論文の要旨

題 目

Enhancing Conceptual Understanding through Concept Map Recomposition: Strategies for Improving the Activity and Extending its Use to the Procedural Domain

(概念マップの再構成による概念的理解の促進：活動の改善と手続き的領域への活用のための戦略)

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Conceptual understanding is the core component of learning. It refers to a state of learning where new knowledge is related to learners' previous knowledge, which allows for the application and use of knowledge in new contexts other than the base context. Concept map is a popular method for promoting conceptual understanding, as it creates a visual representation of the relationships between various concepts. Concept map recomposition is a specialized concept map activity tailored for educational purposes, where the teachers' understanding of a topic is an essential component of it.

In concept map recomposition, the learners are given the necessary components to recompose the ideal concept map. These components are generated by decomposing the ideal concept map created by an expert (mostly teachers in the educational setting). Although many studies confirm the superiority of recomposition method compared to traditional concept map in multiple aspects, the activity of recomposing concept maps can be difficult and cognitively demanding, especially when dealing with complex topics. Investigating best practices during concept map recomposition is heavily needed in order to improve learners' experience and significantly influences the efficiency of concept map recomposition in conceptual understanding.

In this study, the effectiveness of concept map recomposition in promoting conceptual understanding was examined, with a focus on improving the recomposition activity and extending its use to the procedural domain, particularly in object-oriented programming. Procedural domain knowledge is where the learner focuses on the knowledge-how. It focuses on problem-solving tasks that have practical implications involving specific steps to solve.

To improve the efficiency of the recomposition activity, this study investigates reducing its' cognitive load. Reducing the cognitive load in recomposition is crucial to allow learners to focus more on the content of the learning task, rather than being overwhelmed by the instructional demands of it. However, cognitive load is necessary to create motivation and prevent learners from becoming bored with the learning task which could impact the learning outcome. Thus, controlling for motivation and learning quality has also been considered. Partial decomposition approach is proposed to reduce the cognitive load while maintaining the learning benefits of traditional concept map recomposition. In partial decomposition, learners are given a partially decomposed ideal concept map instead of a fully decomposed one. The experimental results showed a significant reduction in the embedded cognitive load of concept map recomposition across different dimensions while learning effect and motivation remained similar to the traditional recomposition activity.

In addition, understanding the relationship between reading materials and learning quality during the recomposition activity is important for improving the activity. To investigate this relationship, a study was conducted, examining the influence of reading time on reading comprehension and the effect of providing access to the reading material on reading comprehension during concept map recomposition. Analysis revealed that higher reading times were associated with better reading comprehension and better retention. Furthermore, having access to the reading

material improves short-term reading comprehension compared to not having access, but long-term retention was not improved. This suggests that having access to the text while recomposing the concept map can improve reading comprehension, but long-term learning can only be improved if students invest time in accessing both the map and the text. The use of proposed strategies improved the effectiveness and efficiency of the recomposition activity. Results suggest that when preparing for recomposition activity, educators consider using partially disconnected concept maps to save time and keep the learners motivated so that the saved energy and time can be directed toward a different form of activity to boost the learning process. One recommended activity could be to encourage learners to take time to read the base material during the concept map recomposition as the results showed that reading time during the recomposition activity is associated with higher learning quality.

Moreover, the application of concept map recomposition to object-oriented programming (OOP) was explored. OOP is a programming paradigm that consists of several core concepts which are crucial to the novice learner, and it is said to be challenging at the same time. Novice learners often struggle to see the connections between the concepts of OOP and how their practical implications are applied in real-world scenarios. To address this, a novel cognitive diagram was created for both theoretical and practical knowledge of OOP. Theoretical knowledge refers to the principles and concepts of a subject, while practical knowledge is the application of those concepts in actual source-code. By combining both theoretical and practical knowledge in the cognitive diagram and using concept map recomposition to improve understanding of OOP concepts, this study aims to support novice learners in their learning of these complex topics within the procedural domain of programming. The implementation of this approach in a real classroom setting suggested that the new cognitive diagram is well-received and highly engaging for learners. The results suggest that the proposed strategy can be considered as one important activity to increase the conceptual understanding of OOP concepts and their practical application.