Design and Develop an Instructional Tool and Assessment for Chemistry

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Abstract

E-learning is an effective alternative educational tool on the gap between school learning and what learners actually want. It highlights that when given a choice, learners want relevant, personalized and self-paced content at a point of need. E-Learning plays a big part in the lives of the students who are studying in school and also at home.

The study aims to fill up the existing gap. Most of the students are experiencing a traditional way of teaching with incomplete facilities available in the school; (1) especially institutions that have deficient laboratory equipment with respect to chemistry laboratories; (2) poor performance of experiment for visualization and reaction of elements; (3) do not have proper supervision in performing chemistry experiments; (4) diverted focus; and (5) least updates about new elements found. To evaluate the effectiveness of having a chemistry oriented application as an e-learning alternative tool for teaching, descriptive research was applied with the use of survey research method in gathering data. The survey has two forms of questionnaires: a questionnaire for the users; the teachers, administrations, and students, and a questionnaire for the IT expert for technical perspective of the application. The users' questionnaire contains a total of four (4) categories; functional suitability, performance efficiency, usability, and reliability, these categories are used to determined how effective the application is. To determine the functionality and technicality of the application the questionnaire for the IT experts added three (3) categories; security, maintainability and portability. The survey research was performed at San Roque Catholic School with 177 Grade 9 students, 5 teachers and 5 IT experts. The purpose of the research is to develop an alternative learning tool for chemistry, especially with the element, properties, structure, composition, behavior and changes from the chemical reactions in a just one platform. Therefore, users can use it as an alternative tool for doing laboratory experiments in chemistry. In taking users own points of view the system should have more elements to be mixed and more utensils that can be available in the activity area. Incorporate sound effects and music, for making the application more interactive.

Keywords**:** *alternative learning tool, chemistry, computer generated tool, e-learning, instructional tool, chemistry assessment*

1. Introduction

E-Learning is a tool that can be used in different subjects especially in Chemistry class. E-Learning is applied in a chemistry subject is a very powerful tool for teaching, as many aspects of chemistry is applicable in E-Learning. Imaging a chemistry laboratory inside a computer that is full of resources and an assessed through exams included in the application feels like a laboratory setup.

There are various effects of the computer-simulated experiment (CSE) and the problem-solving approach on students' chemistry achievement, science process skills, and attitudes toward chemistry at the high school level. The computer-simulated experiment approach and the problem-solving approach produced significantly greater achievement in chemistry and science process skills than the conventional approach did. The CSE approach produced significantly more positive attitudes toward chemistry than the problem-solving approach, with the conventional approach being the least effective (Geban, Askar & Oskan, 2010). So that the focal point of this study is to give an effective way of learning for ninth grade in the subject of chemistry by the use of Angry Chemist, as this will let the students to learn more, experiment in their own laboratory with equipment, and achieve a well science method ability. According to Smetana and Bell, to provide a comprehensive, critical review of the literature on the impact of computer simulations on science teaching and learning, with the goal of summarizing what is currently known and providing guidance for future research. Findings suggest that simulations can be as effective, and in many ways more effective, than traditional (i.e. lecture-based, textbook-based and/or physical hands-on) instructional practices in promoting science content knowledge, developing process skills, and facilitating conceptual change (Smetana & Bell, 2012). On the other hand, the development of Angry Chemist as a supplement tool

for learning in chemistry is to grant an effective way of learning in the absence of the equipment, to grasp the concentration of the learners and to encourage student reflection, present the fine routine of experiment for visualization, advantages such as flexibility, protection, and effectiveness deserve awareness.

