American Journal of Educational Research, 2022, Vol. 10, No. 8, 501-507
Available online at http://pubs.sciepub.com/education/10/8/4
Published by Science and Education Publishing
DOI:10.12691/education-10-8-4

CHEMIKA and Students' Academic Achievement in Chemistry

Jerick E. Aquino[1], Romiro G. Bautista[2,*]

[1]Secondary Education Department, College of Teacher Education, Quirino State University, Philippines
[2]International Relations Office, Quirino State University, Philippines
*Corresponding author: romiro.bautista@qsu.edu.ph

Received July 13, 2022; Revised August 19, 2022; Accepted August 28, 2022

Abstract The provision of virtual laboratory is paramount to a continuum of providing scientific concepts and principles even during pandemic. The study was conducted to determine the effectiveness of alternative hands-on laboratory e-session through simulated multi-media and interactive knowledge simulation approach on student's academic achievement in Chemistry. The One Group Pretest-Posttest Design (OGPPD) of the Pre-experimental Design was used in this study as it intends to collect viable data on the employment of Project *CHEMIKA* as a way of leveraging the academic achievement of Junior High School (JHS) students in Chemistry particularly in the study of Matter. The mean score of the students in the pretest and posttest is increased. This increase is coined as an effectual result of the implemented provisions of Project *CHEMIKA*; There is a significant difference on the pretest and posttest mean score of the students in Chemistry. This posts a significant increase in the posttest results; The provisions of Project *CHEMIKA* posted a medium effect on the academic achievement of the students in Chemistry. While the result of the study seems to suggest that the students have better test results when exposed to the proposed intervention, there are important limitations to note. The study was limited in the areas of size, duration, content, and methodology. Albeit limited with the aforementioned parameters, Crocodile chemistry still appears to be a viable application in aiding students learn Chemistry concepts and thereby enhancing students' academic achievement. Chemistry teachers are encouraged to use this instructional application in teaching Chemistry. Likewise, school administrators may consider presenting it among Chemistry teachers for synchronous class discussions and experiments to enhance existing approaches with the help of modern technology.

Keywords: *academic achievement, action research, CHEMIKA, crocodile chemistry, virtual laboratory*

Cite This Article: Jerick E. Aquino, and Romiro G. Bautista, "CHEMIKA and Students' Academic Achievement in Chemistry." *American Journal of Educational Research*, vol. 10, no. 8 (2022): 501-507. doi: 10.12691/education-10-8-4.

1. Introduction

The onslaught of CoViD-19 pandemic in 2020 had challenged all schools and teachers to innovate and reinvent classroom teaching procedures especially on the provision of laboratory sessions in the sciences like the case of Chemistry. Teachers are invited to think of alternatives that can provide experiences at par with the residential teaching and learning without compromising the results and impact on the quality of teaching and learning. Such alternatives include virtual laboratory, computer-based applications, science apps, multi-media, among others [1,2].

Chemistry, as a subject, presents concepts in an abstract presentation that needs a complementary concept formation to build a strong foundation as a science: the concept learned from the Theory Room and the practical applications and skills learned in the Laboratory Room. The complementation between these two important aspects of science instruction calls for strategic intervention programs, procedures, and materials that can help teachers promote learning and to stimulate students' interest in learning Chemistry. The inclusion of hands-on activities and other alternatives that incorporate scientific processes, instrumentations, and technological inclusions are believed to stimulate interest in learning the subject no matter how intricate and abstract it is [3,4,5]. Among the alternatives suggested by the authorities include simulations or virtual laboratories.

Virtual laboratory is a virtual teaching and learning environment aimed at harnessing students' laboratory skill. Virtual laboratories allow the execution of experiments without teacher's presence; therefore, students have a major role in their learning process. Studies suggested that virtual laboratory is an appropriate tool with which Chemistry students prepare for practical work recalling which stimulates interest, motivation, and efficacy in learning [6,7,8]. When properly motivated and involved in the process, students will come across learning affecting their academic achievement [3,5,9].

Academic achievement in science is controlled by the learners' experiences, skills, and self-regulation as they employ their distinct cognitive strategies in learning to various learning encounters in both Theory and Laboratory rooms [10,11,12]. As such, teachers should

offer science subjects in such a way that the progression of scientific concepts and skills is assured even during home-schooling like the current educational state.

