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Development and assessment of "Chem this Vlab" learning package

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ABSTRACT

This study determined the difficulty level of answering Chemistry problems of the STEM students ofLibertad National High School. The respondents of the study were seventy-three (73) purposely selected students for the school year 2020-2021. Thereafter, the researcher developed a Learning Package in Chemistry to augment the learning in the new normal. It will be known as Chem in this VLab Learning Activities that focus on Chemical Solutions, Thermodynamics, and Chemical Kinetics. To validate the quality of the learning package, selected experts assessed the tool on three components: content, technical, and instructional qualities. The results revealed that students had poor performance in answering Chemistry problemsand find Chemistry as difficult subject to learn. Therefore, learning activities are developed to aid their understanding on the selected topics. The instructional material was rated as a good instructional tool in learning Chemistry by the experts and recommended to be utilized in the online distance learning modality.

Keywords: Development and assessment; General chemistry; STEM; Virtual laboratory

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1. Introduction

Many trends in Science education reforms propose a lot of changes from curriculum to approaches, yet the current situation in science lessons manifest similarities with the lessons taught even a century ago (Bevins et al., 2005). They elucidated in their study that while students have particularly strong inclinations and interest in science, the way science is taught in school deteriorates their enthusiasm because the problems and concepts given are not directly related in the encounters in their daily life. Some students even claim that their understanding in some of science's basic concepts is self-learned.

However, in the general scope worldwide, there is declination in the enrollment of students in chemistry courses that can be restored by reducing fear of the subject, particularly anxiety related to performing experiments (Kurbanoglu & Akim, 2010). It is where the teacher's role is that chemistry as an autonomous science needs to be taught to students. A holistic subject that requires both an intrinsic logic and methodology in order to reverse this situation and inspire new

enthusiasm among chemistry practitioners (Pagliaro, 2010).

With various approaches used in teaching Science, thus, more engaging and computer- driven teaching has been the trend. Since, teachers may avoid using laboratories because of some different reasons like insufficiencies in traditional verification method, safety doubts of teachers in some risky experiments, some teachers' lack of self-confidence, inadequate effort and time required to perform experiments (Walton, 2002).

In the advent of virtual laboratory in learning Chemistry further studies confirmed that students' learning improved (Woodfield, Andrus, Anderson, Miller, Simmons, and Stanger, 2005). Virtual Laboratory was found to be more effective for improving difficult conceptsand scientific inquiry self-efficacy (Husnaini & Chen, 2019). Moreover, as confirmed that VLab is at least as effective as the traditional laboratory, both in terms of students' attitudes and cognitive achievements (Laridaet al., 2021). However, there are studies that it can produce a more positive attitude of students who are using computers for learning. They find simulations of laboratory assignments motivating and creating a lot of experience. Consequently, simulation supports students in the accomplishment of cognitive tasks and enhances their learning processes (Josephsen & Kristensen, 2006).

With its popularity in the academic field, there are augmentation and improvement done in the forms of numerous educational applications, computer-assisted physical and chemical simulations, copying of natural phenomena and conditions of an experiment (Tatli & Ayas 2013) which are applicable for more engaging activities. The utilization and using computers in learning can create a more interesting learning environment and increase the student's learning achievement (Jagodzinski & Wolski, 2015).

To qualify the development in teaching and learning using Virtual laboratory, various assessments may employ. CAI tools or virtual laboratory are separate from the instruction itself. Serin (2009) treated the effectiveness of CAI and its tools statistically through the achievements the samples attained and a study of interactive interfaces used summative design-evaluation through user preferences, which yield consistent results as regards to the effects of computer- aided instructional tools. VLab tools can indeed be evaluated and assessed in many various ways, be it quantitative or qualitative. This only proves the versatility it brings in classroom dynamics and more meaningful learning.

This study aimed to develop and assessed a Virtual Laboratory (VLab) Learning Package in teaching General Chemistry II among STEM students Specifically, it answered the following questions:

1. Determine the difficulties of STEM students in answering Word Problems in General Chemistry in terms of:
   1.a. Organizing information
   1.b. Appropriate Chemistry Concepts
   1.c. Application
   1.d. Mathematical Procedure
   1.e. Logical Progression
2. Develop a Learning Package with Adapted VLab; and
3. Assess the developed Learning Package with Adapted VLab Tool interms of:
   3.a. Content quality
   3.b. Technical quality
   3.c. Instructional quality

2. Materials and Methods

2.1 Research Designs

As presented in the Figure 1, this study utilized an Input-Process-Output design. Moreover, it is a descriptive research that determined the difficulty of the STEM students in learning General Chemistry. Subsequently, development of Virtual Laboratory package was implemented and assessment of the Learning Package was followed.

