were collaboratively working in pairs of two (dyads). Students of the CSM group created their concept maps with the usual open-ended concept mapping approach, contrary to composing concept maps from a kit. However, the CKB group students created their concept maps from a pre-defined Kit-Build concept map kit. In determining the pairs, the students could freely choose their collaboration partner in concept mapping. Thus, presuming they have no problem communicating and could freely express their thinking, emotions, or ideas without reluctance.

3.4 Experiment Design

The experiment started with the preparation and training phase, where all participants were introduced to the concept maps and the Kit-Build concept map. The training and preparation phase aimed to develop a common perception concerning the underlying theory of concept maps and carry out the necessary preparations before the actual concept mapping activity was carried out. Additionally, the techniques in composing good concept maps, how to compose a concept map with Kit-Build concept map tool, and communicating using the tool's communication features were introduced. The flow of the experiment of this study is shown in
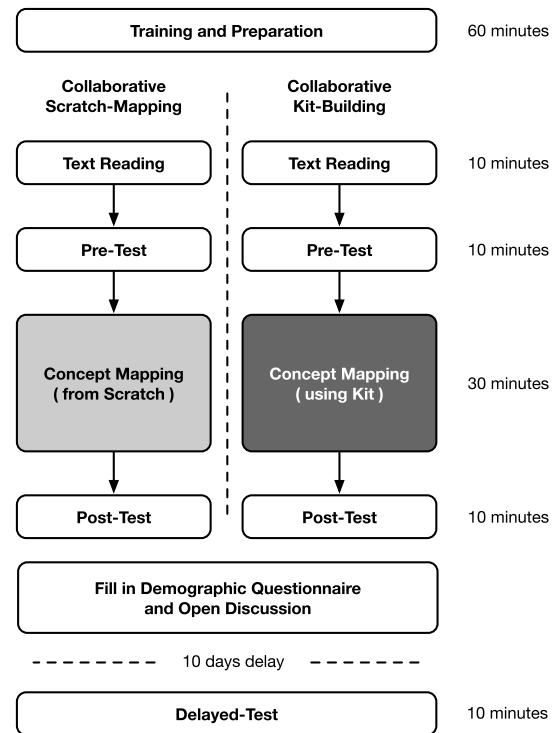

Fig. 3 Experiment flow.

Fig. 3.

All participants were given a user manual document regarding the concept mapping tool to try the system before participating in the experiment. During the experiment's training and preparation phase, the participants practiced concept mapping using the online collaborative Kit-Build concept mapping tool. These activities were carried out to ensure that all participants would not encounter any difficulties composing their concept map while also communicating with their collaboration partner.

For the experiment, an online system has been built specifically to follow the designed workflow. The system provided a mechanism to display the reading text on the screen. Thus, the students could read the text while they were composing their concept maps. The tool has convenient features to make the concept mapping composing of a text document faster and more convenient. Parts of the displayed text could be selected to generate concept or link nodes whose labels were obtained from the selections. However, these added features were relevant solely to participants who created their concept maps from scratch. Hence, composing concept maps from text documents could be performed with less typing and more quickly. Activities in the reading phase, pre-test, concept mapping, post-test, and delayed-test were conducted using the system. However, the experiment demographic questionnaires were given to the participants on a paper basis.

All participants in both groups were requested to work and collaborate in pairs. They composed and discussed the concept map they made in the concept mapping phase. Unless they were currently answering the tests, they could read

the reading passage and access other information resources, including the Internet. During the experiment, every participant used a different computer and worked collaboratively with their partner from two separate rooms. The room in which they do the concept mapping is designed to the extent they neither can see nor have direct face-to-face communication with their collaboration partner. Therefore, simulating an online learning activity where direct communication was somewhat difficult or impossible to conduct verbally.

3.5   Measurements

During the experiment, the participants were given three kinds of tests, i.e., pre-test, post-test, and delayed-test. The pre-test and post-test were given right before and after they conducted the concept mapping activity, respectively. The delayed test was given after ten days of delay. The questions for the tests were made according to the lower and higher order of Bloom's taxonomy [21] in a similar manner with prior studies [22]–[24]. The pre-test was used to measure students' understanding before the Concept Mapping phase. The pre-test score was also used later in the analysis to evaluate the participants' homogeneity of variance. The post-test was immediately given to all participants following the Concept Mapping phase and measured the learning effect of collaboration activity with concept mapping towards participants' comprehension regarding the text. The test results were analyzed to discover whether students' understanding and discussion during collaboration were different.