This study demonstrates that by simply viewing the appropriate manipulations performed by an educator on a computer model during a recitation period, students in both semesters of introductory organic chemistry performed significantly better on a post-test measuring understanding of molecular structure than those who did not view the computer models. While having a dedicated computer laboratory and software for students use might be too costly for some institutions, displaying computer models during a lecture is an inexpensive way to achieve significant gains in students' understanding of molecular structure. (Springer, 2014). According to Amanda Edwards and Michelle Head a well-accepted research-based method for improving student understanding and the ability to apply many of the abstract concepts presented in chemistry is through the use of conceptual modeling. This lesson involves the use of a pretest to gauge student understanding and misconceptions about modeling, an activity to introduce vocabulary surrounding models and allow students the opportunity to create and assess a conceptual model, and a post-test to evaluate student growth in understanding the modeling practice (Edwards & Head, 2016). Based on the study, it is well-known that laboratory applications are of significant importance in chemistry education. However, laboratory applications have generally been neglected in recent educational environments for a variety of reasons. In order to address this gap, this study examined the effect of a virtual chemistry laboratory (VCL) on student achievement among 90 students from three different ninth-grade classrooms - an experimental group and two control groups (Tatli & Ayas, 2013). According to Alday and Panaligan, author of Reducing Math Anxiety, since teenage students used to engross themselves with the use of technology specifically computers, this study maximized the capability of computers in reducing math anxiety by teaching mathematics subject using e-learning thus improving student academic performance. (Alday & Panaligan, 2013). Based on the study explored, the use of social media as a tool in enhancing student's learning experiences, by using online instruction as a supplement to a face-to-face general education course, such as biological sciences. Findings from this study indicate that students had a better experience, better engagement, and appreciated both the social learning experience given by the online social network. Results revealed that students through student-student interaction and student-teacher interaction enhance their own experiences and improved their learning ability. The findings were used as a basis in developing new practices and methodologies involving social networking tools for learning. Moreover, findings were used to design a blended format syllabus and blended learning guidelines (Cruz & Cruz, 2013). Based on the study of Chua and Montalbo, when used correctly, Virtual Learning Education may transform learning experience of students into a more enjoyable, satisfying and effective setting. This paper evaluated students' satisfaction on the use of Virtual Learning Education as a support technology in teaching students in graduate school (Chua & Montalbo, 2014). The degree of implementation of the teaching and learning with technology is moderate. It has an aggregate mean of 3.21, showing that teaching and learning with technology is already in the strategic plan of the higher education institutions; however, action has yet to be done. The study also reveals a significant positive relationship between degree of implementation of the teaching and learning with technology and conceptual skill of the respondents. (Marcial, 2012). The study were supported by the following researches because in learning especially in the applying such technology in the modern way of teaching it should incorporate the high-quality support structures, teachers spend a good deal of their working day preparing and refining their lessons through a collaborative process with other teachers. Teachers at the exemplary sites in this study acknowledged that they were engaged in a collective effort, and exhibited a commitment to teacher collaboration. Technology is dependent upon the ways in which they are used technology ushers in fundamental structural changes that can be integral to achieving significant improvements in productivity. Used to support both teaching and learning, technology infuses classrooms with digital learning tools, such as computers and hand held devices; expands course offerings, experiences, and learning materials; supports learning; increases student engagement and motivation; and accelerates learning. Technology also has the power to transform teaching by ushering in a new model of connected teaching. This model links teachers to their students and to professional content, resources, and systems to help them improve their own instruction and personalize learning. The students and teachers have a new avenue to enhance learning providing tools, giving students

and teachers more opportunities in feedback, reflection and revision and expanding opportunities in teachers and student learning.

2. Objectives

Most of the students are experiencing a traditional way of teaching with incomplete facilities available in the school; (1) especially institutions that has deficient laboratory equipment with respect to chemistry laboratories; (2) poor performance of experiment for visualization and reaction of elements; (3) do not have proper supervision in performing chemistry experiments; (4) diverted focus; (5) least updates about new elements found. The purpose of the research is to develop software that can be an alternative learning tool for the subject of chemistry, especially with the element, properties, structure, composition, behavior and changes from the chemical reactions in a just one platform.

