

Web-based Database Courses E-Learning Application

Aaron paul m. Dela rosa^a, Luigi Miguel m. Villanueva^b, john mardy R. San miguel^c, John emmanuel B. Quinto^d

^{a,b,c,d}Bulacan State University, City of Malolos, Bulacan, Philippines

Corresponding author: ^aaaronpaul.delarosa@bulsu.edu.ph

Abstract

This study was focused on the development of a web e-learning application for the database courses taken by Information Technology (IT) students of the College of Information and Communications Technology (CICT) of the Bulacan State University (BulSU). The research methodology used in this project was the developmental approach. The Agile Software Development methodology was followed phase by phase, up to the development phase, to develop the system. It was used to produce the desired output rapidly while allowing to go back phases without finishing the whole cycle. Moreover, this study was focused on providing lessons about Structured Query Language (SQL) in MySQL and SQL Server approach. The project provided quizzes and examinations to allow self-assessment of learning.

Additionally, an Entity Relationship Diagram (ERD) simulation was included to provide ERD creations in drag-and-drop. This study was evaluated using ISO/IEC 25010 software quality evaluation criteria. The study's overall mean was 4.24, 4.41, and 4.33, all with the descriptive meaning of the Very Good, which showed that the system performed its necessary functions as perceived by students, faculty members, and experts, respectively. The project was fully developed and may improve students' learning upon its implementation.

CCS CONCEPTS

• Information technology → E-Learning and Educational Software

Keywords: learning management systems, e-learning, database, entity-relationship diagram, relational schema, query languages

1. Introduction

People can learn, communicate, and play with other people all around the globe. Learning online through technology-based can spread knowledge to other people [1]. Students could be in a class using the internet and can get feedback instantly through online learning. Because of that, education online became popular and beneficial to an institution [2,3].

E-Learning is a catch-all term that describes training or any educational activity delivered to learners through an electronic device [4]. Typically, through a website or an application, the learner accesses a computer [5,6]. E-Learning web application is different when students are reading a book. This web application can help people to study databases. The research's specific objective focuses on discussions, quizzes, case studies, and simulations about databases. This application can resolve other people who do not read a book anymore and use technology [7,8].

W3schools is a web application that allows its users to study and learn anything about developing websites using web programming languages such as JavaScript (JS), Hypertext Pre-processor (PHP), Cascading Stylesheet (CSS), and more [9]. This web application provides a part of their learning course where the user may code independently, try out the examples given, and enhance them as to how the user wants. Another excellent web application for programmers to learn different languages is the w3resource [10]. W3resource provides topics about a programming language and provides a complex set of exercises depending on a given topic. Each of the activities has its solution, and the user may code in their solution on a given problem to try it out on their own.

Bulacan State University (BulSU) is a state university located at Malolos, Bulacan, which has 13 colleges in the main campus, and four external campuses, namely: (1) Meneses Campus, located at Bulakan, Bulacan, (2) Hagonoy Campus, located at Hagonoy, Bulacan, (3) Bustos Campus, located at Bustos, Bulacan, and (4) Sarmiento Campus, located at San Jose del Monte, Bulacan. The researchers focused on one of the colleges on the main campus, the College of Information and Communications Technology (CICT), which has approximately 2,300 Information Technology (IT) students from 1st to 4th-year levels. 1,000-1,100 students from the total number of IT students of CICT are on their 2nd-year level. Having the number of students who need to learn the subject Database Management Systems (DBMS) and the number of faculty members who have expertise in DBMS may fail in its ratio.

An e-learning web application for database courses offered by the College was developed to address the issue. This application provided lessons about the syllabus's flow in the said College on teaching the database courses. This application also contains Structured Query Language (SQL) lessons in MySQL and SQL Server. Quizzes are given per lesson, and an examination is given per topic.

Other faculty members may use the web application to teach their class based on the College's syllabus in the database. This application could be used as an additional teaching tool in aiding distance learning.

1.1 Project Objectives

The study aims to develop a web-based e-learning framework covering database topics provided by Bulacan State University's College of Information and Communications Technology in the Philippines.

Specifically, this also answered the following questions:

1. How may the design and development of the web e-learning application of database courses be addressed?
2. How may an entity-relationship diagram simulation be integrated within the system?
3. How may the system acceptability be determined using the ISO/IEC 25010 standard software quality evaluation criteria as perceived by:
 - 3.1. IT Students;
 - 3.2. Faculty Members; and
 - 3.3. IT Experts?

