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Chemistry Made Easy: Unravelling the Experiences of Biological Science Majors in Using a Virtual Laboratory

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Abstract Science education, in the midst of technological advancement, calls for the integration of ICT facilities that can enforce hands-on sciences both in theory and laboratory to leverage it at par. The integration of Crocodile Chemistry in the learning experiences of the students provide a complementary leap that enables learners to understand concepts better in an interactive manner. This study was designed to explore the experiences of a group of pre-service secondary school teachers in using simulated laboratory sessions in understanding select concepts in chemistry. Employing phenomenology of the qualitative research design as strategy for inquiry, thematic analysis, and document trail, the following are found: crocodile chemistry provides an avenue to easily understand concepts, provision for exciting and interesting supplemental learning experiences, provision for new laboratory experience, and extraction of results. Owing to the aforementioned results, this study concludes that the integration of crocodile chemistry in classroom teaching and learning complements knowledge construction to select concepts in chemistry from the traditional laboratory encounters.

Keywords: *chemistry education, crocodile chemistry, virtual laboratory, simulation, ICT in education*

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1. Introduction

Science instruction at the helm of the 21st century calls for a dynamic classroom procedure with the integration of Information and Communication Technology (ICT) vis-à-vis pedagogical advantage. The employment of experimental laboratory works is one of the most effective methods for acquiring knowledge in sciences where scientific process is observed. From a didactive point of view, experimental work is of utmost importance because it sometimes discontinues the monotonous teaching of theory with practical work. Experimental works maybe implemented as real and virtual. Classical experimental work is the best-known method of practical work and is commonly used in science teaching. For students who choose the subject, experiments in chemistry are fundamental and predominant form of such scientific works. Students are trained with their manual skills, developed with the ability to describe chemical changes, learned about physical and chemical properties of matter, developed safety at work abilities in the school laboratory, strengthened with complementary knowledge, abilities and skills, and developed in an experimental approach as a form of research work [1].

The experimental works allow students to develop and deepen their science literacy, basics of scientific works, complex thinking, and linking theory with practice as students are to be elevated with the frequency of laboratory work covered in traditional classes [2]. Hence, the complementation of ICT facilities in classroom teaching and learning is introduced to augment their learning experiences [3,4]. Less cost but efficient and less harm, yet beneficial. Virtual laboratory brings many advantages. Students can perform dangerous experiments without endangering themselves or others. Simulations are affordable. Once developed, they can be done at no extra costs as many times as they want. The results are always the same. A virtual laboratory provides independent or collaborative work, which is not necessarily related only to school time, school laboratory or available chemicals and laboratory facilities. Educational softwares are available in the market; just like a virtual chemistry laboratory called "Chemistry Crocodile Clips". This program also enables learners to work independently or in groups, where the interface gradually leads them step by step through virtual experiments.

Interactive 3D virtual environments have great educational potentials because they enable the active participation of students, research, and management of virtual objects. Virtual laboratories reproduce the conditions of a real chemical laboratory and enable learning through an interactive simulation and are valuable tools for distance learning and lifelong learning in chemistry. Virtual laboratories allow the execution of experiments without teacher's presence; therefore, students assume a major role in their learning process. Studies have shown that the

virtual laboratory is an appropriate tool with which chemistry students prepare for practical work [5,6].

The visualization of science education is used in its widest sense - from physical models to a variety of images, multimedia, and interactive animations conveying virtual reality [1,3,4]. All these modern visualization approaches enable the rapid development of ICT as it has become an increasingly important tool of modern science lessons. Visualization methods and representation of science can be viewed as metaphors, analogies of models or theoretical constructs represented by different symbols, developed within chemistry to explain the real world. Combination of different visualization elements can be designed in units within which macro, sub-micro, and the symbolic components of the multimedia phenomena are incorporated [1].