The tests were composed of 15 multiple-choice questions. Each question included five options with one correct answer, and the pre-, post-, and delayed-test were using the same set of questions. However, the question order and options for the answer were shuffled to motivate students to think more carefully and avoid remembering the answers. The questions were categorized into two categories, i.e., In-Kit and Not-In-Kit. The In-Kit category consisted of eight questions whose answers were implied by the kit, covering the lower and higher order of Bloom's taxonomy. However, as the name implied, the answers to the Not-In-Kit category questions were not covered by the kit. Thus, separate analyses between two concept mapping groups could be conducted based on the information covered by the kit.

Table 1 shows several examples of the In-Kit questions whose answer was implied by the kit. Referring to the classification of questions as demonstrated in [21]–[24], questions Q2 and Q8 are the types of questions that evaluate students' comprehension and ability to recall information from the text. Conversely, questions Q3 and Q9 fall into higher order questions that require students to transfer their learning and relate parts of the information. Thus, encourage the students to think deeply.

3.6   Coding the Discussion and Talks

Due to the design of the experiment, all participants were not allowed to have direct face-to-face communication. As

Table 1   Examples of In-Kit questions of the pre-test and post-test

ID	Question and Options for Answer
Lower Order: Remember and Understand	
Q2	How many digits the assigned ID for every authentic Kobe Beef?
	A. 8 digits D. 11 digits
	B. 9 digits E. 12 digits
	C. 10 digits
Q8	Which of the following words that best explained the word "oxymoron"?
	A. Illusion D. Contradictory
	B. Analogy E. Retoric
	C. Stupidness
Higher Order: Apply and Analyze	
Q3	What is the minimum grade and marbling level of a Kobe Beef to be classified as authentic?
	A. A4 - Marbling Level 5 D. A5 - Marbling Level 6
	B. A4 - Marbling Level 6 E. A5 - Marbling Level 10
	C. A5 - Marbling Level 4
Q9	According to the text, which of the following statements is TRUE regarding Matsusaka Beef and Kobe Beef?
	A. Kobe Beef is more expensive Wagyu than Matsusaka Beef.
	B. Kobe Beef has richer fat than Matsusaka Beef.
	C. Kobe Beef has lower BMS level than Matsusaka Beef.
	D. Kobe Beef has higher Omega-9 acid than Matsusaka Beef.
	E. Both Beef are coming from breeds of Japanese Brown cow.

previously mentioned, the system provided text-based communication channels for participants to communicate and discuss with their partners. Even though it was possible to provide a video or voice-based communication channel in the concept mapping tool, it was neither implemented nor used in this study.

During the concept mapping, all participants communicate and discuss their concept map using the provided communication channel. They were allowed to use their native or any other local languages that they were comfortable communicating with their partner. All of their utterances, including one that linked to link and concept nodes, were recorded. In measuring and analyzing the dynamics of problem-solving in groups or teams, the talks in the discussions were coded with the Advanced Interaction Analysis for Teams (act4teams) coding scheme [25]. The coding scheme categorized the talks into four main facets of group communication, i.e., problem-focused statements, procedural statements, socio-emotional statements, and action-oriented statements. Each talk or message sent by the dyad's member to the discussion window was classified into one category of the coding scheme and counted as one articulation, expression, or speech.

4.   Result and Discussion

The experiment was conducted in April 2020 and held on scheduled dates and times. However, the participants could also decide the date and time at their convenience. Even though not all participants participated on the same sched-

Table 2 Descriptive statistics of test score for In-Kit questions.

Test Type	Group	n	Mean	s.d.
Pre Test	CSM	20	4.29	1.61
Pre Test	CKB	20	4.25	1.49
Post Test	CSM	20	6.14	1.32
Post Test	CKB	20	7.63	1.21
Delayed Test	CSM	20	4.86	1.50
Delayed Test	CKB	20	6.25	1.41

Table 3 Descriptive statistics of test score for Not-In-Kit questions.

Test Type	Group	n	Mean	s.d.
Pre Test	CSM	20	4.21	1.64
Pre Test	CKB	20	4.63	1.52
Post Test	CSM	20	6.21	1.81
Post Test	CKB	20	6.25	1.41
Delayed Test	CSM	20	5.00	1.50
Delayed Test	CKB	20	5.06	1.60

ule, they agreed to follow the entire experiment workflow. The experiment was conducted at Learning Engineering Laboratory, Hiroshima University. All participants used computers with similar specifications to interact with the system.