2 Experimental And Computational Details

2.1 Research Methodology

For the effectiveness and accuracy of the developed system, developmental research was applied. In developmental research, the processes necessary were studied upon developing the web application and evaluate each process that it shall meet the set criteria for evaluators' acceptance to the developed e-learning web application. All gathered data were analyzed from its intended users, leading to the development of the database e-learning web application.

2.2 Software Development Methodology

The system was developed by following the phases of Agile software development methodology [11,17]. It allowed the web application development by going on different phases, revisiting a phase if changes shall be done on past phases, and modifying contents from past phases if anomalies were found during the web application development.

2.2.1 Requirements. The gathered data through a questionnaire were answered by IT students, mainly 2nd-year level students, as they are the students who were currently taking the database courses. Faculty members who were teaching databases were also encouraged to answer the said questionnaire.

2.2.2 Plan. In this phase, the data gathered from students and faculty members were analyzed. From then, the possible features and their contents were formed and identified for the web application.

2.2.3 Design. The focus of this phase is designing the user interface of the web application. A visual table of contents (VTOC) was intended to identify which contents and functionalities are under the web application feature. A context diagram was also formulated in this phase.

2.2.4 Develop. After finalizing the requirements on the past phase, development of the database e-learning web application, maximizing web technologies were started. In this phase, all the features and functionalities of the web application were designed and programmed. Different tools were used for development that achieved the developed web application. Hypertext Markup Language (HTML), CSS, JS, and PHP were used to create both ends of the e-learning web application. Frameworks, such as Bootstrap and jQuery, were also used as part of the development tools.

2.2.5 Release, Track, and Monitor. In the release phase, the system is deployed, operational, and used by its intended users. After the deployment, the track and monitor phase shall be done to maintain and update the developed web application. These phases were no longer covered by the study as the study only covers up to the web application development.

2.3 System Evaluation: Software Quality Evaluation Criteria from ISO/IEC 25010:2011

The software quality evaluation criteria from International Organization for Standardization/International Electrotechnical Commission (ISO/IEC) 25010:2011 [12] were used to determine the acceptability of the developed web application's quality. Most software developed was tested by its quality in terms of its functionality and delivery of features without any anomaly. The ISO/IEC 25010:2011 standards were used as the evaluation criteria of the developed system.

For the sampling techniques used, the expert or judgment sampling [13] was used to 10 IT experts and professionals who evaluated the web application's acceptability in terms of its technicality. On the other hand, convenience sampling [14] was used on 50 2nd year IT students of BulSU-CICT. These students were the intended users of the web application. As part of the beneficiaries, convenience sampling [14] was also used to 10 faculty members of the College handling the database courses.

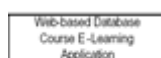
An evaluation survey was conducted on the students and faculty members of BulSU-CICT that evaluated the developed web application's quality. ISO/IEC 25010:2011 was used to measure the web application's usability and was computed using the five-point Likert-type Scale [15,16].

Numerical Rating	Interpretation
4.50-5.0	Excellent
3.50-4.49	Very Good
2.50-3.49	Good
1.50-2.49	Fair
1.0-1.49	Poor

3 Results And Discussion

3.1 Design and Development of the Web-based Database Course E-Learning Application

The functionalities under each feature were shown using VTOC. The flow of the web application was described using VTOC, which was exposed in a list format. The list of menus available on the web application and their relevant contents are shown in Fig. 1 and are used as a reference in creating the web application.



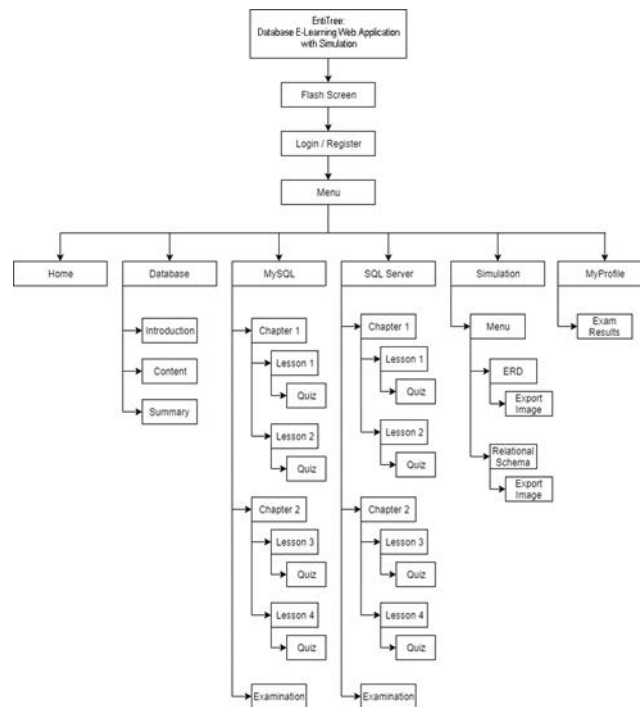


Figure 1: Visual Table of Contents of the E-Learning Web Application

A context diagram, otherwise known as a level 0 data flow diagram (DFD), was used to direct the researchers about how data can flow as users interact with the web application. DFDs show all data flow from process to process and how to create each function based on the data. The context diagram used as a reference during the web application development is shown in [Fig. 2](#).

