Article 7

Game-based application for normalization learning

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Abstract
Normalization is a relational database design for the organizing data process to minimize redundancy. The main aim for this study is to develop a game application for normalization learning. Besides, the study also focusing on identifying the preferred learning technique for normalization, the suitable multimedia and game-based elements for the development of a game application for normalization learning, and measuring the applicability of the application. Design science research methodology was implemented throughout the study which consists of five phases. Unity 3D software is used to develop a game-based application for normalization learning. The application has applied the Multimedia Principles, Game Based Principles and Marczewski's Gamification Framework in the development. Game-based environment provides an alternative on how to learn database normalization interactively. There are two types of testing used in measuring the application; heuristic evaluation and user acceptance at public university and were analyzed based on statistical analysis. The analysis from heuristic evaluation indicates that the game-based application is usable and practicable for normalization learning while analysis by user acceptance shows that the respondents are strongly agrees on the technical aspects in the application and they are ready to use this application. Therefore, the research has achieved its objective. Besides, the application will enhance the student's ability to easily recognize the various normal forms and will be skillful in the hands-on process of database normalization.

Keywords: *Game-based, game application, gamification, multimedia, normalization*

Introduction

Normalization is operationally defined as method used to design relational database tables for reducing duplication of information and protecting the database (Georgiev, 2008). Database normalization is the main topic in database theory and a good understanding on the matter important for students. Eessaar(2016) stated that database normalization process helps database developers to reduce data redundancy and thus avoid certain update anomalies. The major problem emerged when students are unable to receive purely theoretical subject (Georgiev, 2008). However, most of the students in the university are taught using textbooks and additional materials like presentation slides to learn database normalization. This learning technique will disrupt their learning due to the lack of good tools which could aid the students in database normalization.

On the other hand, a study by Nik NurulIzzasalwani (2017) found that 90.9 % of the respondents strongly agreed that they prefer to use multimedia presentation compared to text. It can be suggested that through the use of a game application, students can improve their understanding besides it is easy to learn. Therefore, this research is intended to create a game-based application for normalization learning. This game-based application will enhance the student's ability to easily recognize various normal forms of normalization. As a result, students will have more skills and interactive hands-on in the process of normalization. Besides, games also can be used by students, and teachers in any institutions for the learning

process. The research is important as it will provide an alternative on how to learn database normalization in interactive ways. The game application for normalization learning will help the students to learn normalization more easily and quickly.

Thus, technique for identifying games based on learning normalization must be investigated. The methods used are web based learning and interactive multimedia. Interactive Multimedia (IMM) package has a higher potential of supporting an individual to inherent strength of media characteristics (Kulasekara, Jayatilleke, &Coomaraswamy,2008). With multimedia technology in education, traditional educational materials will be translated into interactive electronic form through the use of multimedia authoring tools.

Database normalization is very important because it is a process in the database for organizing data. Database normalization process helps database developers for diminishing the data redundancy to avoid update anomalies featured (Eessaar, 2016) because there are combinatorial effects between propositions that are recorded in a database. Combinatorial effects mean that inserting, updating, or deleting of additional propositions in the same table or other tables. According to Demba (2013), Edgar F. Codd is a creator of the database relational model in 1970 and introduced the theory of normalization in the database. Normalization is a relational database design for the process of organizing data to minimize redundancy. Normalization is a method of producing good relational database designs (Bahmani, Naghibzadeh, &Bahmani,2008). There are three stages of the normalization called first normal form (1NF), second normal form (2NF) and third normal form (3NF).

Meanwhile, there are four game-based principles which are intrinsic motivation, authenticity, self-reliance and autonomy and experiential learning created by Perrotta, Featherstone, Aston, and Houghton (2013). Firstly, the learning must have intrinsic motivation where it is the game or one voluntary activity. In addition, it is also the best game for learning in the context of an invitation rather than coercion. Secondly, authenticity is a must have which involves the true nature of the learning and distinct from imitation or decontextualized forms of learning that are placed in schools as stated by Perrottaet.al (2013). Thirdly, the learning environment must be self-reliance and autonomy. There are many aspects of the game based including the basic technical skills like programming, writing, painting and music. Fourthly, experiential learning is important in order to create game-based learning (Perrottaet.al, 2013). The experience of learning is a very long and influential in the educational field.