4.1 Online Collaborative Concept Mapping Tool

The trial of the extended Kit-Build concept map tool in this study could depict the potential implementation of Kit-Build concept map framework in an online learning environment or another learning context that involved concept mapping as one of its activities. Despite the tool's limited features in facilitating communication, effective conversation and discussion can be made without major issues that could disrupt the collaboration process of composing a concept map. Complaints from participants who were having difficulties in communicating with their partners were absent. However, according to the feedback from post-experiment and open discussions with the participants, they strongly demanded audio and video-based communication to the extent of minimizing communication delay during collaboration. The participants also suggested supports for graphical and numerical contents.
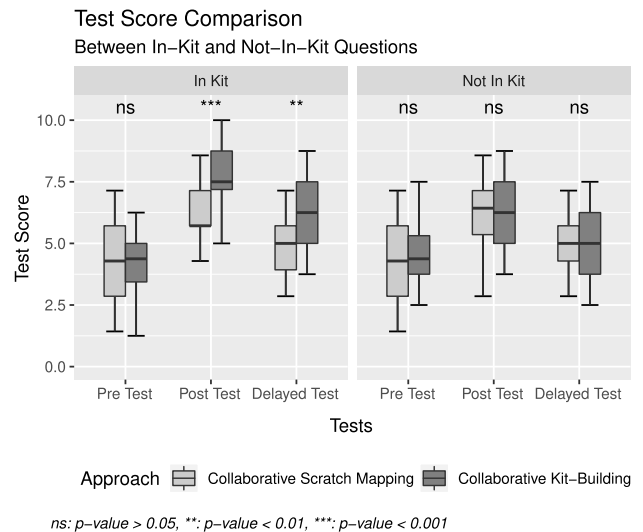
4.2 Test Score

The test results were divided into two categories per question's group. One score was given for each correct answer. However, no penalty was given for incorrect answers or unanswered questions. The maximum score was 8 and 7 for the In-Kit and Not-In-Kit questions set, respectively. Therefore, if they answered all questions correctly, they would be given a score of 15. However, analysis of the scores was carried out per question's type.

As each question category has a different number of questions, the test scores between each group were normalized for comparison analysis. The descriptive statistics of test scores for In-Kit questions, which are grouped by test type, and the concept mapping type, are shown in Table 2, and the descriptive statistics for Not-In-Kit questions are shown in Table 3. All scores in Table 3 have been normalized to a maximum score of 10.

Figure 4 shows the graphical comparison of pre-test, post-test, and delayed-test scores between two concept mapping approaches as well as the question type. Regarding Not-In-Kit questions, students from both CSM and CKB

Fig. 4 Test score comparison between different concept mapping approach.

groups obtained similar scores. No statistical differences in the pre-test, post-test, and delayed test scores between the CSM and CKB group could indicate that all students could have a similar cognitive competence regardless of the group. However, the post-test and the delayed test result for the In-Kit questions between the CSM and the CKB group were different. Hence, the difference in learning effect.

Because of the small number of participants who participated in this study, the experiment's data were failed to conform to the Shapiro-Wilk normality test. Therefore, non-parametric approaches were used to analyze the data and interpret the results. According to the non-parametric Mann-Whitney U test to compare the test results between the CSM and CKB group, the pre-test scores for the In-Kit questions were statistically insignificant (*p-value* = 0.87). Therefore, it can be said that students from the CSM and CKB group have a similar level of understanding prior to collaborative learning with concept maps. However, significant differences were shown for the post-test score (*p-value* = 0.0001958) and the delayed-test score (*p-value* = 0.003786) between the CSM and CKB group for the In-Kit questions score. The differences were significant because the p-values of Mann-Whitney U tests were less than the specified significance level of 0.05. Therefore, students who used the Kit-Building approach gained better scores than the CSM group students who collaboratively created their con-

Table 4 GLM analysis result of the delayed-test score.

	Estimate	Std. Error	t value	p-value	Sig.
(Intercept)	−10.56	10.71	−0.99	0.331	
post-test	0.61	0.16	3.84	$4.62×10^{-4}$	***
group	0.49	0.46	1.06	0.296	

Table 5 The number of students who answered the questions correctly.

ID	Pre-Test		Post-Test		Δ_{kb}	Δ_{sm}	Δ_C
	C_{kba}	C_{sma}	C_{kbb}	C_{smb}			
Lower order questions							
Q1	12	13	19	16	7	3	4
Q2	12	8	19	14	7	6	1
Q4	5	6	8	10	3	4	1
Q8	8	6	11	10	3	4	1
Higher order questions							
Q3	7	5	19	7	12	2	10
Q6	9	8	16	10	7	2	5
Q9	11	11	19	13	8	2	6
Q14	5	4	11	8	6	4	2

cept maps from scratch.