Classroom teachers should consider how to prepare learning environments in which students will be active in accordance with their characteristics and then present these environments to students [13]. Creating and adopting techniques, strategies, methodologies, as well as interventions programs, softwares, and application are at helm of innovating classroom procedures which are expected to better the attainment of such competencies specific to the subject [1,2,3,13].

The crux is: the pandemic challenged the researchers to think modality inclusions on how to fortify their teaching procedures amid their remote teaching: the possible integration of simulated, interactive virtual laboratory to complement the concepts learned from both theory and laboratory rooms. These are expected to efficaciously attain the specific competencies in the subject which may increase the academic achievement of the students.

1.1. Objectives of the Study

This study is designed to provide a substitute of the conventional residential laboratory procedure in school science through an interactive computer-based simulation of select laboratory activities in Chemistry particularly Matter.

Specifically, it aimed to determine the mean pretest-posttest results on the academic achievement of the students in matter; evaluate on the significant difference on the mean pretest-posttest results on the academic achievement of the students in matter; and discriminate on the effect size of the programmed interventions on the academic achievement of the students in matter.

1.2. Theoretical Framework of the Study

Bandura's theory of self-efficacy has proven to be an immensely useful framework to scaffold the development of our work [14,15,16]. The theory classifies behavior as a product of (1) the perceptions people hold about their own abilities, and (2) the consequences they expect to follow from their performances. Those who believe strongly in their abilities typically step up their efforts and persist in situations that appear threatening. In contrast, individuals inhibited by self-doubt will diminish their efforts, if not give up entirely, thereby settling for compromised or sub-par outcomes [17].

In academic achievement of students, self-efficacy plays an important role along with hope and engagement [18]. Reports suggest that students with high self-efficacy have showed higher level of participation in classrooms, greater efforts to study, and better performance in exams [19,20].

2. Methodology

The One Group Pretest-Posttest Design (OGPPD) of the Pre-experimental Design was used in this study as it intends to collect viable data on the employment of Project *CHEMIKA* as a way of leveraging the academic achievement of Junior High School (JHS) students in Chemistry particularly in the study of Matter. Project *CHEMIKA* involves the employment of an interactive computer-based simulation of laboratory activities through the Crocodile Chemistry Application. This design involves a pretest or baseline observation which allows the investigator to determine the effects of the treatment conditions by comparing the pretest and posttest results. Aptly, pre-test results are used as covariate values in establishing the causal effects of the treatment condition.

The Intervention Program – Project CHEMIKA, Chemistry at the Helm of alternative hands-on laboratory e-sessions through simulated Multi-media and Interactive Knowledge simulation Approach.

The onslaught of CoViD-19 pandemic challenged the science teachers to provide continuum on the conduct of laboratory activities as residential learning is not allowed. As such, science teachers reinvented classroom science instruction with the alternatives of providing laboratory sessions through computer simulations such a virtual laboratory.

Each learning task was developed with the usual classroom instruction using the known methodologies and approaches of teaching and learning. These were fortified with interactive computer-mediated simulations and multi-media – the Crocodile Chemistry. The topics covered in this study include the simulations of Atomic Structure, Conductivity, Melting points, and Solubility of Ionic and Covalent Compounds, and Melting Ice and Boiling Water.

The Crocodile Chemistry. This science application is a comprehensive simulated chemistry laboratory where students can model experiments and reactions safely and easily. The usability of Crocodile Chemistry proved to be a very good one due to the both ways of its usage: "Beginner" and "Advanced". For the "Beginner mode", the users have just to follow the instructions of the program to interact with ready to use modules. After two or three clicks, the users are running a very visual interactivity.

Project *CHEMIKA* is designed and implemented in the following manner:

1. Lecture-discussion by one of the proponents: a typical lesson development that employs the time-tested methodologies and strategies in teaching like Lecture Method, Demonstration Method, Laboratory Method, Inquiry Approach, POE strategy, among others;
2. Virtual laboratory with computer simulations. Each lesson requiring laboratory is provided with additional session which is a take-home activity or session. The application is installed in the computers of the students so they can work at their own pace. Students can repeat the sessions until they can master the competencies. The topics included in the simulation session were Atomic Structure, Conductivity, Melting points, and Solubility of Ionic and Covalent Compounds, and Melting Ice and Boiling Water.