Principles

There are five game elements to create a game-based like Intro Page, Instructional Support, Game Board, Assessments at each level, and Rapid Feedback (Athmika, 2016) but there are three game elements that were used to develop a game application for normalization learning like Intro Page, Instructional Support and Assessments at each level. The researchers choose these elements in order to give a good first impression to users. A big logo will attract player's attention to the next step, which is the intro page. A nice logo attracts users to keep and play. Moreover, Instructional Support is applied to tell the player the rules before start the games and to know the overall value of what they have learned (Athmika, 2016).

Besides, Marczewski's gamification framework(Andrzej Marczewski, 2015) is adapted to determine and designing the game-based application. There are 5 of 8 parts of Marczewski's gamification framework were chosen;i) what is being gamified, ii) why is it being gamified, iii) who are the users, iv) how is it being gamified, and v) tested with users. The first part of

Marczewski's gamification framework is what is being gamified. Learning activities is being gamified into an application to students understand better about normalization using game application. The second part is why it is being gamified. Gamification can increase motivation its users. The game application for normalization learning will help the students to learn normalization more easily and quickly. People who use (third part) are the users from Faculty of Computer and Mathematical Sciences (FSKM) students who are going to learn normalization using game application. The fourth part is how it being gamified. As mentioned previously, the elements that need to be in the game-based application are intro page, instructional support, game board, assessments at each level and rapid feedback (Athmika, 2016). Another element is computer-controlled integration of text, graphics, drawings, video, animation, audio, and any other media where every type of information can be represented, stored, transmitted and processed digitally. The fifth part of Marczewski's gamification framework is tested with users during the research. The testing is conducted in Evaluation Phase. There are some improvement were made to the game-based application based on the given feedback.

As far as multimedia development is concern, two of the multimedia principles were used in developing a game-based application; Spatial Contiguity and Temporal Contiguity Principle. Spatial Contiguity principle can facilitate the people when text and graphics placed at the same screen, while Temporal Contiguity Principle can help people to learn better through graphics (Mayer, 2009). Wherein for multimedia elements are color, text, graphics, animation, audio and design screen.

Related Works

i. Learn Database Normalization

A web-based environment for learning normalization of relational database schemata is developed to give interactive hands-on experience to students on normalization process (Georgiev, 2008). Concepts of web-based learning environment, called Learn Database Normalization (LDBN). One of the reasons for this is the lack of good tools which could aid the students during the learning process of relational database normalization. Thus learning environment was developed in order to give students the ability to easily and efficiently test their knowledge of the different normal forms in practice. The concept of assignments is a major difference between LDBN and the other normalization tools, which only provide one possible solution (decomposition) to the users, without users having the ability to test the structure themselves (Figure 1). On the other hand, LDBN can be used for checking the correctness of any proposed decomposition. This method could be useful to lecturers who need to test handwritten assignments.

