Promotion of ERD Design Comprehension Using Recomposing Method

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Abstract: Conceptual modelling is a critical ability for a computer science student, enabling them to create a variety of conceptual models such as Entity Relationship Diagrams (ERDs). However, learning to create an ERD is a challenging task especially for novices because it involves various cognitive processes and actions. This research proposes a recomposing approach using kit-build exercise for ERD design learning. In a kit-build exercise, a student is provided a set of components of a structure and asked to recompose the structure using these components. The kit-build exercise has advantages as (1) reducing student's cognitive load by providing available components and (2) realization of automatic assessment by comparing recomposed structure with the original structure. This exercise has been already implemented for concept maps and the learning effect has also been confirmed both experimentally and practically. Considering the structural similarities between ERDs and concept maps, we have applied the kit-build exercise approach to ERDs. In this paper, we describe the kit-build exercise for ERD with automatic assessment and feedback.
Keywords: ERD, Kit Build, Concept Map.

1. Introduction

In software engineering, conceptual modelling is an important skill. It involves using a modelling language to reconstruct statements about certain domains, such as data or process modelling. This activity is required in computer science, software engineering, and related majors, as it is mandated by curricula standards (ACM and AIS).

Creating a conceptual model, such as an entity-relationship diagram, involves various cognitive processes and actions such as goal setting, abstracting, conceptualizing, contextualizing, interpreting, evaluating, anticipating, visualizing, communicating, discussing, and agreeing. Therefore, creating a conceptual model is considered a complex task that requires understanding of theoretical foundations, modelling languages, methods, and tools, as well as critical thinking and reflection on the application domain. Codified and tacit knowledge are also required to complete this task successfully (Rosenthal et al., 2022). Several study reports that novice student having difficulties and create errors when designing an ERD. Fessakis reported that students' face difficulties when deciding entities and attributes in an ERD (Fessakis et al., 2005). Rashkovits and Lavy mentioned that identifying relationships between entity is a serious challenge for novice designer (Rashkovits & Lavy, 2020). The difficulties when designing relationships between entities in ERD also explored by Batra and Antony their study revealed that novice students' common errors were incorrect relations between entities (Batra & Antony, 1994). Batra and Davis observed that ERD created by novice students' were different with the ERD created by experts in terms of ternary relationships, unary relationships and categories (Batra, n.d.). Furthermore, Batra mentioned that designing ERD is an activity with high complexity for novice students since the activity involve extensive use of memory, no mental aids and unconstrained choices (Batra, 2007).

Kit Build Concept Map (KB Map) is a framework for concept map where a concept map created by students can be diagnosed programmatically, KB Map uses the recomposing approach(Hirashima, 2019). In this research proposal we propose kit-build exercise for ERD. We chose Kit Build Concept Map (KB Map) because KB Map have advantages over normal concept map. KB Map able to reduce complexity by providing available components for

student to recompose. KB Map also provide ability to automatically assess the students' answers with teachers' solution by comparing the students' map with goal map.

In KB Map a domain expert or lecturer creates a goal map, then this goal map is decomposed to create a kit (parts). These parts are provided to learners and the learners are required to recompose their own map (recomposing) based on provided kits. This map is called learners' map. Kit build utilizes the goal map and learners map to detect defects in the learners' map. Several learners' maps can be overlayed to create a group map. This group map can be compared with a goal map to re-examine the goal map. Since the ERD have similarities and difference with KB map in terms of concept and link between concept, the extending process will involve several adjustments to fit an ERD to KB map.

2. Extending Kit Build for ERD Learning
2.1 Subject for Experiment
The subject for this research is sophomore student in Politeknik Negeri Malang.
2.2 Steps to Extend Kit Build for ERD Learning
To extend kit build for ERD learning there are several differences between ERD and Concept Map, the first difference is in concept map there are two items concept and link meanwhile in ERD the concept can be an entity or attribute. To fit entity and attribute to kit build we will convert entity and attribute to a concept in kit build. The second difference is link between concept where the connection between entity in ERD can be divided into three types such as "One To One Relationship", "One To Many Relationships", and "Many To Many Relationships". To fit the relation to kit build we will convert the relation into link in kit build this relation include link between entity and attribute.
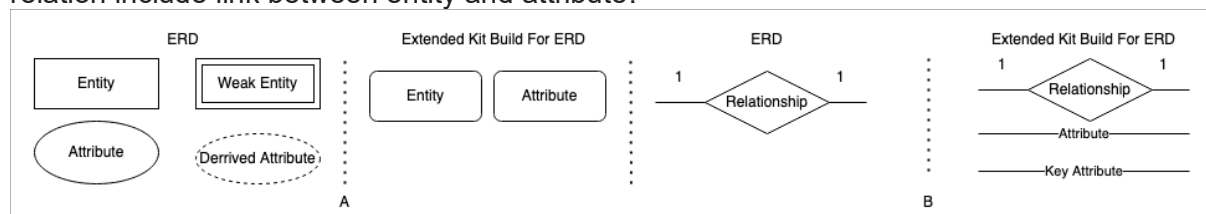