The following are the sample simulations made during the implementation of the Intervention Program:

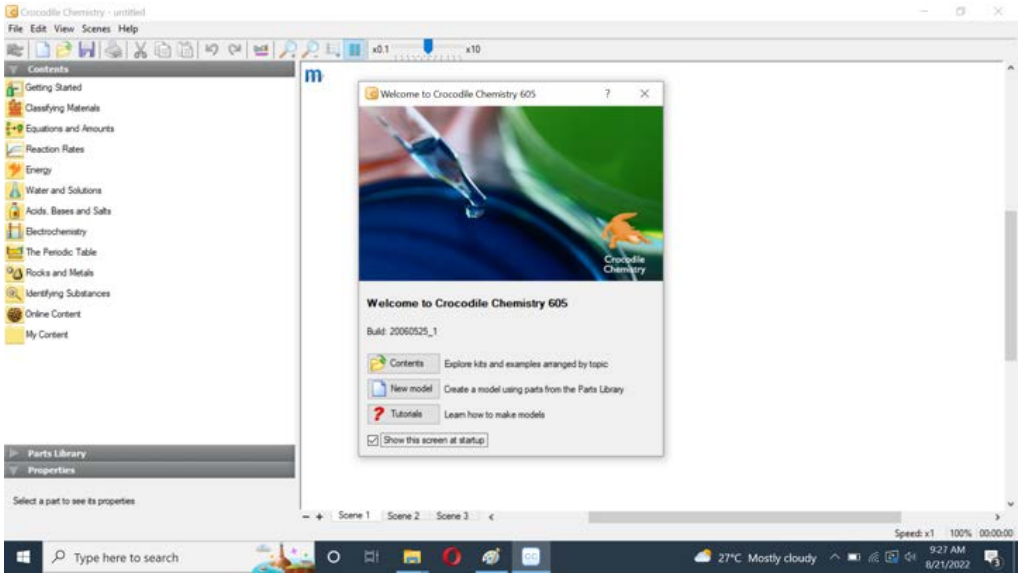

Figure 1. The Crocodile Chemistry at a Glance. Topics are found in the Menu Bar. Upon Clicking, topics are presented with the simulated activities which the students can view and repeat anytime

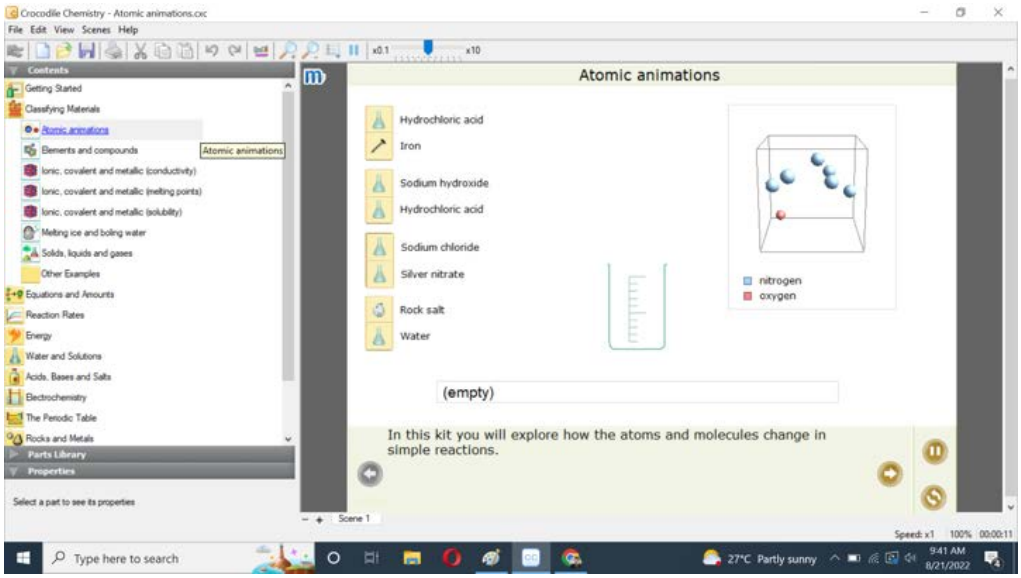

Figure 2. Simulation on Atomic Animations exploring how the atoms and molecules change in simple reactions