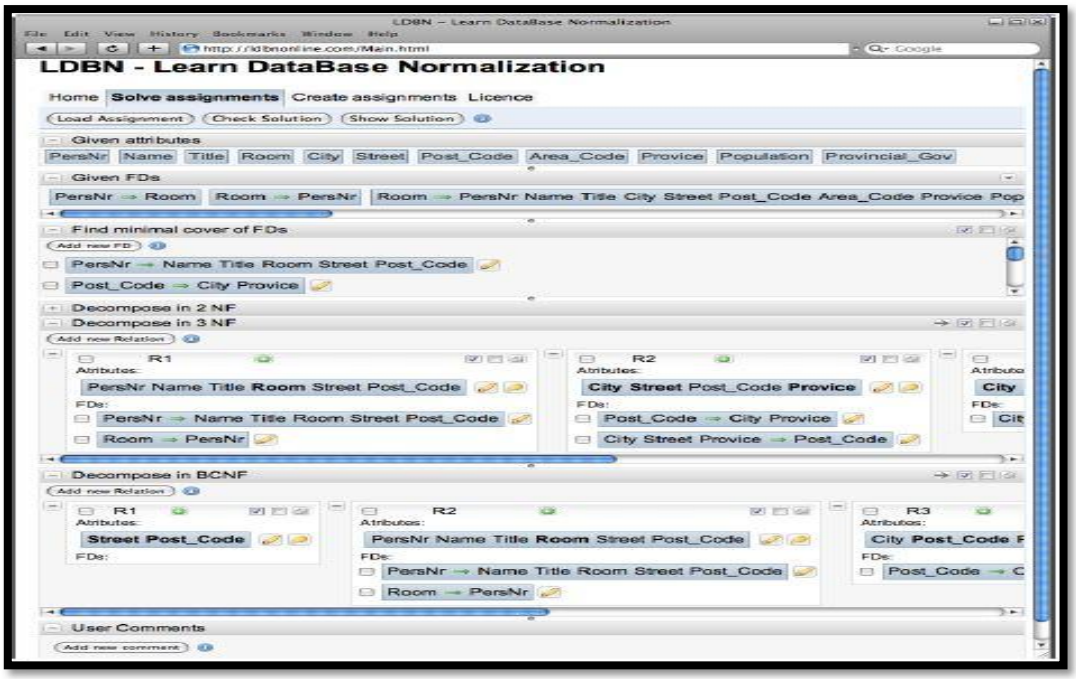

Figure 1: Learn Database Normalization (LDBN)

ii. NORMIT

Mitrovi (2005) claimed that NORMIT is a Web-enabled tutor with a centralized architecture. It is also a constraint-based tutor that teaches data normalization. Database normalization is a procedural exercise as depicted in Figure 2. So the students can go through steps provided to analyze the quality of a database. Basically, NORMIT requires students to determine candidate keys, a set of attributes, prime attributes and functional dependencies to determine normal forms. NORMIT will give a general description of the error, specifying what general domain principles have been disrupted.