3. Materials and Methods

To evaluate the effectiveness of having a Chemistry oriented application as an e-learning alternative tool for teaching, as descriptive research was applied with the use of survey research method in gathering data. The survey has two forms of questionnaires, a questionnaire for the users; the teachers, administrations, and students, and a questionnaire for the IT expert for technical perspective of the application. The users' questionnaire contains a total of four (4) categories; functional suitability, performance efficiency, usability, and reliability, as these categories are used to determine how effective the application is. To determine the functionality and technicality of the application the questionnaire for the IT experts added three (3) categories; security, maintainability and portability. The survey research was performed at San Roque Catholic School with 177 Grade 9 students, 5 teachers and 5 IT experts. The weighted mean is used to determine the average responses from each item in the questionnaire with 5 options; 5 excellent, 4 very good, 3 good, 2 fair, 1 poor. The Lickert scale shown below determines the responses of all the respondents by computing the weighted mean as shown in the table 1.

Table 1 Lickert Scale

Range	Scale	Rating
4.20 – 5.00	Excellent	5
3.40 – 4.19	Very Good	4
2.60 – 3.39	Good	3
1.80 – 2.59	Fair	2
1.00 – 1.79	Poor	1

4. Results and Discussion

Using the Agile Model in the implementation of the application;

4.1 Planning

During the planning, the researchers think about what kind of application can help to improve students' interest in the subject of chemistry. Through this, the researchers come up with the idea of computer based chemistry laboratory to visualize their activities. With this, the subject of chemistry will be enjoyable while being knowledgeable.

4.2 Analysis

The researchers analyzed the requirements, and fully understand the problems of how can learning be an interactive tool for third year students. The researchers had the study by conducting surveys and observations from teachers who teach chemistry in their class. The development of the application is based on what the schools have to provide without having problems with the budget, time and effort giving quality teaching and accurate information to their students.

4.3 Design

The researchers provided virtual chemistry laboratory application for third year students, to make chemistry laboratories not only exciting but also easy to comprehend. By the use of adobe Photoshop and moving pictures, researchers make it interactive for the students.

4.4 Implementation

The system will be implemented upon the principal approval on the proposed application; it is going to be installed in the computer laboratory of the San Roque Catholic School. Once the design is approved, technical implementation begins. The system requires at least a Pentium 4.2 Gigahertz, 128 megabytes memory and 10 megabytes hard drive as a computer hardware requirement. For the software requirements the proposed application needs a Windows XP or Higher. The application can be used in devices such as laptop and computer desktop. It involves installing the application on the user computer.

4.5 Maintenance

The researchers must be able to fix any issues that may come up during testing and operation. For example, changes, corrections, additions, and or malfunctioning of the application, the computer laboratory assistant should have knowledgeable troubleshooting skills.

In the application of binary search, the researcher creates an array that would determine each mixture and output in every input of the user. Each element comes with a corresponding number that adds and the output of its equation determines what information and visual representation to be shown. The use of binary search algorithm is mostly used with the play button or the virtual chemistry where the user mix elements and view information about each mixture and the activity area the user have to input answer to come with the results. Brute Force Algorithm is used in the student activity for experimentation of the system because the algorithm applies the fastest way on every move of the student in the experimentation. It will help the system from the experimentation to evaluate the student in their performance in overall activity.

User Interface

If figures are inserted into the main text, type figure captions below the figure. In addition, submit each figure individually as a separate file. Figures should be provided in a file format and resolution suitable for reproduction, e.g., EPS, JPEG or TIFF formats, without retouching. Photographs, charts and diagrams should be referred to as "Figure(s)" and should be numbered consecutively in the order to which they are referred.

Figure 1 Teacher's activity form

The teacher's activity form shown in Figure 1 is composed of eight activities. In this form the teachers can see and have authority to activate and deactivated access of the class in each activity. The activated activity is the only one that the student can access.