In evaluating the memory effect of post-learning activity with concept maps, a Generalized Linear Model (GLM) analysis of the delayed-test score was carried out. However, this study did not evaluate participants' cognitive competence before learning with concept maps; thus, it cannot be included in the analysis. The GLM analysis provided the delayed-test score as the dependent variable and set the post-test score and group as the influencing factors. According to the GLM analysis result as shown in Table 4, it can be said that the delayed-test score, which measured the students' retained knowledge, was significantly affected by their knowledge after the concept-mapping activity (*p-value* < 0.05) instead of the instructional method used during concept mapping (*p-value* > 0.05). The delayed-test score of the CKB group students is higher than the CSM group students because the post-test score of the CKB group students is also higher. In other words, all students retained their knowledge in a similar manner. Nevertheless, students who collaboratively learn with Kit-Build could retain more knowledge as they could focus more on the topics represented by the kit than the students who did not use Kit-Build.

As in other studies about learning with concept maps, collaboratively learning with Kit-Build concept map could also improve learners' understanding of a particular topic. In this study, the students' understanding of the reading was improved, regardless of how they do the concept mapping. However, the CKB group students have better post-test scores than the students of the CSM group. By collaborating with the provided kit, students of the CKB group could focus more on recomposing a concept map by connecting key ideas implied by the kit into correct propositions; less-thinking about concepts and links that should be identified from the text in restructuring their concept map. Thus, the Kit-Build approach could help students deepen their understanding and answer questions of a higher cognitive level.

In delving into questions that Kit-Build could help the students to understand more, the number of students who correctly answered the In-Kit questions of pre-test and post-test (*C*) was counted and is shown in Table 5. The In-Kit questions consisted of eight questions, i.e., four lower-order questions and four higher-order questions. Finding the difference in the number of students between pre-test and post-test using (1) portrayed the questions that the Kit-Build approach has helped the students understand more than the traditional concept mapping approach. According to the difference in the number of students between the two groups (Δ_C), the Kit-Build concept map approach helped the students to answer relatively higher order questions; thus, encouraging

more profound and meaningful thinking.

$$\Delta_C = | (C_{kbb} - C_{kba}) - (C_{smb} - C_{sma}) | \\ = | \Delta_{kb} - \Delta_{sm} | \quad (1)$$

On the contrary, there were no significant statistical differences in the pre-test, post-test, and delayed-test scores of Not-In-Kit questions between the CSM and CKB group. The Mann-Whitney U comparison tests to both groups' pre-test, post-test, and delayed-test scores resulted in non-significant differences with a *p-value* of 0.7228, 0.8486, and 0.8701, respectively. Therefore, it can be said that both groups have a similar comprehension level before and after concept mapping. It can also be said that they could retain a similar level of information after several days.

A study showed that concept maps helped students focus their attention on essential ideas and explore what to learn and how they learn [26]. With Kit-Build concept map, the students could focus more on restructuring the learning contents into concept maps [8]. One might argue that when the students focused more on restructuring a concept map with a Kit-Build kit, they would ignore the remaining part of the contents. However, the argument appears incongruously to the analysis result of the score of Not-In-Kit questions in this study. According to the answers to Not-In-Kit questions, students from both CKB and CSM groups have a similar understanding level on all tests. In answering the Not-In-Kit questions, if the CKB group students ignored parts uncovered by the kit, they could have lower scores than the CSM group students. The score comparison tests to the Not-In-Kit questions showed non-significant differences; hence, a similar learning effect.