The crux is: the integration of Crocodile Chemistry in classroom teaching and learning enriches learners' academic ventures as it supplements their laboratory explorations. Learners may use it at their own pace; thereby creating a community of practice and inquiry in the subject. The exposure to technologies and a-priori learning experiences and indulgence of learners of today to technologies add potential success to the introduction of this virtual laboratory.

2. Methodology

This study employed the Qualitative Research designed using Phenomenology as strategy for inquiry. The informants, where qualitative data were generated, were the pre-service secondary school teachers majoring in biological science who experienced a virtual laboratory session using the Crocodile Chemistry software.

This study introduced the Crocodile Chemistry – a simulated virtual laboratory. At first, the informants were oriented through a briefing session. After which, the informants had their hands-on session for six occasions: Acids and bases, acid rain, stomach acid, making salts, neutralization, and acid dissociation.

We personally interviewed the informants to gather data needed in the study. Before the interview was conducted, we briefed the informants that their participation in the interview is voluntary and they can terminate it anytime. Data from the informants' interview were transcribed by a researcher whose credibility is beyond compare. Document trail was employed in routing the transcripts of the interview among the informants in ascertaining the veracity of their claims. Data were analyzed thematically to conclude on the research objectives. Themes were formulated according to the recurring claims of the informants which served as bases in an inquiry-based analysis vis-à-vis the research problem.

3. Results and Discussion

The following themes were formulated based on the gathered data from the informants' interview. Data were validated through document trail among the informants to ascertain the veracity of each claim.

Avenue to easily understand concepts. Learners nowadays find better ways on how to learn more easily. They want an easy life of their hectic and heavy learning tasks. So, we are lucky today because technology provides software that can hasten the tedious laboratory activities. Through the manipulation of this software, learners can easily perform laboratories and classroom activities at their fingertips - easy to perform and understand results. Therefore, this software helps students achieve better learning and attain higher order thinking skills in learning chemical reactions. Today, teachers in the academe integrate organizational supports like training manuals, process sheets, and job aids; feedback and learning technology research; and online learning assumptions to support millennials' leaning vis-à-vis millennials preferences to improve their learning. It is believed that the lack of applicable workplace organizational learning support inhibits learners' grandest opportunities to explore every learning task and opportunity. Furthermore, it was claimed that the failure of the teachers to understand, design, and implement organizational learning preferred by millennials can under-optimize their learning outcomes and performances [7].

The following transcripts from the informants qualify the claim of this study that Crocodile Chemistry is an avenue to easily understand concepts in Chemistry:

Mildred

"… it helps me to understand the concepts easily since the instructions were already there. I easily understand the concepts and reactions: results are made available in a click and the chemicals needed are readily available with no hassle of identifying and preparing…"

Paz

"… it allows me to understand the concepts easily since the instructions were already there and the chemicals and other things that I'll be needing are already available in some accurate results…"

Provision of exciting and interesting supplemental learning experiences. In such a way that the software has good graphic design, the Crocodile Chemistry allows learners to be more interested and excited on the things that the software can offer. The software may also lessen risks during actual laboratory setups especially accidents. Moreover, the software also fosters better learning because it supplies and extracts information needed for further analysis and exploration. It is claimed that educational software like Crocodile Chemistry brings the dogmatic classroom instruction into interactive learning clips and modules. These learning opportunities allow millennials to personalize their learning at their own pace [8]. Moreover, it is characterized that millennials value interactive virtual learning and learn best when involved in the process. Given that our students expect for rich, interactive, and enjoyable learning environments, teachers may design curricular approaches intertwined with eclectic procedures based on the newer psychology of learning [3,4,9].

The following transcripts from the informants qualify the claim of this study on the provision of exciting and interesting supplemental learning experiences:

Paz

"… Crocodile Chemistry is exciting and interesting..."