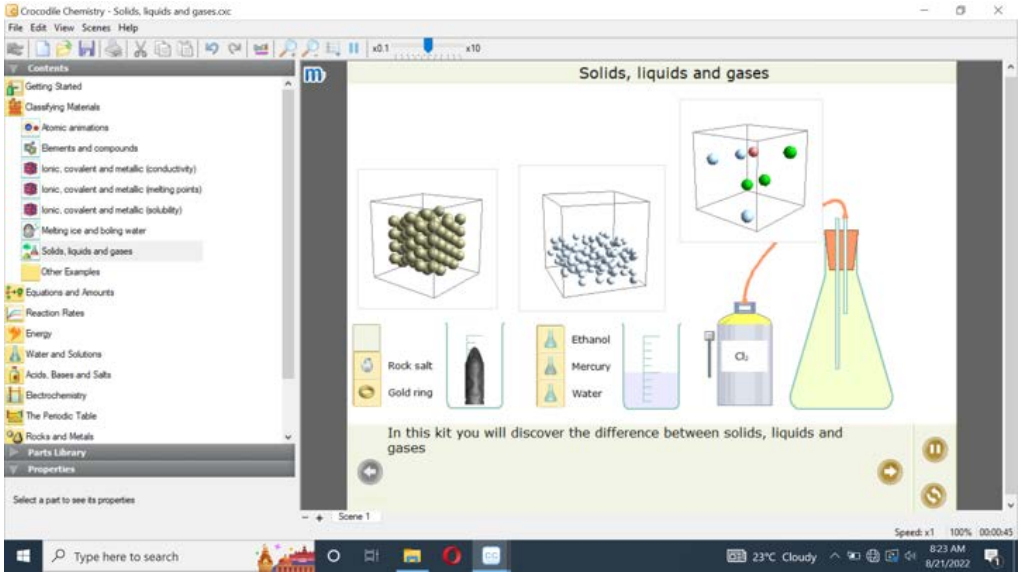

Figure 3. Simulation on the Distinguishing Properties of Solid, Liquid, and Gas

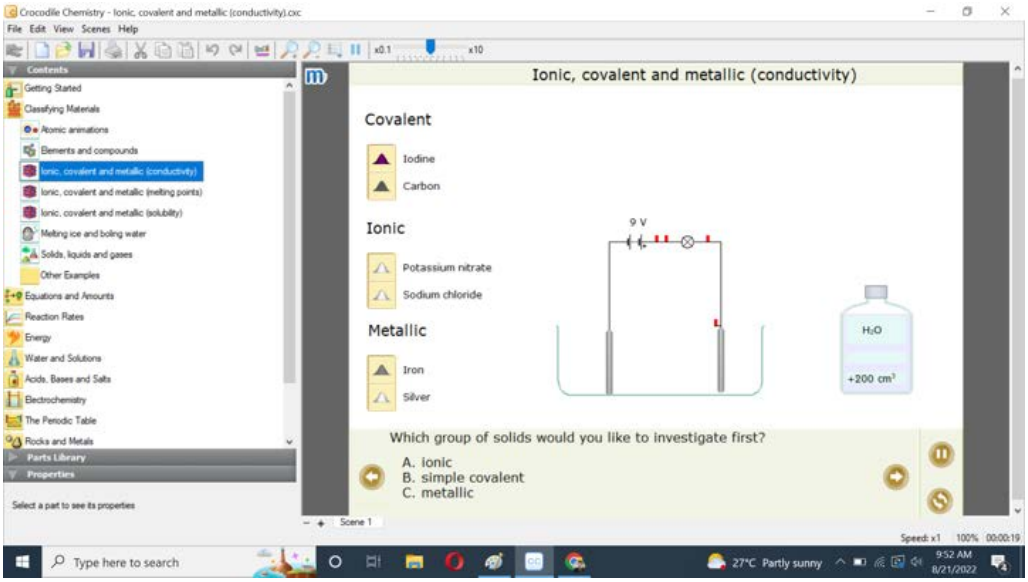

Figure 4. Simulation Set-up for Ionic, covalent, and metallic Conductivity

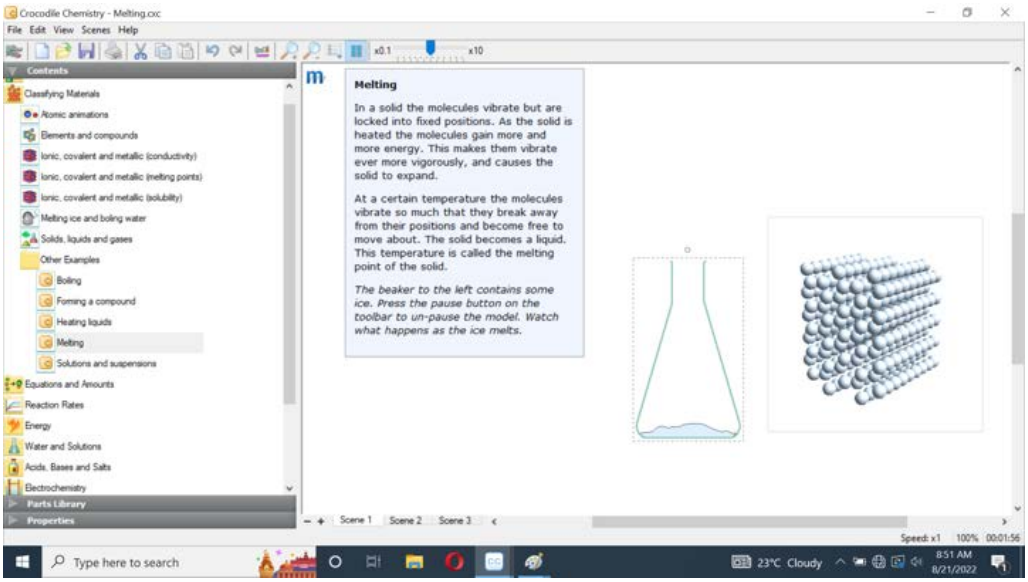

Figure 5. Simulation on Melting

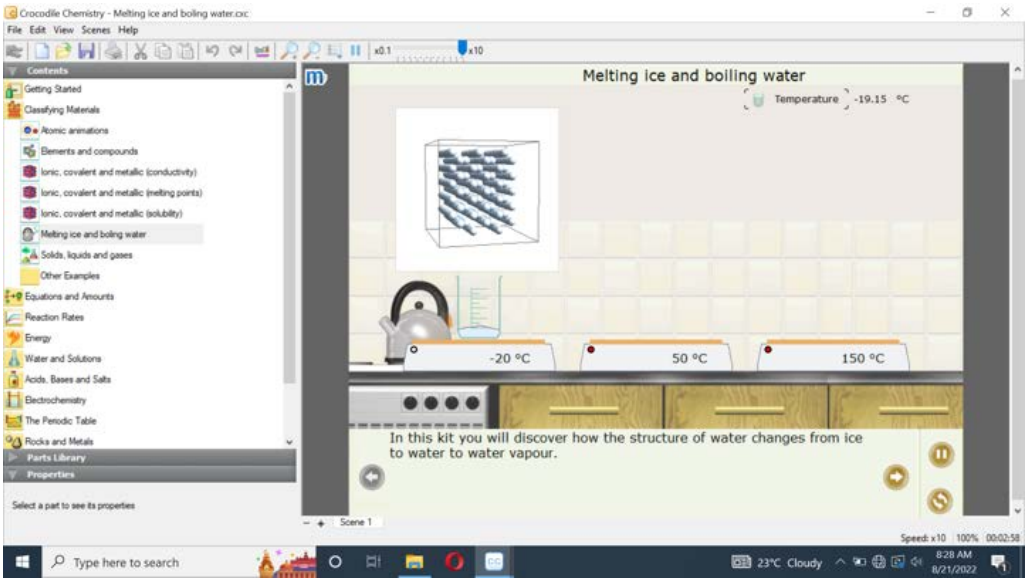

Figure 6. Simulation on Melting Ice and Boiling Water at -20°C

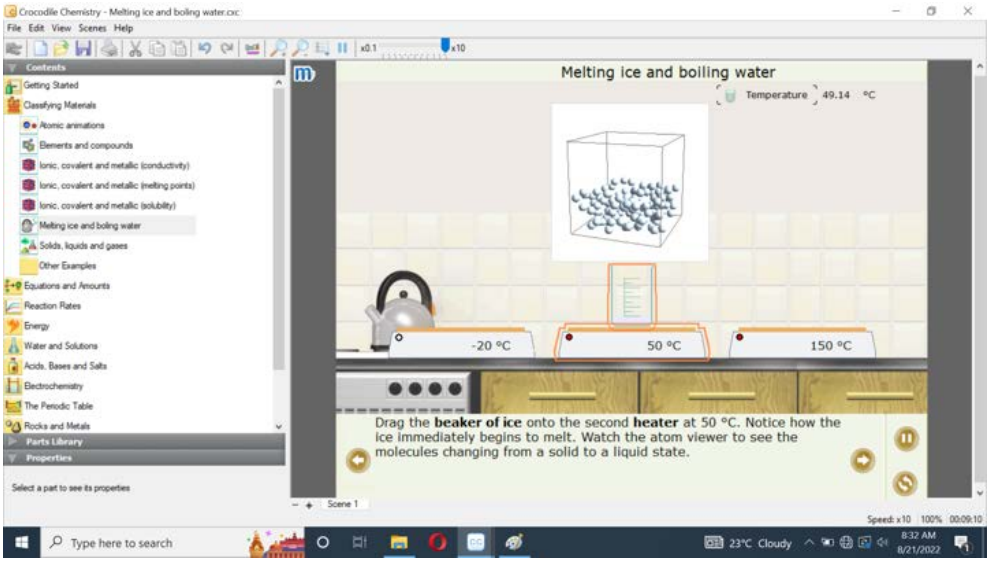

Figure 7. Simulation on Melting Ice and Boiling Water at 50°C