During the post-experiment open discussion, all participants were asked to share their thought and experiences by participating in the experiment. Several participants criticized that recomposing a concept map with Kit-Build should allow them to extend the concept map further, adding more content and ideas to the concept map and discussing more with the new content. Expressing one understanding with a concept map could not be expressed by merely using the kit. Furthermore, extending a Kit-Build concept map to an open-end concept map was known to impact learners' comprehension significantly [12]. Withholding part of the infor-
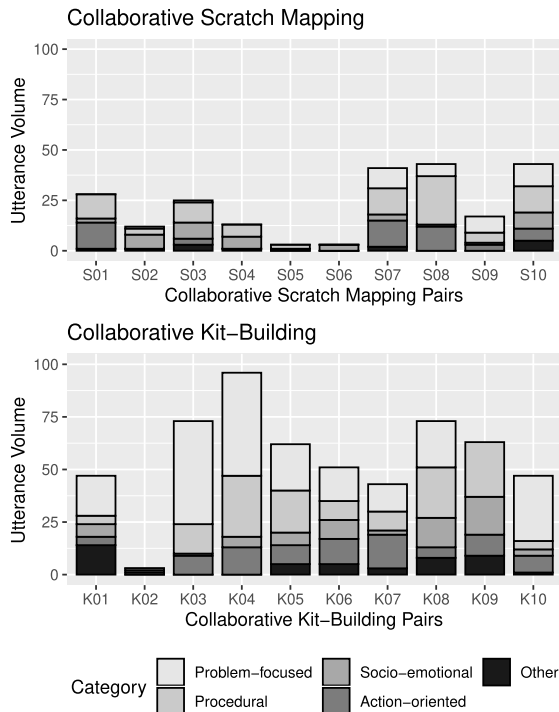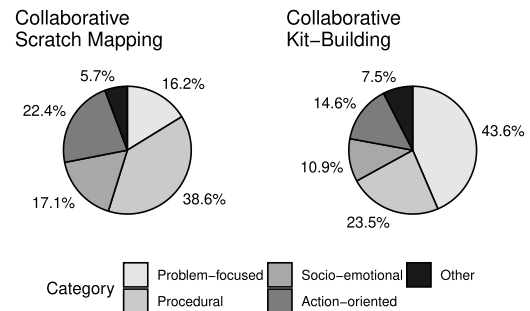
Fig. 5   Act4teams-coded utterance distribution of dyads of collaborative scratch mapping and collaborative Kit-Building groups

Fig. 6   Percentage of utterances between concept mapping approaches

Table 6   Descriptive statistics for the act4teams-categorized utterance.

Approach	Category	n	Mean	SD
CSM	Problem-focused	10	3.7	4.547
CSM	Procedural	10	8.8	7.131
CSM	Socio-emotional	10	3.9	3.071
CSM	Action-oriented	10	5.1	5.547
CSM	Other	10	1.3	1.636
CSM	Total Volume	10	23.1	15.466
CKB	Problem-focused	10	26	15.909
CKB	Procedural	10	14	10.132
CKB	Socio-emotional	10	6.5	5.681
CKB	Action-oriented	10	8.7	4.473
CKB	Other	10	4.5	4.696
CKB	Total Volume	10	59.7	28.593

mation into a concept map kit stimulated students' curiosity towards uncovered parts of the learning contents, hence the "spread of effect" that rippled the students' thinking to think about information outside the parts covered by the given kit. As their focus spread to nearby information, their comprehension regarding the topic shall follow. Therefore, this explains why students who used Kit-Build have similar learning effects with students who composed their concept maps from scratch.

4.3   Utterances in the Discussion

Finding how participants communicate while using the online concept mapping tool to compose a concept map collaboratively is interesting. From the experiment, the collaboration system has captured 828 utterances from 20 dyads during the Concept Mapping phase. Of the total utterance data, 597 (72%) talks came from the CKB group and the remaining 231 (28%) talks came from the CSM group. The utterances were captured from the general and node-linked communication channels. For analysis, their utterances were coded into four categories of act4teams coding scheme and is shown in Fig. 5. Each talk or message, which was sent by a dyad member, was counted as one utterance. The graph in Fig. 5 also shows the number of utterances (volume) sent by members of each dyad for each concept mapping group. The comparison of the act4teams-categorized utterance of the CSM and CKB group is shown in Fig. 6.

According to the graph in Fig. 5, most dyads of the CKB group tended to talk or communicate more than dyads

of the CSM group. The comparison chart in Fig. 6 shows that the CKB group dyads discussed the content more (43.6%) than procedural matters (23.5%) during collaboration. However, the situation in the CSM group was quite the opposite of the CKB group. Dyads of the CSM group tended to talk more about the map creation procedure than have a more focused discussion towards the contents. Nevertheless, it is interesting to see that dyad K02 of the CKB group did not talk much during the collaboration activity, and dyad K09 did not talk about the contents. Further investigation might be required to discover issues that might overcome them to discuss during collaboration. The descriptive statistics for the act4teams-categorized utterance data are shown in Table 6.