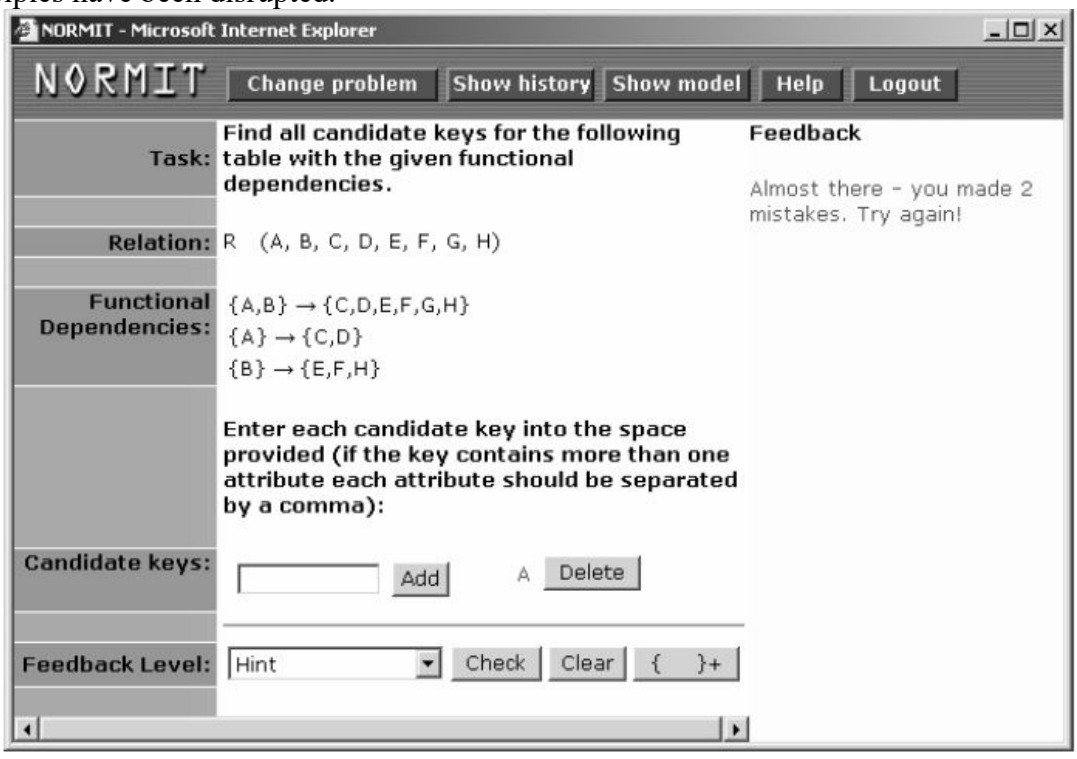

Figure 2: NORMIT Exercise

iii. NERD

NERD is a learning tool for learning ERD development and normalization (Cortez, 2014) and this application is developed using Java. The advantages of this application are four functionalities like generating ERD from text, performing normalization process, display the topic to students and giving students a set of questions such as quiz as shown in Figure 3. NERD application allows students to identify database problem specifications and provide learning through examples to enable students to learn.

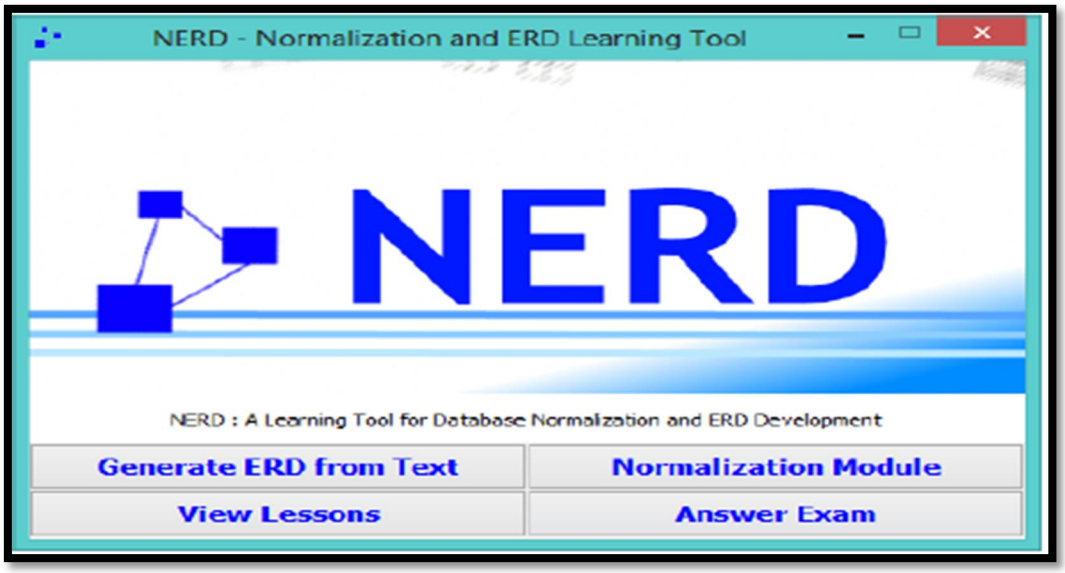

Figure 3: NERD

Research Methodology

This research consists of five phases of the design science research methodology adapted from Peffers, Tuunanen, Rothenberger, and Chatterjee (2007) which are Awareness of Problem, Suggestion, Development, Evaluation and Conclusion. In the first phase, the activities for the problem to be identified consist of preliminary study, literature study, content analysis, as well as comparative study normalization technique and game application for learning. The second phase of the study is to provide some suggestions to solve the problem consist of expert's feedback on normalization learning among lecturers and integration of database normalization using multimedia and game-based learning.

Then, phase three of the development comprises the proposed normalization learning using game-based application. The evaluation phase contains a few actions such as the development of evaluation strategies, test the proposed game application using evaluation strategies and test the applicability of the game application. Conclusion phase is the final stage in the game application development which consists of analyzed result from evaluation strategies as well as report writing.