Figure 2 Student's my profile form

In Figure 2 the student/user can view his/her information and performance. It shows the overall percentage of the student/user performance each activity. In Figure 3 shown below is the IT expert evaluation towards the application. It gained with a weighted mean of 4.17 for Functional Suitability, consists of completeness which the set of functions covers all the specified tasks and user objectives, correctness of a system provides the correct results with the needed degree of precision and its appropriateness of the functions facilitate the accomplishment of specified tasks and objectives. Four (4) for Performance Efficiency, with respect to the system response and processing times and throughput rates of a system, when performing its functions, and meet its requirements, the amounts and types of resources used by a system, when performing its functions, meet requirements with respect to resource utilization, and the maximum limits of a system parameter meet its requirements. Appropriateness provides the users to recognize that the system is appropriate for their learning. System is used by the specified users to achieve specified goals of learning to meet its effectiveness, efficiency, freedom from risk and satisfaction in a specified context of use in learnability aspect. When it comes to operability the system has attributes that make it easy to manage and control by the user. The system protects users against making errors. In user interface aesthetics, it enables a pleasing and satisfying interaction for the user. In accessibility system can used by the people with the widest range of characteristics and capabilities to achieve its goal within a specified context of use with the total of 4.15 for Usability, in the aspect of maturity the system component meets the needs for reliability under normal operation. The component is operational and accessible when required for use by the student in the availability aspect. Fault tolerance component operates as intended despite the presence of hardware or software faults. In the event of an interruption or a failure, the system can recover the data directly affected and re-establish the desired state of the system gained 4.10 for Reliability. The system ensures that data are accessible only to those authorized to have access. The system component prevents unauthorized access to, or modification of, computer programs or data. Actions or events can be proven to have taken place, so that the events or actions cannot be repudiated later. The actions of an entity can be traced uniquely to the entity and identity of a subject or resource can be proven to be the one that claimed the weight gained 4.17. For Security, the system is composed of discrete components such that a change to one component has minimal impact on other components. An asset can be used in more than one system, or in building other assets. Effectiveness and efficiency with which it is possible to assess the impact on a product or system of an intended change to one or more of its parts, or to diagnose a product for deficiencies or causes of failures, or to identify parts to be modified. System can be effectively and efficiently modified without introducing defects or degrading existing product quality. Effectiveness and efficiency with which test criteria can be established for a system, product or component and tests can be performed to determine whether those criteria have been met gained 4.10 for maintainability, and system can effectively and efficiently be adapted for different or evolving hardware, software or other operational or usage environments. Effectiveness and efficiency with which a product or system can be successfully installed and/or uninstalled in a specified environment. The system which a product can replace another specified software product for the same purpose in the same environment

gained 4 for Portability. Based on Figure 3, IT experts rated the applications functional suitability in terms of developing tools used, algorithms and functions used. IT experts looked how organize or easy to understand the functions and codes used on the application. With the performance and usability it is rated based on how progressive the application with the loading and input processes. It is also evaluated on how it can carry a mass of records, users and data. In terms of security the IT experts graded it in how the application can manage and protect the confidentiality of each user accounts and data. In maintainability and portability it was evaluated technically by the IT experts based on their perspective on how the applications independent and free from bugs or unnecessary functions. The IT expert evaluated the entire system very good with the mean of 4.09 for its total performance.