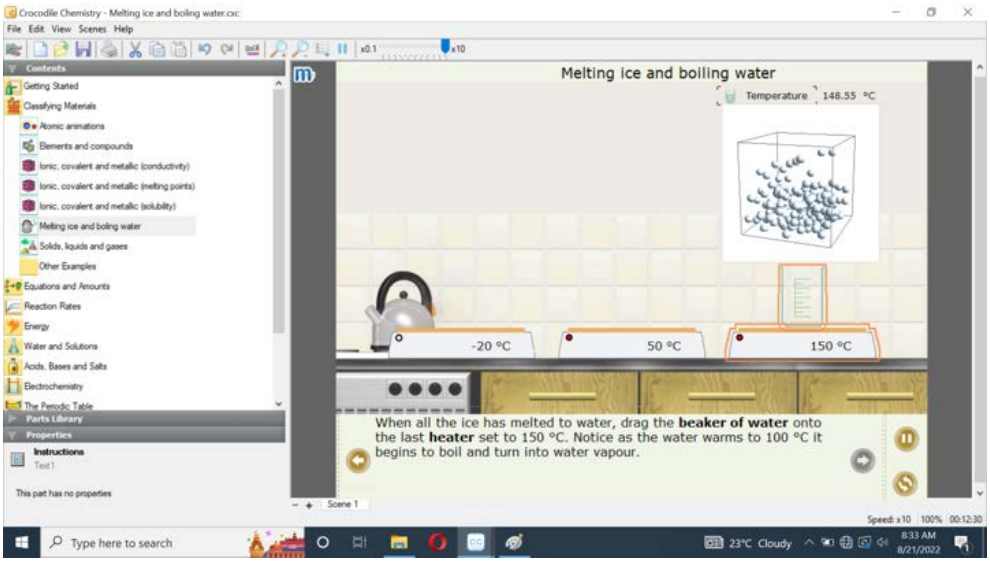

Figure 8. Simulation on Melting Ice and Boiling Water at 150°C

These simulation set-ups were observed and experienced by the students as provision for their continuous learning sessions in lieu of the traditional school-based laboratory. This continuum is expected to provide the necessary laboratory concepts and principles which is ought to be mastered by every student.

3. Synchronous sessions. These sessions are collective with the teacher as facilitator. Students are expected to share their observations, experiences, and inferences on the simulated activities.

Prior to the employment of these interventions was a pretest, a 25-item test that covers the entire unit on Matter. The pretest was shuffled and was given as the posttest after the intervention program was conducted. The instrument used was based on a Table of Specifications along the unit covered in the study: Matter. The reliability was known through Cronbach's alpha: an alpha of .813. According to Taber [21], a value of at least .70 suggests acceptable reliability.