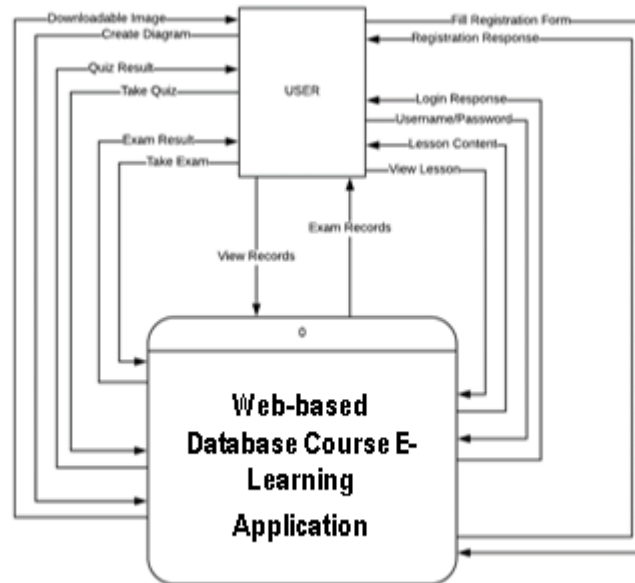


Figure 2: Context Diagram of the E-Learning Web Application

[Fig. 3](#) and [Fig. 4](#) show the web application section, which included the discussion and web application lessons. Discussions of MySQL and SQL Server were given as lessons. Each query language was broken down into chapters that covered everything from the basics to advanced techniques.

In terms of the lessons offered by the web application, [Fig. 3](#) depicts the created web application. [Fig. 3](#) shows the lesson's discussion.

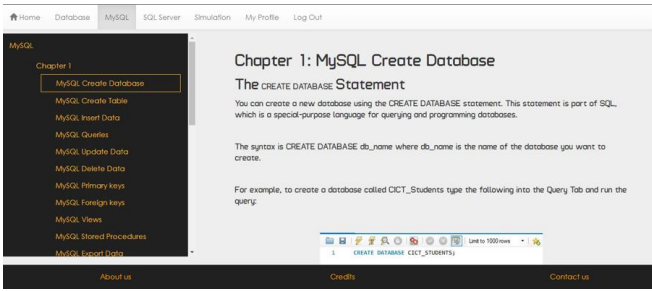


Figure 3: Part of the Web Application that Provides the Lesson Part

Fig. 4 shows the developed web application in terms of the example code provided by the web application. The lesson that presented an example of SQL code and its resulting outcome if executed is shown in Fig. 4.

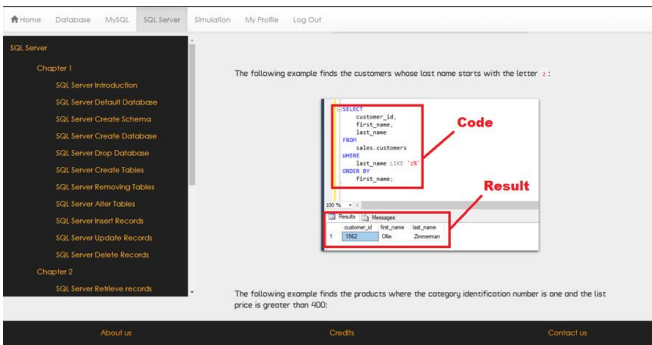


Figure 4: Part of the Web Application that Provides the SQL Code and its Corresponding Result Part

3.2 Integration of ERD Simulation

An ERD Simulator was integrated to which the students may use on creating their ER Diagrams. Fig. 5 shows the simulation page where the students may select which element shall appear in the diagram. The components may be moved through drag-and-drop action to arrange the diagram according to their liking.