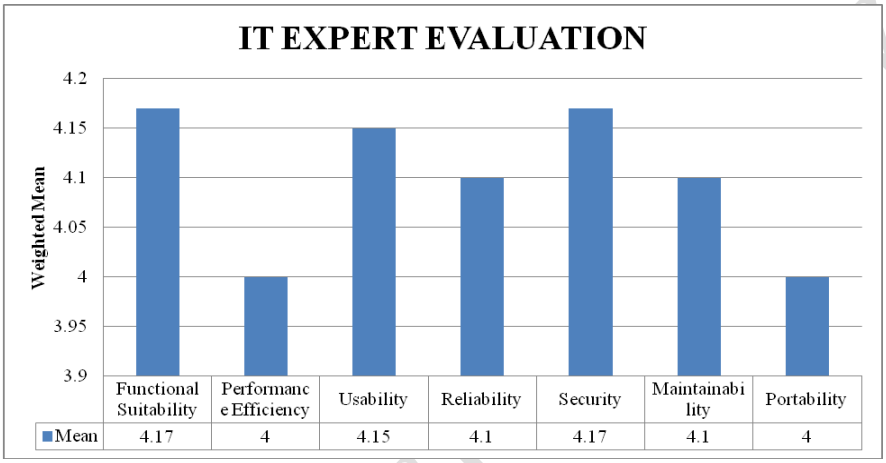

Figure 3 IT expert evaluation

In Figure 4 shown below is the total mean of users that rated the application, it was rated excellent and reliable as an alternative tool for chemistry as it provides the requirements needed for the research and application. The user's evaluation comes up of a mean of 4.49 with functional suitability as it provides the needs of the user and help them in chemistry education, performance efficiency of 4.39 as it saves time searching, performing activities and providing the elements and information about chemistry. In terms of usability the application is easy to use, accessible and knowledgeable as it gets the highest mean of 4.52. The users also rated the application excellent in terms of reliability as it protects their data, security and the application is accessible. The system was evaluated by the users with the total mean of 4.48 as Excellent for providing all the necessary and important information for the students learning in chemistry, and as for the users acceptance.

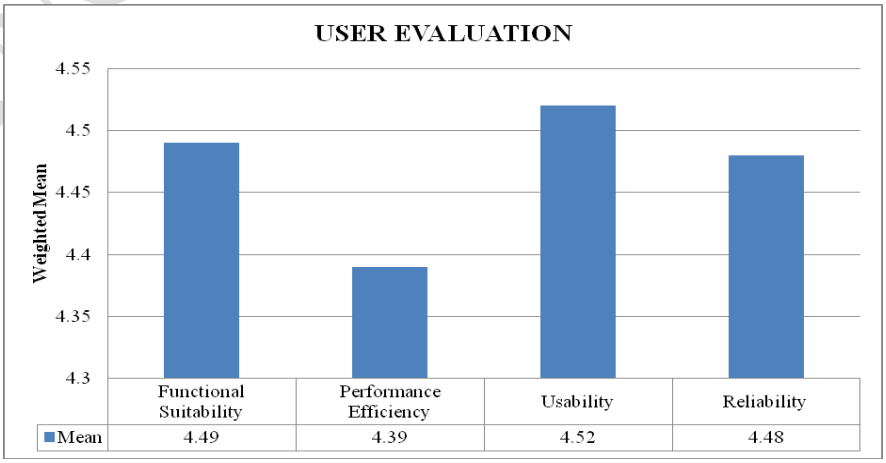

Figure 4 User evaluation

5. Conclusion

Based on the results and interpretation of the study as for the following; for IT experts the results entail that some of the features and functions of the application provided the following: the system provided application generated the laboratory tools that the student can use in processing the activity. The computer system included an interactive experiment with computerized visualization and reaction of elements that the student can explore the chemical reaction; it also has a 2D visualization and proper instruction in performing chemistry experiments. Moreover, the application presented a user responsive application for easy access and use of the system. The software product also included the updated information, discovered elements and mixtures as of 2017. Therefore, user can use it as an alternative tool for doing laboratory experiments in chemistry. The following are the suggestions and recommendations of the users in terms of Angry Chemist application. In taking users own points of view the system should have more elements to be mixed and more utensils that can be available in the activity area. Incorporate sound effects and music, for making the application more interactive. For further enhancement of the application it should be available and downloadable online and include online updates for elements, mixtures, and additional student activities. Aside from online it can also be an application for mobile. In order to use as well by the students who are taking chemistry and teachers can include a collaborative sets of activities.

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