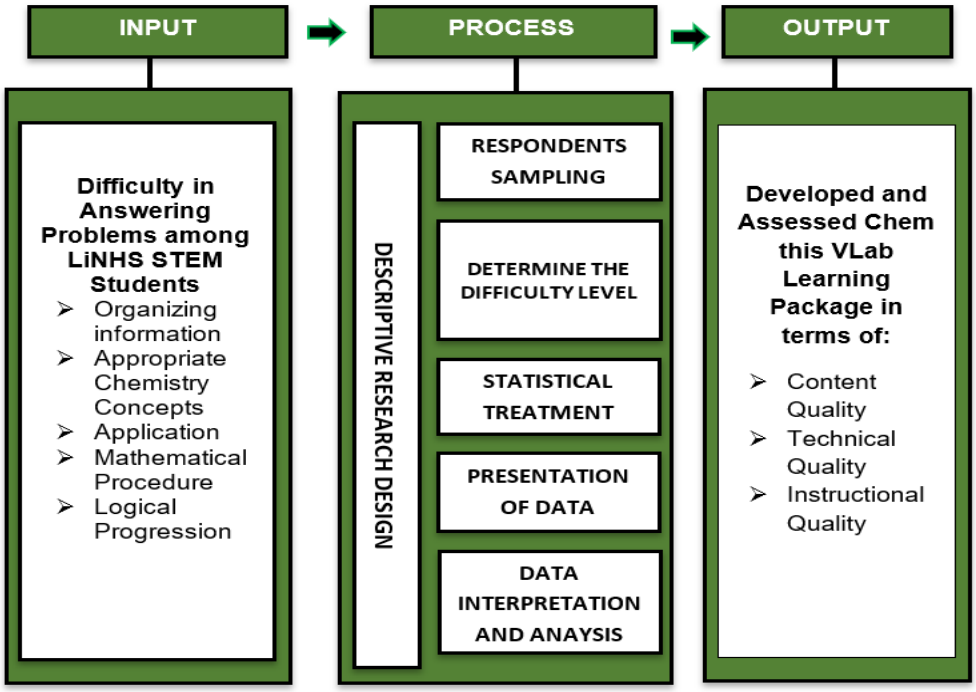

Figure 1. Conceptual framework.

The researcher tested the difficulty of the students in Chemistry problems in different criterion namely Organizing Information, Appropriate Chemistry Concepts, Specific Application of Chemistry Concepts, Mathematical Procedures and Logical Progression. Five word problems were given among students to determine their difficulty in answering Chemistry problems. This was the basis for adapting a computer-aided instructional tool. The assessment of this tool in terms of content, technical and instructional quality followed.

The computer-aided laboratory tool was then adapted to be augmented on the learning package known as "Chem this VLab". CHEMIST® – Virtual Chem Lab Application was designed for tablets and android phones, ideal for the mobile gadgets to conduct chemistry experiments and explore chemistry reactions with different lab tools. The researcher selected topic and activities in General Chemistry 2 such as Chemical Solution, Chemical Thermodynamics, and Chemical Kinetics. Then, developed a laboratory package that can be performed using CHEMIST® – Virtual Chem Lab Application.

In the assessment of the Vlab Learning Package, the researcher demonstrated its features to the selected assessors. Assessment of the content quality,instructional quality and technical quality was

conducted.

2.2 Research Location

The study was concerned with the determination of the Students' Difficulty in learning Chemistry of the Grade 8 students of Libertad National High School. The school is located at Surallah, South Cotabato, Philippines.

2.3 Respondents of the Study

The respondents of the study were seventy-three (73) purposely selected students of the school year 2020–2021 when Online Distance Learning (ODL) is employed all throughout the school levels.

2.4 Research Instruments

In order to determine the difficulty of the students, the researchers developed a set of wordproblems in General Chemistry that involve the concepts of Chemical Solutions, Thermodynamics, and Chemical kinetics. Each word problem is accompanied with a House Model (Byun et al., 2010). The House Model was used by the respondents for analyzing and solving process. This was the basis for scoring the students' difficulty through a rubric. The content validity of the questions was checked by different Chemistry teachers. Then, the questions were pilot-tested and item- analyzed to further affirm the validity of the questions. The respondents answered in the given spaces in the House Model. For Visualizing, they were asked to draw a free-body diagram based on their interpretation on the problem. For Knowing, the respondents have looked for the given from the problem. Then, the Finding is the space for determining what is asked in the problem. In the Planning, the compilation of the set of derived formula was filled in. Finally, the respondents did their solving in the space for the Execution.