The respondents of this study were the 20 students of one of the authors in his Student Teaching during the School Year 2021-2022. They were all chosen to participate in this study considering the number size of the class. There was no grouping made in this study as this is a pre-experimental in nature, One Group Pretest-Posttest Design (OGPPD).

The mean, t-test, and Cohen's D were used in analyzing the gathered data in this study vis-à-vis the research problems.

3. Results and Discussions

Table 1. Pretest and Posttest Results on the Academic Achievement of the Students in Chemistry

Input	Mean Score	t-value	p-value
Pretest	10.800	-10.340	.000*
Posttest	19.200		

*significant at .05 level.

Presented in the foregoing table are the mean pretest and posttest scores of the students after the provisions of Project *CHEMIKA* were implemented. It shows that a

mean difference of 8.400 was established on the mean pretest and posttest scores of the students yielding a t-value of -10.340. The mean difference denotes a large margin which further suggests a convincing increase. Likewise, the p-value of less than .001 suggests a very highly significant result implying that the null hypothesis of the study is rejected.

This further implies that the provisions of Project *CHEMIKA* made significant effect on the academic achievement of the students in studying matter. Henceforth, employing interactive computer-based applications like the Crocodile Chemistry brings potential effects on the academic achievement of the students.

The studies of references [1,2,6,22] on employing simulated virtual laboratory brings significant effect in understanding scientific phenomena. Furthermore, it was concluded that students in this learning engagement are not only provided with the necessary competencies relative to the subject matter but they also found enjoyment in doing it in lieu of the typical hands-on science activities. Furthermore, the studies of references [1,7,12] suggested to employ science applications like Crocodile Chemistry as a leveraging engagement and activity to continually enhance the interest and motivations of students in studying science. Corollary to this is the claim that science teachers need to sustain or even pole-vault the interest of students in studying science through innovative and interactive mechanisms of providing the necessary scientific competencies [11,23]. It must be noted that the interest, attitude, and motivation of students in science is diminishing across all levels, a world-wide phenomenon which calls for a skin-deep process and analysis of reinventing the school science program [9,24,25]. It is in this context that this study was designed and implemented.

Table 2. Effect Size of Project *CHEMIKA* on the Academic Achievement of Students in Matter

	Cohen's D Value	Interpretation
Pretest, Posttest Results	.462	Small to Medium

Presented in the table is the approximate value of r showing the effect size of Project *CHEMIKA*. According to the Cohen's criteria [26], the value of r shows that there is a small-to-medium effect of Project *CHEMIKA* on the mean gain scores of the students in their achievement test in Chemistry. This implies that the provisions of Project *CHEMIKA* impacted significant effects on shaping the academic achievement of the students. Thus, it can be inferred that the provisions of Project *CHEMIKA* are significantly effective in raising the academic achievement of the students.

4. Conclusion

Based on the findings of the study, the following are drawn:

1. The mean score of the students in the pretest and posttest is increased. This increase is coined as an effectual result of the implemented provisions of Project *CHEMIKA;*
2. There is a significant difference on the pretest and posttest mean score of the students in Chemistry. This posts a significant increase in the posttest results;
3. The provisions of Project *CHEMIKA* posted a medium effect on the academic achievement of the students in Chemistry.

5. Implications to Theory and Practice

While the results of the study seem to suggest that the students have better test result when exposed to the programmed intervention, there are important limitations to note as this study was limited in the areas of size, duration, content, and methodology.

Aptly, Crocodile Chemistry appears to be a viable application in aiding students learn Chemistry concepts and thereby enhancing students' academic achievement. Chemistry teachers are encouraged to use this instructional application in teaching Chemistry. Likewise, school administrators may consider presenting it to Chemistry teachers for synchronous class discussions and experiments to enhance existing approaches with the help of modern technology [1,2,6,7,12,22].

References

[1] Okori O. A. & Jerry, O. (2017). Improvisation and Utilization of Resources in the Teaching and Learning of Science and Mathematics in Secondary Schools in Cross River State. Global Journal of Educational Research, 16, 21-28.

[2] Martin, RB., Acenas, RCB., & Bautista, RG. (2019). Chemistry Made Easy: Unravelling the Experiences of Biological Science Majors in Using a Virtual Laboratory, *American Journal of Educational Research*, 7(2), 170-173.