Students' utterance data were analyzed with Spearman's correlation test to discover whether the talks were correlated with the concept mapping groups. Spearman's correlation test between the concept mapping group and the number of problem-focused utterance category showed a significantly strong correlation (p-value = 0.0002245, ρ = 0.73). The concept mapping approach and the total utterance volume also have a significant strong correlation (p-value = 0.0006488, ρ = 0.69). However, Spearman correlation test results for the remaining categories showed weak and non-significant correlations (p-value > 0.05 and 0.20 < ρ < 0.39). Therefore, students of the CKB group, which used the Kit-Build approach, tended to discuss the contents more than students of the CSM group. The result was in
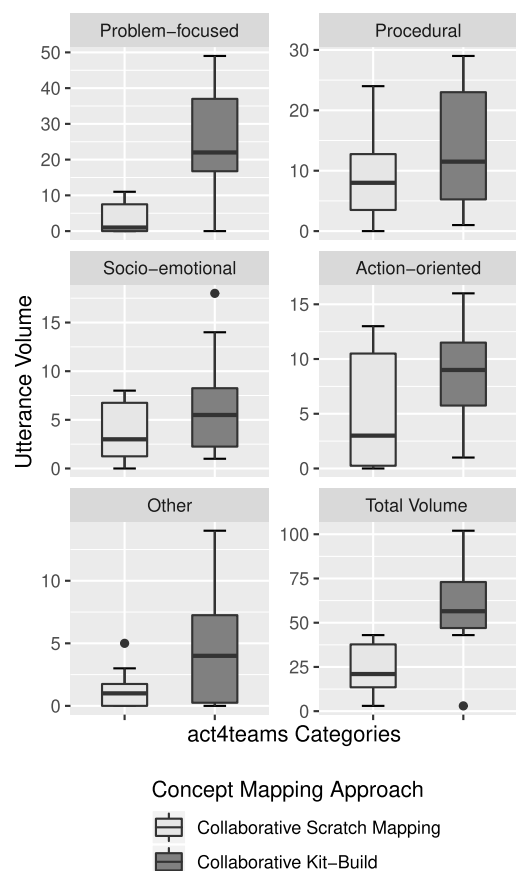
Fig. 7 Comparison of utterance category between concept mapping approaches

harmony with the previous study regarding reciprocal use of Kit-Build concept map in collaborative learning. Students who discuss using Kit-Build concept maps have more exploratory talks than students who discuss using self-created concept maps [10].

In analyzing the difference in students' utterances of the two groups, the non-parametric Mann-Whitney U test for independent samples was utilized for each act4teams category. The analysis also included one "other" category to classify talks that did not fit into other act4teams categories during the collaboration. Additionally, their utterance volume was analyzed. The comparison analysis tests showed that the total volume and problem-focused utterance between the CSM and CKB group were significantly different. The comparison test for the total utterance volume and the problem-focused utterance of the CSM and CKB groups resulted in a significant *p-value* of 0.002404 and 0.001361, respectively. However, the remaining categories, i.e., procedural, socio-emotional, action-oriented, and other, were insignificantly different as the comparison tests to the categories resulted in p-values of higher than the specified significance level of 0.05. Therefore, it can be said that other than discussing the contents, both groups talked similarly. The comparison of students' utterances between the CSM and CKB group for each act4teams category is shown in

Fig. 7.

5. Conclusion and Future Work

According to the experiment result and analysis, using the online collaborative Kit-Build concept mapping tool effectively supports collaborative learning of reading comprehension of English as a Foreign Language that involves concept mapping activities. Both scratch-mapping and kit-building approaches effectively improve students' comprehension of English reading in an online collaborative learning environment with concept maps.

In harmony with previous studies of Kit-Build, recomposing concept maps in collaborative learning with Kit-Build helps students focus more on essential ideas depicted by the kit, hence significantly better comprehension than composing concept maps from scratch. The findings in this study showed that partially included the information about the contents into a Kit-Build kit could arouse students' curiosity, creating the "spread of effect" to think about ideas other than one that implied by the kit. The students who composed concept maps with Kit-Build would have similar knowledge with the other students who composed concept maps from scratch when asked about information uncovered by the kit. Therefore, it is better to use Kit-Build than the traditional concept map to learn EFL reading comprehension collaboratively.

According to the analysis of the students' conversation, using a kit to construct and discuss with concept maps will allow them to talk more about the contents rather than talk about procedural matters. Nevertheless, it is difficult to generalize the result in larger contexts due to the relatively small number of students who participated in this study. Furthermore, more in-depth analysis and investigation might be required to analyze problems that might have overcome students during collaboration while using the tool.

This study neither evaluates the quality nor measures the correctness of concept maps made with different concept mapping approaches by the two groups. Assessing students' concept maps during online collaboration and analyzing their discussion further could find the correlation between their discussion with the yielded concept maps. Additionally, the analysis result could benefit more towards the study of collaborative learning with Kit-Build concept map and also improve its learning tool. Further improvements, integration, and inclusion of Kit-Build concept map framework into broader contexts, such as Massive Open Online Courses (MOOCs) and other learning subjects, are several potential research topics of learning research with Kit-Build concept map.

