題　目　Design and Development of Kit-Build Concept Map Authoring and Collaborative
　　　　Support System
　　　　（キットビルド概念マップにおけるオーサリング機能と共同利用機能の設計・開発）

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Computer and mobile devices have become an enabler to greater access to learning contents in distance learning. In a situation where learning activities are shifting to online learning, the need for online and mobile learning platform and infrastructure becomes imminent to deliver digital learning content and media remotely and seamlessly. One example of learning media other than textbooks and lecture notes for learning is concept map. Despite the simplicity in its graphical form, concept map can been put into various uses, such as dialogue, collaboration, discussion, and feedback, enriching the learning environment, especially for learning.

In many studies, concept maps can help students depict and explore their understanding, optimizes their learning as it may influence students' self-efficacy and self-regulation during learning, thus, improve their learning achievement. Incorporating a computer-supported concept mapping tool could promote the learning an assessment more interactive, fun, and engaging. One example of learning framework that uses digital concept map and concept mapping tool is Kit-Build concept map. In its early development and use, Kit-Build helped teachers or instructors to quickly gain insight into the development of students' knowledge and evaluate their teaching through recomposing a set of concept map components—known as a kit. Importantly, recomposing a concept map from components could help students focus more on knowledge and ideas represented by the kit. Furthermore, the framework has a tool that provided an automatic comparison analysis feature for quick assessment of concept maps built by the students.

Regardless all the benefit of learning with Kit-Build concept map, the teachers should prepare a concept map before using the map to teach, decomposed the map into a Kit-Build kit, and let the students recompose a concept map from it. Preparing concept maps prior to teaching has been an obstacle for teachers to adopt Kit-Build as their teaching strategy. Prior research suggested that concept mapping activity put additional cognitive load for students and teachers. Therefore, in the situation where the time to compose the map is short, a useful support for efficient concept map composition and authoring—for both teacher and student—becomes necessary.

In another way of learning—collaborative learning with concept maps is also considered important because it could benefit students socially, psychologically, and academically. Interactions in collaborative learning include students' participation and social interaction where learning becomes an act of rewriting knowledge than merely receiving the information uncritically; hence, meaningful learning. Collaboratively constructing knowledge, exchanging ideas, embodying one's understanding, or sharing past experiences with concept maps could promote not only meaningful learning but also memory retention Activities involved in composing concept maps also help students enhance their critical thinking skills, thus develop deeper, higher-level cognitive processing.

Recently, due to the 2019 Corona Virus Disease (COVID19) pandemic situation, many education systems were forcefully shifting from offline to online learning; transforming the interaction style between teacher and student in learning activities, and induced collaborative learning difficult. Learning in a virtual, online-based learning environment, becomes more challenging than before, forbidding a direct face-to-face communication in almost every aspect of interaction. It is tedious to maintain a straightforward and natural interactive learning activity similar with what can be conducted in offline classrooms. In such an offline classroom, there is no time and space separation to maintain good interaction that involves emotion, empathy, and physical activity. Learning technology, which supports online learning, needs to tackle, or at least lessen the problems. Subsequently, support for online collaborative learning also becomes necessary, including support for online collaborative learning with Kit-Build concept map. However, the current system and authoring tool of Kit-Build concept map does not support online collaboration. Even though previous studies suggested that incorporating Kit-Build in collaborative learning promoted better learning and discussion, the collaboration was conducted offline. Each discussion group use only one device to compose concept maps collaboratively and discuss the maps in a face-to-face manner. Hence, the existence of collaboration system for online learning with Kit-Build concept map that supports real time composition and discussion becomes necessary.

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 concept mapping technology being used needs to provide seamless transition between offline and online, maintain the discussion and interaction style natural; hence, meaningful learning in online collaborative learning with concept maps. With the currently available computer and Internet technology, it is possible for the concept maps be authored, distributed, and used in digital form online.

This study designed and developed a concept map authoring tool that adopted semi-automatic concept map generation to support efficient concept map composition for learning. The tool's functionality is also further extended to support collaborative learning with concept maps online. The tool is providing authoring assistance through semi-automatic concept map generation process with CMM. The collaboration system is allowing student and teacher collaboratively learn online with Kit-Build concept map and allow real-time communication and collaboration of concept map through composing and recomposing Kit-Build concept maps. Thus, the study demonstrates the effectiveness of the using the tool in learning with Kit-Build concept map online.

The authoring support tool was developed with CMM approach, thus adapted the NLP and several text mining techniques to extract concepts and propositions from text-based learning material. The tool provided the assistance by suggesting concepts and propositions to be incorporated as part of the author's concept map. In addition to have a good assisting performance in the authoring process, the tool was perceived useful by both teacher and student for learning. By using the support feature to compose concept maps from learning material is shown to improve the efficiency of producing larger and more detail concept maps at a slightly better quality. They expressed their positive response and acceptance regarding the authoring support tool through UEQ-S and TAM evaluation.

The result of TAM analysis from this research identifies aspects that influence the students' intention in using Kit-Build concept mapping tool for learning. This research experiment result shows

that several future improvements to the authoring tool can be made, focusing to the areas that influence the most or lack of. A further usability analysis can also be carried out to evaluate and analyze the user experience in using the concept map authoring tool. This study also confirmed that learning with Kit-Build concept map in online settings has similar learning effect to learning with Kit-Build offline.

Evaluation to the online collaboration feature also demonstrated the tool effective for collaborative concept mapping composition use where multiple users could work with concept maps remotely on the same concept mapping space in real-time. Further improvements, integration, and inclusion of Kit-Build concept map framework into broader contexts, such as Massive Open Online Course (MOOC) and other learning subjects, are several potential research topics of learning research with Kit-Build concept map.