Figure 1 Change from ERD to Concept Map

To demonstrate the process the following example questions for ERD learning / problems is used: "Create a ERD for a simple blogging system, in this system a post consists of a title, post body, and category. To create a post a user must assign the post category, one category can have multiple blog post, each category consists of category name."
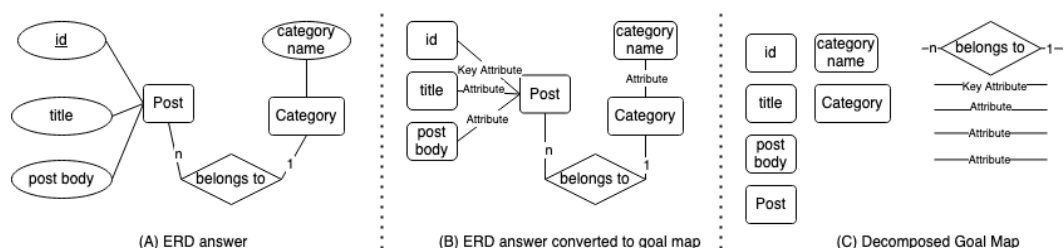

Figure 2 Example of ERD answer and ERD converted to goal map

A lecturer will create the goal map by converting ERD (Figure 2 A) answer into a goal map. The process of converting ERD to goal map following the rules in Figure 1, the result of this process can be seen in Figure 2B. Then for the learning purpose the goal map in Figure 2C is decomposed into parts of goal map. From this goal map students will be given the questions text and must create their own version of the concept map. This map called student map.
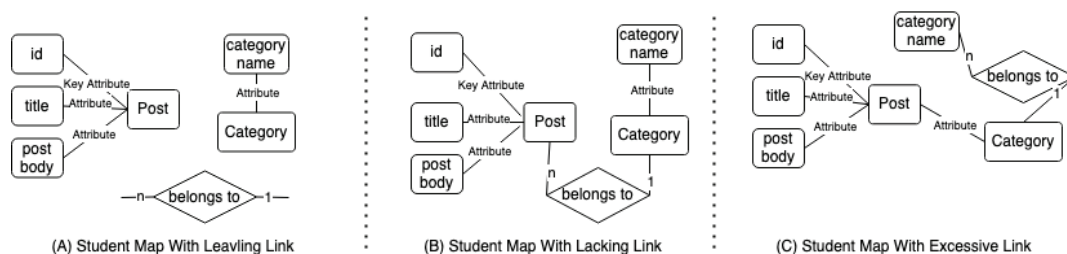
Figure 3 Variation of a Student Map

In the learning process the students will get a questions text and a decomposed goal map Figure 2C and they will recreate their own map (Student Map) example of a possible student map shown in Figure 3. There are several variations of a student map can be recomposed the first is a student map with "leaving link" Figure 3 A, this happen when student leaving a link on their map. The second variation is student map with "lacking link" this link happens when student connecting a concept to another concept but put wrong link on one of the concepts. The third variation is when student link two concepts with completely wrong link.
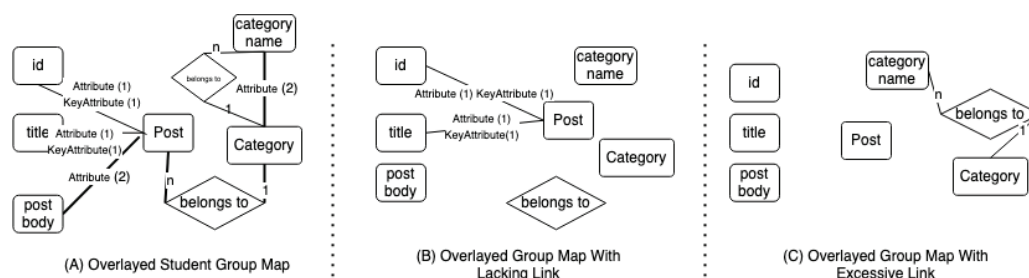

Figure 4 Example of Overlayed Group Map and the analysis

For analysis purpose in kit build student maps can be overlayed on top of goal map to find difference between student answers and teachers answer. Several student map also can be overlayed to get the insight of what students think about the answers in kit build this map called a group map Figure 4A. In the group map the similar answers between student represented by a bold link between concepts, meanwhile the lacking link (Figure 4B) and excessive link (Figure 4C) can be obtained by comparing group map with goal map. Both lacking and excessive link are the links that many learners failed to connect correctly.

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