題　目　Enhancement of Meaningful Learning with Extension Concept Mapping
　　　　（拡張概念マッピングによる有意味学習の強化）

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Concept mapping is a student-centered knowledge representation that facilitates complex problem solving, critical thinking, and creative productions, which are the top skills needed in the 21st century. Concept maps are simple and easy to use graphical tools. There are two kinds of concept map construction styles: open-ended or low-directed and closed-ended or high-directed maps. Open-ended provides no components, and it allows learners to use any concept and any linking words in their maps. On the contrary, a closed-ended style provides finite links and concepts. The learners must use the provided components to construct their maps. Both of these creation styles have their advantages and disadvantages.

Concept maps have proven to furnish useful approaches for improving and assessing meaningful learning accurately. Meaningful learning occurs when new related ideas are combined with prior knowledge to form individual understanding. In order to realize meaningful learning, individuals need to have a well-organized, relevant knowledge structure in a particular area and a strong emotional commitment to integrating new with existing knowledge. Meaningful learning is recognized as the most prominent factor in developing robust knowledge structures and an important educational goal. Meaningful learning can be improved by expanding the concept map in a student-centered situation.

Extension of concept mapping is a technique for connecting the prior existing concept map with further knowledge in certain domains. The extended concept map construction is efficient in organizing design work and building a solid knowledge base. Extending activities play an essential task in each stage of the knowledge-integrating process through reviewing initial ideas and connections, eliciting missing ideas and relationships, and adding new concepts and relationships. A previous study posits that the initial "expert" map expanded through collaborative critique and revision activity could increase and construct a more coherent knowledge structure. However, little information has been studied on the extended concept mapping activity and investigate its effects on learners' achievements.

The present study proposes two concept mapping extension designs: Extended Scratch-Build (ESB) and Extended Kit-Build (EKB) maps. ESB concept map is a graphical tool aimed to enhance meaningful learning and facilitate knowledge building. ESB was inspired by an open-ended concept mapping technique that experienced to capture differences across students' knowledge structures. The ESB design extends the previous open-ended concept map by using the same technique. Thus, students are allowed to add concepts, links, and define propositions according to their understanding. On the other hand, EKB extends the prior KB map using open-ended maps as well.

KB itself is a re-compositional concept map, which is a subcategory of a closed-ended concept map. Both ESB and EKB designs yield the original map for the Phase 1 mapping activity and produce an additional map in Phase 2, which is an expansion of the concept map.

The first aim of this thesis is to introduce the design and effects of ESB concept mapping. ESB is an extended concept mapping design that requests the student to connect the prior-existing original concept map with the new additional map on related material topics. The performance of ESB was confirmed through students' achievements and a questionnaire. A pre-test, post-test, delayed-test, map size, and quality of map proposition scores were involved in assessing students' attainment. The results indicated that ESB could improve meaningful learning through an extended concept mapping approach and positively affect students' learning outcomes. This study also emphasized that there was a correlation between the original and additional maps on students' learning outcomes

This thesis's second objective is to propose EKB, a new KB extension that allows the learner to expand the KB map using an open-ended technique. The performance of EKB was compared with ESB that also employed an extended concept mapping design. A pre-test, post-test, and map size were involved in evaluating students' achievements. The findings show that both ESB and EKB are an extensible concept mapping design which facilitates enhanced meaningful learning. The results reported that EKB not merely outperformed ESB in terms of total understanding scores and number of propositions but also had a more even distribution of mastery in all material subtopics.

The final aim of this thesis is to investigate the practical use of the extended concept mapping tool in a blended learning situation. The experimental group students used the ESB technique, and those in the control group used the whole-class discussion and summarization method. The results reported that the experimental group students outperformed the control group in terms of immediate-test scores. These results suggest that the extension of concept mapping has a positive effect in supporting a blended-learning situation. In particular, the use of EKB in a blended learning environment is also predicted to make a more significant contribution.

This study emphasizes that ESB positively impacted students' learning understanding measured by using test scores. Students could also increase the number of propositions and the quality of propositions in additional maps. In the second study, students that used EKB outperformed those who used ESB in terms of understanding measured by post-test scores. The number of ESB propositions on the original map was superior, while the EKB was higher in the additional map. However, the EKB proposition's distribution on all material topics was more equal, and the total mean was higher. The last study indicated the students who used ESB in blended learning obtained higher scores than those who did not utilize mapping activities. The average achievement of ESB's students in original and additional materials was higher than those without concept mapping, although there was no significant difference.