The software that has been used in the game-based application construction is Unity3D, and Adobe Photoshop is used for creating images and text. There are some features and functions that have been built and developed for game-based application for normalization learning like Home screen, Tutorial Site, Home, Game and Page Score Construction.

Results and Findings

There are two types of testing on the game-based application (Figure 4) were conducted during the evaluation phase which are heuristic evaluation and user acceptance test. Heuristic

evaluations were carried out by seven experts who are the IPT lecturers. Meanwhile, user acceptance was tested to 40 students of FSKM, UiTM Perlis and the result from the testing was analyzed based on the questionnaire.

Figure 4: One of the scene in the game-based application

From the conducted testing,heuristic evaluation indicates that the game application is usable for normalization learning and practicable. In addition, user acceptance shows that the multimedia and game elements that were used had fulfilled of elements requirement in the game application. Besides, most of the respondents are strongly agreed to use this application.

The game-based application has achieved its target because it is usable to be one of the effective learning methods. Therefore, it can be concluded that the users satisfied with this game-based application for normalization learning.

Conclusion

As the conclusion, the research has achieved its objective. The game application has been successfully developed using multimedia elements and games elements that are suitable such as text, audio, animation, graphics. Besides, the game application will enhance the student's ability to easily recognize the various normal forms of normalization and will be skillful in the hands-on process of database normalization learning.

References

Andrzej Marczewski, (2015). *Gamified UK Gamification Consultancy.* Retrieved October 20, 2016, from https://www.gamified.uk/gamification-framework/

Athmika, T.(2016). *5 Must have Elements of Game-based Mobile Learning Courses.* Retrieved October 7, 2016, from http://blog.commlabindia.com/elearning-design/elements-of-game-based-mobile-learning

Bahmani, A. H., Naghibzadeh, M. and Bahmani, B. (2008).*Automatic database normalization and primary key generation.* Canadian Conference on Electrical and Computer Engineering, Niagara Falls, ON, 2008, pp. 000011-000016. doi: 10.1109/CCECE.2008.4564486

Cortez. (2014). *NERD: A Learning Tool for Database Normalization and ERD Development*. Department of Physical Sciences and Mathematics

Demba, M. (2013).*Algorithm for Relational Database Normalization Up to 3NF.*International Journal of Database Management Systems (IJDMS) Vol.5, No.3, June 2013. pp. 39–51.

Eessaar, E. (2016). *The Database Normalization Theory and the Theory of Normalized Systems: Finding a Common Ground.* Baltic J. Modern Computing, Vol. 4 (2016), No. 1, 5-33.

Kulasekara, G.U., Jayatilleke, B.G., &Coomaraswamy, U. (2008).*Designing Interface for Interactive Multimedia: Learner Perceptions on the Design Features.* Asian Association of Open Universities Journal, Vol. 3 Issue: 2, pp.83-98, https://doi.org/10.1108/AAOUJ-03-02-2008-B002.

Georgiev, N. (2008). *A Web-Based Environment for Learning Normalization of Relational Database Schemata*, Computing Science Master Thesis.Ume˚a University, Sweeden.

Mayer, R.E. (2009). *Multimedia Learning (2nd ed.).*Cambridge University Press, New York, NY, USA.

Mitrovi, A. (2005). *Scaffolding Answer Explanation in a Data Normalization Tutor*.Facta Univ. Ser. Elec. Energ. vol. 18, No. 2, August 2005, 151-163.

Nik NurulIzzasalwani (2017), *Developing a Game Application for Normalization Learning.*Bachelor of Information Technology Thesis.UniversitiTeknologi MARA (UiTM), Malaysia.

Perrotta, C., Featherstone, G., Aston, H. & Houghton, E. (2013).*Game-based Learning: Latest Evidence and Future Directions* (NFER Research Programme: Innovation in Education). Slough: NFER.

Peffers, K., Tuunanen, T., Rothenberger, M. a., & Chatterjee, S. (2007). *A Design Science Research Methodology for Information Systems Research*. Journal of Management Information Systems, 24(3), 45–77. doi:10.2753/MIS0742-1222240302