References

[1] K. Stegmann, A. Weinberger, and F. Fischer, "Facilitating argumentative knowledge construction with computer-supported collaboration scripts," Computer Supported Learning, vol.2, pp.421–447, 2007. DOI: 10.1007/s11412-007-9028-y

[2] M. Laal and S.M. Ghodsi, "Benefits of collaborative learning," Procedia - Social and Behavioral Sciences, vol.31, pp.486–490, 2012.

[3] C. Angeli, N. Valanides, and C. Bonk, "Communication in a web-based conferencing system: The quality of computer-mediated interactions," British Journal of Educational Technology, vol.34, no.1, pp.31–43, 2003. DOI: 10.1111/1467-8535.d01-4

[4] B. Bannan-Ritland, "Computer-mediated communication, eLearning, and interactivity: A review of the research," The Quarterly Review of Distance Education, vol.3, 2002.

[5] R. Gray, "Meaningful interaction: toward a new theoretical approach to online instruction," Technology, Pedagogy and Education, vol.28, no.4, pp.473–484, 2019. DOI: 10.1080/1475939X.2019.1635519

[6] Y. Woo, and T.C. Reeves, "Meaningful interaction in web-based learning: A social constructivist interpretation," Internet and Higher Education, vol.10, no.1, pp.15–25, 2007. DOI: 10.1016/j.iheduc.2006.10.005

[7] M. Moallem, "An interactive online course: A collaborative design model," Educational Technology Research and Development, vol.51, no.4, pp.85–103, 2003. DOI: 10.1007/BF02504545

[8] T. Hirashima, K. Yamasaki, H. Fukuda, and H. Funaoi, "Framework of kit-build concept map for automatic diagnosis and its preliminary use," Research and Practice in Technology Enhanced Learning, vol.10, no.1, p.17, 2015. DOI: 10.1186/s41039-015-0018-9

[9] A. Pinandito, H.M. Az-zahra, T. Hirashima, and Y. Hayashi, "User Experience Evaluation on Computer-Supported Concept Map Authoring Tool of Kit-Build Concept Map Framework," 2019 International Conference on Sustainable Information Engineering and Technology (SIET), pp.289–294, 2019. DOI: 10.1109/SIET48054.2019.8986005

[10] W. Wunnasri, J. Pailai, Y. Hayashi, and T. Hirashima, "Reciprocal Kit-Build Concept Map: An Approach for Encouraging Pair Discussion to Share Each Other's Understanding," IEICE Trans. Inf. & Syst., vol.E101-D, no.9, pp.2356–2367, 2018. DOI: 10.1587/transinf.2017EDP7420

[11] L. Sadita, T. Hirashima, Y. Hayashi, P.G.F. Furtado, K. Junus, and H.B. Santoso, "The effect of differences in group composition on knowledge transfer, group achievement, and learners' affective responses during reciprocal concept mapping with the Kit-Build Approach," RPTEL, vol.15, no.13, 2020. DOI: 10.1186/s41039-020-00133-9

[12] D.D. Prasetya, T. Hirashima, and Y. Hayashi, "Comparing Two Extended Concept Mapping Approaches to Investigate the Distribution of Students' Achievements," IEICE Trans. Inf. & Syst., vol.E104-D, no.2, pp.337–340, 2021. DOI: 10.1587/transinf.2020EDL8073

[13] M. Alkhateeb, Y. Hayashi, T. Rajab, and T. Hirashima, "Comparison between Kit-Build and Scratch-Build Concept Mapping Methods in Supporting EFL Reading Comprehension," Information and Systems in Education, vol.14, no.1, pp.13–27, 2015.

[14] B.S. Andoko, Y. Hayashi, T. Hirashima, and A.N. Asri, "Improving English reading for EFL readers with reviewing kit-build concept map," Research and Practice in Technology Enhanced Learning, vol.15, no.7, 2020. DOI: 10.1186/s41039-020-00126-8

[15] C.-C. Chang, G.-Y. Liu, K.-J. Chen, C.-H. Huang, Y.-M. Lai, and T.-K. Yeh, "The Effects of a Collaborative Computer-based Concept Mapping Strategy on Geographic Science Performance in Junior High School Students," Eurasia Journal of Mathematics, Science and Technology Education, vol.13, no.8, pp.5049–5060, 2017. DOI: 10.12973/eurasia.2017.00981a

[16] H. Gao, E. Shen, S. Losh, and J.E. Turner, "A review of studies on collaborative concept mapping: What have we learned about the technique and what is next?," Journal of Interactive Learning Research, vol.18, no.4, pp.479–492, 2007.