In assessing the content, instructional and technical quality of the Learning Package with Virtual Laboratory tool (Alegre, 2012). They evaluated the Chem This VLab Learning Package through an evaluation sheet.

3. Results and Discussion

3.1 Difficulties of Students in Chemistry

Based on Table 1 in the Organizing Information the highest mean is in the Problem 2 with thevalue of 3.07 (**Average**) while the lowest mean in organizing information is in the Problem 4 which is 1.45 (**Very Low**). For the Appropriate Chemistry Concepts the highest mean of 2.94 (**Average**) is in Problem 2. The respondents got thelowest mean in Problem 4 with the value of 0.89 (**Very Low**). In the Specific Application of Chemistry, the highest mean is 2.82 (**Average**) in Problem 2. However, the lowest mean is 0.80 (**Very Low**) in Problem 4.

On the Mathematical Procedure Problem 2 has the highest mean of 2.92 (**Average**), while the lowest among them is still Problem 4 with the mean of 0.88 (**Very Low**). Lastly, in the Logical Progression, Problem 2 got 2.76 (**Average**) as the highest mean value and the lowest is in Problem 4 with 0.86 **(Very Low).**

Meanwhile, the Organizing Information criterion got the highest rating. This means that thestudents have highly significant insights on how the concepts are interrelated and interconnected.Moreover,

this tells us that the students are able to visualize concepts in Chemistry and create applications of the problem out of it. According to Bodner (2015) organized problem solving that captures physical reality encourages learners to think carefully about how ideas are communicated to students.

However, the relative scores show that the mean scores do not even exceed 3 which tells us that in general, the students still find **great difficulty** in all criteria presented in answering Chemistry problems.

Table 1. Means of the Difficulties of Students in Chemistry Problems

	Organizing Information	Appropriate Chemistry Concepts	Specific Application of Chemistry	Mathematical Procedure	Logical Progression
Problem 1	2.68	2.08	1.94	1.85	1.94
Problem 2	3.07	2.94	2.82	2.92	2.76
Problem 3	2.32	1.90	1.58	1.61	1.75
Problem 4	1.45	0.89	0.80	0.88	0.86
Mean	**2.38**	**1.95**	**1.79**	**1.82**	**1.83**

Scale: 4.51-5.00 - Very High; 3.51-4.50 – High; 2.51-3.50 – Average; 1.51-2.50 – Low; 0.00-1.50 - Very Low (Latif et al., 2017)

3.2 Development of Lesson in Chemistry Using Virtual Laboratory

The Chemistry Learning Package will be known as Chem this VLab Tool in Chemistry that was adapted was a freeware program. It belongs to the software package called CHEMIST®. The augmented software tool is entitled CHEMIST® – Virtual Chem Lab App. It features an interactive simulation of a Chemistry laboratory technique, where students can undergo laboratory activities same as the real-setting laboratory. It features various hundreds of chemicals, apparatus, and realistic simulation. The splash screen of CHEMIST® – Virtual Chem Lab App is presented in Figure 2.

