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Development of an Interactive Learning Module for Visualizing Self-Regulated Learning Skills

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Abstract: Interactive Learning Module (ILM) is a type of learning module where you can conduct a self-learning activity with certain study materials. The use of ILM can facilitate learners to demonstrate Self-Regulated Learning (SRL) skills. However, most ILMs can be used interactively but cannot record and visualize SRL aspects in the learning process. The purpose of this study is to develop an ILM prototype that can record learner's behavior from SRL perspective. This study also attempts to define qualitative requirements for an ILM that is able to record SRL aspects. The sample material used in this ILM prototype is Boolean logic that is one of the basic fundamentals in Computational Thinking.

Keywords: Interactive Learning Module, Self-Regulated Learning, Computational Thinking, Boolean Logic

1. Introduction

Recent studies have developed an Interactive Learning Module (ILM) using VR or AR technologies (Joo-Nagata, Abad, Giner, & García-Peñalvo, 2017; Papathomas & Goldschmidt, 2017; Sampaio & Almeida, 2016). For example, a study was conducted to create a VR device where users could learn history by animating historical sites into VR (Joo-Nagata et al., 2017). Another example is a study by Sampaio and Almeida (2016) which was carried out to find a proper pedagogical strategy for ICT class that uses AR devices. From this point we could assume that AR and VR related research in education will grow in quantity in the near future.

Despite all of that research, there is no sign that there will be a piece of research related to the development of an ILM that could record its users' behavior and help them to formulate meaningful feedbacks, specifically from Self-Regulated Learning (SRL) perspective. SRL is a multidimensional construct that involves complex interactions such as cognitive strategy, motivation, and metacognition (Kauffman, 2004). Other studies also sought to define SRL as a process that involves construction of understanding related to a particular topic or domain using strategies and goals, as well as regulating and monitoring certain aspects of cognition, behavior, motivation, and behavior manipulation to achieve desired goals (Pintrich, 2000). The objective of the study is to build an ILM prototype that records users' behavior and map them to SRL aspects.

2. Method

This research is divided into five stages. *First*, researchers searched for relevant literature to study the concept and the techniques for designing and implementing the prototype. *Second*, researchers attempted to design and implement the system. Design techniques such as blueprints and content mapping were used in this step. This phase was intended to produce working software that would serve as a prototype. *Third*, the resulting working prototype was tested to representative users. Techniques such as usability testing and contextual interview were used here. An Indonesian version of System Usability Scale (SUS) questionnaire was used as a tool for gathering data (Sharfina & Santoso, 2006). Aside from the ten statements provided in SUS, the questionnaire also features additional open-ended questions to help researchers identify problems and to compare whether ILM materials are as good as school materials or not. *Fourth*, researchers analyzed participants' data from the SRL records and attempted to formulate conclusion from those data. Feedbacks from usability evaluation were used to formulate qualitative requirements in this phase. *Fifth*, researchers presented the processed data and formulated a general conclusion from those data.

3. Implementation

3.1 Conceptual Design

The ILM prototype is divided into three parts: *game*, *learning module*, and *data*. The *game* part consists of eight stages. Each of the stages presents a Boolean Logic related game called *Dropzone*. In this game, players are challenged to drag a bunch of colored boxes into a part of window called *Dropzone*. The player has to put the right box into the *dropzone*. To know which box has to be put inside the *Dropzone*, they need to read the instruction that is written in *Boolean expressions*. The *learning module* part consists of materials that are divided into five parts. Those parts are *introduction module*, *proposition module*, *NOT module*, *AND module* and *OR module*. Each of the three *Boolean operator* modules (AND, OR and NOT) consists of three parts. Those parts are *definition*, *examples*, and *truth table*. The *definition* part explains the formal definition of each *Boolean operators*; the *example* part presents the users with usage examples related to the corresponding *Boolean operators*; and the *truth table* part shows the True-False configuration of each *Boolean logic operator*. The last one is the *data* part. In this part, users' game data are displayed. These data consist of the distribution of each SRL aspect and a *line chart* that displays SRL actions in a sequential manner.

3.2 Technology & Record Representation

The technologies used to implement ILM prototype are ExpressJS as a *web framework*, PostgreSQL that acts as *database driver*, and Heroku service that is used to host the prototype online. *Drag and drop* animation in the prototype is implemented using InteractJS. In the *game* section of the system, all actions performed by a user will be recorded in the database. The database will record each action in tuples that contain action name, timestamps, and the user who did it. Then, every action will be given tags to map them into one of the SRL aspects. There are four SRL aspects defined in this research, which are *planning strategies*, *monitoring strategies*, *cognitive action*, and *regulating strategies*. After being recorded and given tags, all of these actions are visualized in the *data* section. Figure 1 is an example of the line chart representation. Every dot in represents an action performed by the user.

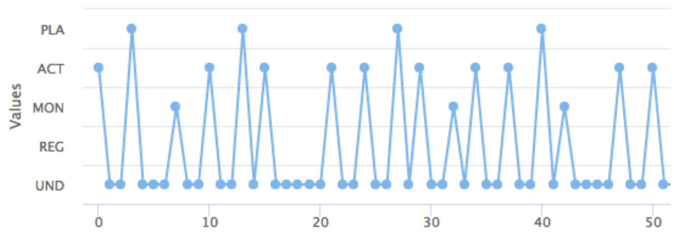

Fig. 1. SRL line chart representation with tags

4. Usability Evaluation

4.1 Participants & Task Scenarios

Thirty two sophomore students from 21 Senior High Schools in Jakarta, Indonesia were participated in the study. They came from a science-based class that uses a science curriculum to teach its students. They were involved in usability testing that was combined with a contextual interview. The tasks given in usability testing consisted of two tasks. The first task was to register into the system until the user successfully logged in into the system. The second task was to complete the tutorial provided by the system. After the usability testing was conducted, participants filled the SUS questionnaire provided.

4.2 SUS Score & Feedback from Contextual Interview and Questionnaire

The SUS score obtained by the system was 74.25. The adjective score obtained by the system was Excellent with grade C. From the first question in contextual interview that reads "What is the most disturbing thing in this application?", we obtained this collection of problems from the participants: (1) bug from animation; (2) server took a long time to respond; (3) little time to understand a problem; (4) and complicated English. In response to the second question that reads "Which is better, Boolean logic material provided at school or from the ILM application?", 87.5% of the participants said that ILM material was better, while 12.5% of them said that school material was better. Lastly, there are several recommendations offered by the participants in usability testing: (1) make a mobile version of the application; (2) improve study material and user interface; (3) provide other games to add options; (4) use the Indonesian language; and (5) replace colored boxes with real life objects.

5. Conclusion

From the data gathered and processed in this research, there are several facts that we could draw from this study. *First*, the participants' plan is not well thought. Plan was not considered important by *usability testing* participants. *Second*, "trial and error" is more considered. This behavior can be seen from participants' *cognitive action* score that is much bigger than that of other SRL aspects. This also means that participants did a lot of *cognitive action*-based actions compared to those of the other aspects. *Third*, users do not learn from their mistakes. They did not really reflect on their learning actions. Furthermore, from this study we found that many participants favored ILM material over school material. Learning activities provided on ILM are much more interesting than those provided at school. In addition, ILM methods of learning involve encouraging material understanding and immersion to game activity. The "intuitiveness" of ILM game activities creates an impression on the participants that the material provided on ILM is easy. This might be what makes ILM much more interesting than school material.

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