[17] J. Pailai, W. Wunnasri, K. Yoshida, Y. Hayashi, and T. Hirashima, "The practical use of kit-build concept map on formative assessment," Research and Practice in Technology Enhanced Learning, vol.12, no.20, 2017. DOI: 10.1186/s41039-017-0060-x

[18] N. Ibrahim, M.S.Y. Shak, T. Mohd, N.A. Ismail, P.D. Perumal, A. Zaidi, and S.M.A. Yasin, "The Importance of Implementing Collaborative Learning in the English as a Second Language (ESL) Classroom in Malaysia," International Accounting and Business Conference 2015, IABC 2015, vol.31, pp.346–353, 2015. DOI: 10.1016/S2212-5671(15)01208-3

[19] A. Hirumi, "The design and sequencing of E-learning interactions: A grounded approach," International Journal on E-learning, vol.1, no.1, pp.19–27, 2002. https://www.learntechlib.org/primary/p/8390/.

[20] M. Farrokhnia, H.J. Pijeira-Diaz, O. Noroozi, and J. Hatami, "Computer-supported collaborative concept mapping: The effects of different instructional designs on conceptual understanding and knowledge co-construction," Computers and Education, vol.142, 2019. DOI: 10.1016/j.compedu.2019.103640

[21] N.E. Adams, "Bloom's taxonomy of cognitive learning objectives," Journal of the Medical Library Association: JMLA, vol.103, no.3, pp.152–153, 2015. DOI: 10.3163/1536-5050.103.3.010

[22] J. Dalton and D. Smith, Extending Children's Special Abilities: Strategies for Primary Classrooms, Curriculum Branch, Schools Division, 1986.

[23] L.W. Anderson and D.R. Krathwohl, A taxonomy for learning, teaching, and assessing, Abridged Edition, Boston, MA, 2001.

[24] L. Shorser, (n.d.) Bloom's Taxonomy Interpreted for Mathematics. https://www.math.toronto.edu/writing/BloomsTaxonomy.pdf

[25] S. Kauffeld, N. Lehmann-Willenbrock, and A.L. Meinecke, "The Advanced Interaction Analysis for Teams (act4teams) Coding Scheme," In E. Brauner, M. Boos, and M. Kolbe (Eds.), The Cambridge Handbook of Group Interaction Analysis, pp.422–431, 2018. DOI: 10.1017/9781316286302.022

[26] V. Vodovozov and Z. Raud, "Concept Maps for Teaching, Learning, and Assessment in Electronics," Education Research International, vol.2015, pp.1–9, 2015. DOI: 10.1155/2015/849678

Aryo Pinandito received S.T. (Bachelor of Engineering) degree in Electrical Engineering from Universitas Brawijaya, Malang, East Java, Indonesia, in 2005, received M.MT (Master of Technology Management) degree in information technology management from Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia in 2011. Since 2012, he has been a lecturer and as a member of Mobile, Game, Multimedia, and Technology Enhanced Learning Laboratory with the Information System Department, Faculty of Computer Science, Universitas Brawijaya, Malang, Indonesia. He is one of the authors of a book in mobile application development and the author of more than 20 research articles. His research interest includes web and mobile application development, analysis and design in software engineering, information engineering, and technology-enhanced learning.

Yusuke Hayashi   is an associate professor of the Graduate School of Engineering at Hiroshima University, ever since 2012. He received his Ph.D. from the Graduate School of Engineering Science, Osaka University, Japan, in 2003. He was a research associate of the school of Knowledge Science, Japan Advanced Institute of Science and Technology (JAIST) from 2003 to 2005, an assistant professor of the Institute of Scientific and Industrial Research (ISIR), Osaka University from 2005 to 2010 and an associate professor of the Information Technology Center, Nagoya University from 2010 to 2012. He has been engaged in research on Knowledge modeling, Ontological engineering, and Learning engineering. He has received international awards as the Best Paper Award of ICCE2006 and the Best Technical Design Paper Award of ICCE2015.

Tsukasa Hirashima   received his B.E., M.E. and Ph.D. from Osaka University in 1986, 1988, and 1991, respectively. He worked at The Institute of Scientific and Industrial Research, Osaka University as a research associate and lecturer from 1991 to 1997. During 1997–2003, he worked in the Graduate School of Information Engineering at Kyushu Institute of Technology as an associate professor. He has been a professor of the Graduate School, Department of Information Engineering, Hiroshima University since 2004. Learning Engineering is his major research field. He has received international awards as the Outstanding Paper Award of EDMEDIA95, the Best Paper Award of ICCE2001 & 2002, Honorable Mention Award of AIED2009, APSCE Distinguished Researcher Award in 2009, and the ICCE2015 Best Technical Design Paper Award.