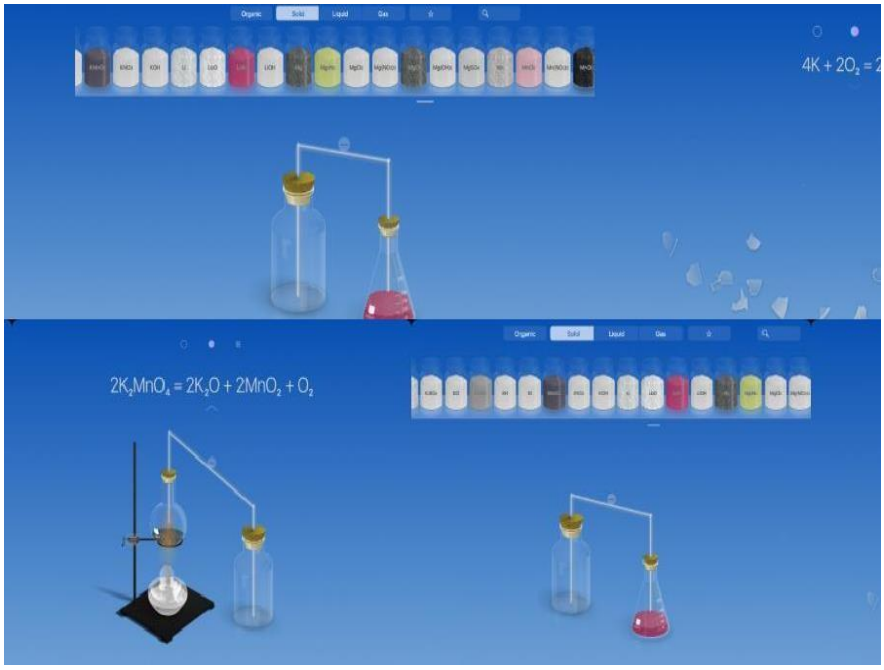

Figure 2. CHEMIST® – Virtual Chem Lab Application.

The CHEMIST® is augmented on the laboratory activities on the three selected topics of General Chemistry 2: Chemical Solution, Chemical Thermodynamics, and Chemical Kinetics.

It is your dream virtual chemistry lab. Experiment with various lab equipment, procedures,and chemicals with complete freedom—no need to buy chemicals or clean up afterwards. Perfect for testing, exploring, learning, or just playing around. It can be downloaded to the computer or android phones.

To fully implement the virtual laboratory package among STEM students it was supplement on the Daily Lesson Log (see Figure 3). From the DLL design, the laboratory activity in each topic is given every Friday of the week.

GRADES 1 to 12 DAILY LESSON LOG	DAILY LESSON LOG			
	School	Libertad National High School	**Grade Level**	12 – STEM
	Teacher		**Learning Area**	General Chemistry 2
	Teaching Dates		**Quarter**	Fourth Quarter
	Teaching Time		**Section**	STEM Grade 11 – A and B

	Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
I. OBJECTIVES					
A. Content Standards	properties of solutions, solubility, and the stoichiometry of reactions in solutions				
B. Performance Standards					
C. Learning Competencies/ objectives Write the LC code for each	At the end of the lesson 90% of the students will be able: - to describe the different types of solutions **STEM_GC11PP-IIId-f-110**	At the end of the lesson 90% of the students will be able: - to perform stoichiometric calculations for reactions in solution **STEM_GC11PP-**	At the end of the lesson 90% of the students will be able: - to explain the effect of pressure on the solubility of a gas **STEM_GC11PP-IIId-f-114**	At the end of the lesson 90% of the students will be able: - to differentiate the colligative properties of nonelectrolyte solutions and of electrolyte	At the end of the lesson 90% of the students will be able: - to perform the solubility of a solid in a given amount of water at different

Figure 3. Sample of Daily Lesson Log used in General Chemistry.

3.3 Chem this VLab Learning Package

The assessment results of the Chemistry and ICT teachers who were the raters on the content quality, technical quality and instructional quality of the adapted CAI tool are presented in Table 2.

Table 2. Overall Mean Responses on Content Quality, Technical Quality and Instructional Quality

Quality Components	N	Mean	Description	Interpretation
Content Quality	5	4.44	Agree	Good Quality
Technical Quality	5	3.94	Agree	Good Quality
Instructional Quality	5	4.22	Agree	Good Quality
Overall	**5**	**4.20**	**Agree**	**Good Quality**

Based on table 2, the over-all quality of the Chem this VLab Learning Package got a **favorable mean** score of 4.20 among the three (3) categorical qualities. The Content quality component was assessed as **good quality** (4.44) learning VLab Learning Package. This elucidates that the package is well organized, scientifically adequate, creates a relevant activity, interesting among learners, free from biases, and allows development of multiple intelligences. Meanwhile, technical quality has **good quality** (3.94) rating from the assessors. This means the VLab package is easy to navigate, allows learners to control the learning process with easy to use graphics and splash screen design, and the app in general is aesthetically pleasing to use. Finally, the instructional quality shows (4.22) rating which is also a **good quality** learning package. Since, it was found out that it has an educational value, supplements to the curriculum, addresses the needs of the learners, facilitates collaborative learning, helps learners in answering Chemistry questions and allows them to reflect in Chemistry instruction. This means that the Learning Package is a **good instructional tool** to be used in virtual laboratory activities.

4. Conclusion

The students of Libertad National High School STEM strand had a **low performance** level in answering Chemistry problems in all parameters. Furthermore, the developed instructional tool can be augmented in learning Chemistry through virtual laboratory experience. It will be known as **Chem this VLab Learning Package**. From that developed package, it was assessed and rated as **good instructional tool** in learning Chemistry through ODL modality.

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