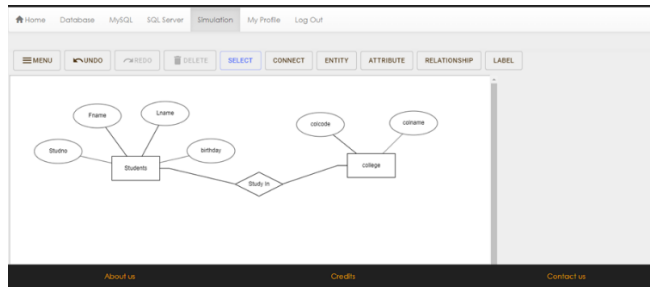


Figure 5: Making an ER Diagram through Simulation

Moreover, they may create a relational schema using the simulation. Fig. 6 shows how a user may create a relational schema. Options for the elements were provided at the top of the workspace. Drag-and-drop action can be done in the workspace to adjust the arrangement of the relational schema elements.

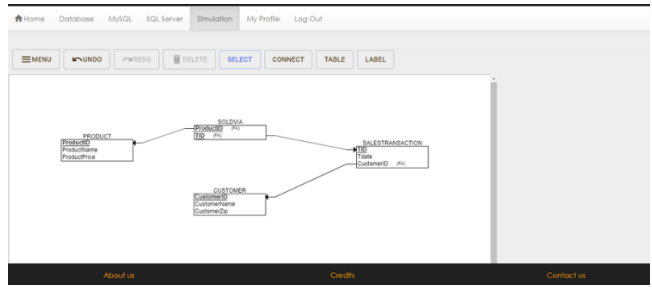


Figure 6: Making a Relational Schema through Simulation

3.3 System Acceptability Using the Software Quality Evaluation Criteria from ISO/IEC 25010:2011

The developed database e-learning web application was evaluated by its intended users, students, faculty members, and experts to measure the system's acceptability [12]. The system's acceptability was calculated from the model of ISO/IEC 25010:2011: Functional Suitability, Performance Efficiency, Compatibility, Usability, Reliability, Security, Maintainability, and Portability. Functional Suitability was measured if the web application met the needs when used under specific conditions. Performance Efficiency was measured through the number of resources used. Compatibility was measured through the web application's ability to communicate to other products or components. Usability was measured if its intended users can use the web application to achieve necessary goals with effectiveness, efficiency, and satisfaction. Reliability was calculated if the web application performs its desired task in a given period. Security was measured on how the web application protects the data. Maintainability was measured through its efficiency and effectiveness upon improvements. Portability was calculated if the web application could be transferred from one environment to another.

3.3.1 IT Students. The result of the web application's evaluation as perceived by the IT students was 4.24 with a descriptive interpretation of the *Very Good*, as shown in [Table 1](#). This indicates that the students who evaluated the system learned something from the web application in a short period of evaluation. As the students tried to use the web application, the web application functioned well and correctly and provided the appropriate contents on each provided lesson.

Table 1: Overall Summary of the Respondents Rating as Perceived by Students to the Web Application

Item	Mean	Interpretation
Functional Suitability	4.37	Very Good
Performance Efficiency	4.33	Very Good
Compatibility	4.34	Very Good
Usability	4.21	Very Good
Reliability	4.16	Very Good
Security	4.04	Very Good
Maintainability	4.15	Very Good
Portability	4.33	Very Good
Total Mean	4.24	Very Good

3.3.2 Faculty Members. The result of the web application's evaluation as perceived by the faculty members was 4.41 with a descriptive interpretation of the *Very Good*, as shown in [Table 2](#). Among the three assessments, faculty members' evaluation achieved the highest rating. This indicates that the web application contents are effective, efficient, and accurate to help their teaching in the database subject.

Table 2: Overall Summary of the Respondents Rating as Perceived by Faculty Members to the Web Application

Item	Mean	Interpretation
Functional Suitability	4.47	Very Good
Performance Efficiency	4.47	Very Good
Compatibility	4.60	Excellent
Usability	4.50	Excellent
Reliability	4.25	Very Good
Security	4.24	Very Good
Maintainability	4.28	Very Good
Portability	4.47	Very Good
Total Mean	4.41	Very Good

3.3.3 IT Experts. The result of the web application's evaluation as perceived by the IT experts was 4.33 with a descriptive interpretation of the *Very Good*, as shown in [Table 3](#). This indicates that for experts, in terms of the web application's technicality, the functionalities of the web application are well-functioning and correct that met the needs of the intended users.