Tommy

"… it seems interesting; I'm still curious on how the functions within the software be manipulated…"

Zelfei

"… actually, my experience in using Crocodile Chemistry is interesting. It brought the computer simulation into a real world. The importance of the laboratory in the study is highlighted even though there is a lacking competency to be mastered and learned by the learner – precision and accuracy. I even tried to experience the lab activities which I didn't try before…"

Mildred

"… Crocodile Chemistry is interesting to use although it is my first time to manipulate it. I'm curious in some functions of the software…"

Provision of a new laboratory experiences. Learners nowadays are fond of using new technologies. They are engaged in a new type of laboratory that introduces new concrete experience that is memorable because of its uniqueness. It provides a new set-up of learning environment and experiences among learners. Students acquire new knowledge out of manipulating the software as every learner has unique mental model that brings values and beliefs, and conceptions of knowledge and skills that create perspectives that filter and guide information, learning experiences, and problem solving [10]. Experiences refine learning schema and expand as new knowledge through online learning mechanism. The expansion process occurs as new information is experienced which adds breadth and depth to the existing model. The application of advanced technologies in teaching and learning provides better opportunities to further analogical thought and skills among learners. This structural building process connects new information with existing knowledge to expand the scope of the learning model powered by the adopted technologies [11,12]. A persistent challenge for scholars and practitioners is to support expanding each learner's unique mental models with new knowledge and experiences that are often delivered uniformly to a large number of learners simultaneously.

The following transcripts from the informants qualify the claim of this study on the provision of a new laboratory experiences:

Paz

"… It is very convenient in learning if your purpose is just to know the concept of the topic and not on the performance of the students…"

Don

"… It's a good experience (quite good) and easy to use..."

Sakura

"… As I use the software Crocodile Chemistry, I experience new and better way in conducting laboratory experiments. It is an easier way of doing laboratory experiments - less effort, less time, and less expenses…"

Quick Extraction of Result. The software is an advance type of educational program with varied modules that can show a complete set of results for the learners to learn effectively. Learners of today, who are called millennials, access learning tasks easily through technology. The software provides the necessary information needed in understanding laboratory concepts. Furthermore, it can instantly offer laboratory results in a less tedious manner; exact outcomes of the laboratory. Learners can write hypothesis and test them with their own. Millennials are enabled to conduct experiments, measure variables, and construct results through simulation techniques. Millennials have unique learning desire which is powered by outcome progression through online learning tools. These concordances sustain their motivation to further explore learning tasks [13]. Research results qualified that millennials prefer learning activities that instigates online learning models regardless of its design and format – the more intricate the model is, the better is the motivation that it brings [12]. Millennials prefer classroom, online, and blended learning experiences, and respond well to feedback, and learning technologies when used to support learning [3,4,12,13,14].

The following transcripts from the informants qualify the claim of this study on quick extraction of results:

Sakura

"…Aside from being useful in the sense that it requires less effort and time, I learn more knowledge in using softwares that are linked in science..."

Tommy

"… the given concepts were in fixed system: the results are extracted instantly with less effort compared in a real laboratory set-up..."

Zelfei

"…The benefits that I gained from learning science concepts through computer simulation are bringing you into the surrounding of chemicals even without perceiving and seeing them. You can repeat if you failed and less effort in preparing lab set-up…"

The integration of virtual instruments as educational tools has been identified as a necessity at all educational levels. The new pedagogical approaches (like blended learning) are combining the face-to-face learning with the distance learning. The specific e-learning technologies bring the practical aspects into the didactic process, by defining different criteria which can be considered in the selection process of a specific software that allow the design of virtual instruments for education [3,4,15,16]. Having in view the particular aspects of training (including the case of distance learning), the most important issue of using virtual instruments is the fact that those instruments can simulate physical phenomena.

4. Conclusion

Based on the gathered data from the informants' interview, the following are drawn:

1. Crocodile Chemistry software enables learners to explore Chemistry at their fingertips;
2. Crocodile Chemistry provides avenue to easily understand concepts, exciting and interesting supplemental learning experiences, new laboratory experiences, and quick abstraction of results.

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