Table 3: Overall Summary of the Respondents Rating as Perceived by IT Experts to the Web Application

Item	Mean	Interpretation
Functional Suitability	4.42	Very Good
Performance Efficiency	4.46	Very Good

Compatibility	4.36	Very Good
Usability	4.25	Very Good
Reliability	4.35	Very Good
Security	4.14	Very Good
Maintainability	4.28	Very Good
Portability	4.41	Very Good
Total Mean	4.33	Very Good

4 Conclusions

In conclusion, the developed web application specifications were thoroughly evaluated based on the expected users' responses to a questionnaire to develop the appropriate features of the e-learning application. The web application was created and tested to assess its acceptability. The evaluation's average descriptive ranking was *Very Good*, indicating that the e-learning web application's functionalities are both right and considered suitable by the evaluators. All of the features were needed for a web-based database courses e-learning application.

5 Recommendations

Considering the conclusions of the study, the following recommendations were drawn and can be used by future researchers in the field of Information Technology or Information Systems:

1. Provide more difficulty on the quizzes and examinations to provide a more complex self-assessment on learning.
2. Include more query languages than MySQL and SQL Server, such as Oracle, PostgreSQL, and the like.

Acknowledgments

We want to thank the Research Management Office of our University for supporting us financially in this paper. We want to thank all our friends, significantly Ralph David Rafael, John Ronel De Leon, Jay Leonard Ruiz, Jan Louie Herrera, and Mark Angelo Zuñiga. They helped and supported us throughout this study's development. And most of all, we want to thank the Lord for guiding us and giving us all the strength and wisdom to complete this paper.

References

- [1] J. Stephenson. 2018. Teaching & Learning Online: New pedagogies for new technologies. Retrieved from books.google.com.ph/.
- [2] Ormond Simpson. 2018. Supporting Students Online, Open and Distance Learning (1st. Ed.). DOI: <https://doi.org/10.4324/9780203417003>
- [3] Susan Ko and Steve Rossen. 2017. Teaching Online: A practical guide (4th. Ed.). DOI: <https://doi.org/10.4324/9780203427354>
- [4] Emma King and Russell Boyatt. 2015. Exploring factors that influence adoption of e-learning within higher education. *British Journal of Educational Technology*, 46, 6 (Nov. 2015), 1272-1280.
- [5] Marko Urh, Goran Vukovic, Eva Jereb, and Rok Pintar. 2015. The model for introduction of gamification into e-learning in higher education. *Procedia – Social and Behavioral Sciences*, 7 (Feb. 2015), 388-397.
- [6] N. Islam, M. Beer, and F. Slack. 2015. E-learning challenges faced by academics in higher education. *Journal of Education and Training Studies*, 3, 5 (Jun. 2015), 102-112.
- [7] Valentina Arkorful and Nelly Abaidoo. 2015. The role of e-learning, advantages and disadvantages of its adoption in higher education. *International Journal of Instructional Technology and Distance Learning*, 12, 1 (Jan. 2015), 29-42.
- [8] Jeff Sauro. 2015. SUPR-Q: A comprehensive measure of the quality of the website user experience. *Journal of Usability Studies*, 10, 2 (Feb. 2015), 68-86.
- [9] W3schools. 2020. W3schools online web tutorials. Retrieved from <https://www.w3schools.com/>.
- [10] W3Resource. 2019. Web development tutorials. Retrieved from <https://w3resource.com/>.

- [11] Sandeep Kashyap. n.d. Traditional vs. Agile project management method: Which one is right for your project? Retrieved from <https://www.proofhub.com/articles/traditional-vs-agile-project-management>
- [12] ISO 25000. ISO/IEC 25010. Retrieved from <https://iso25000.com/index.php/en/iso-25000-standards/iso-25010?limit=3&limitstart=0>
- [13] Stephanie Glen. 2015. Expert sampling/judgment sampling. (May 2015). Retrieved from <https://www.statisticshowto.datasciencecentral.com/expert-sampling/>
- [14] V.K.Maheshwari. 2017. Sampling techniques in quantitative research. (September 2017). Retrieved from <http://www.vkmaheshwari.com/WP/?p=2455>
- [15] Ankur Joshi, Saket Kale, Satish Chandel, and D. K. Pal. 2015. Likert scale: Explored and explained. British Journal of Applied Science & Technology, 7, 4 (Feb. 2015), 396-403
- [16] Fern Willits, Gene Theodori, and A. Luloff. 2016. Another look at Likert scales. Journal of Rural Social Sciences, 31, 3, (Dec. 2016), 126-139.
- [17] Pankaj Patel. 2019. Difference between traditional and Agile software development. Retrieved from <https://www.geeksforgeeks.org/difference-between-traditional-and-agile-software-development/>