[3] Gigante, A., Dell, & Sharkey V. (2011). Students' hands-on experimental work vs lecture demonstration in teaching elementary school chemistry. *Acta Chimica Slovenica*, 58, 866-875.

[4] Taskoyan, S. N. (2018). The effect of inquiry learning strategies on students' skills of inquiry learning, academic success and attitudes. http://hdl.handle.net/20.500.12397/7350.

[5] Ocak, I., Ocak, G. & Olur, B. (2020). The Examination of the Correlation between Scientific Attitudes And Inquiry Learning Skills in Science among Secondary School Students. *International Journal of Academic Research in Business and Social Sciences, 11*(1), 58-66.

[6] Dalgarno, B. & Lee, J. W. M. (2010). What are the learning affordances of 3-D virtual environments? *British Journal of Educational Technology*, 41 (1): 10-32.

[7] Georgiou, J., Dimitropoulos, K. & Manitsaris, A. (2007). A Virtual Reality Laboratory for Distance Education in Chemistry. *International Journal of Social Sciences*, 2 (1): 306-313.

[8] Akcay, H., Yager, R. E., Iskander, S. M. & Turgut, H. (2010). Change in student beliefs about attitudes toward science in grades 6-9. Asia-Pacific Forum on Science Learning and Teaching, 1 (1). https://www.eduhk.hk/apfslt/v11_issue1/akcay/akcay2.htm.

[9] Osborne, J., Simon, S., & Collins, S. (2010). Attitudes towards science: A review of the literature and its implications. International Journal of Science Education, 25(9), 1049-1079.

[10] Cornford, IR. (2004). Cognitive and Metacognitive Strategies as a Basis for Effective Lifelong Learning: How Far Have We Progressed? *Paper presented at the AARE Annual Conference*, Melbourne, 1-15.

[11] Libao, NJP., Sagun, JJB., Tamangan, EA., Pattalitan, APP., Dupa, MED., & Bautista, RG. (2016). Science learning motivation as correlate of students' academic performance, Journal of Technology and Science Education, 6(3), 209-218.

[12] Discipulo, LG. & Bautista, RG. (2022). Students' cognitive and metacognitive learning strategies towards hands-on science. *International Journal of Evaluation and Research in Education*, 11(2), 658-664.

[13] Abdi, A. (2014). The effect of inquiry learning method on students' academic achievement in science course. *Universal Journal of Educational Research*, 2(1), 37-41.

[14] Bandura, A. (1997). *Self-efficacy. The exercise of control. Macmillan*. New York: Worth Publishers.

[15] Bandura, A., & Walters, R.H. (1997). *Social learning theory*. Englewood Cliffs: Prentice-Hall.

[16] Bandura, A. (1986). The explanatory and predictive scope of self-efficacy theory. *Journal of social and clinical psychology*, 4(3), 359-373.

[17] Bandura, A. (1989). Human agency in social cognitive theory. *American psychologist*, 44(9), 1175.

[18] Tomas, J.M., Gutierrez, M., Duit, R. (2020). The effects of self-efficacy, hope, and engagement on the academic achievement of secondary education in the Dominican Republic. *Psychology in the Schools*, 57(2), 191-203.

[19] Galyon, C.E., Blondin, C.A., Yaw, J.S., Nalls, M.L, Williams, R.L. (2012). The relationship of academic self-efficacy to class participation and exam performance. *Social Psychology of Education*, 15(2) 233-249.

[20] AlDahdouh, A.A. (2018). Jumping from one resource to another: how do students navigate learning networks? *International Journal of Educational Technology in Higher Education*, 15(1), 45.

[21] Taber, K. (2018). The use of Cronbach's Alpha when developing and reporting research instruments in science education. *Research in Science Education*, 48, 1273-1296.

[22] Cabañero, MV., Cabañero, JM., Ignacio, NC., & Bautista, RG. (2022). Project SIKAP Upscales Students' Scientific Attitude, *American Journal of Educational Research*, 10(7), 469-475.

[23] Osborne, J.F., & Collins, S. (2001). Pupils' views of the role and value of the science curriculum: A focus-group study. *International Journal of Science Education*, 23(5), 441-468.

[24] Sandika, B. & Fitrihidajati, H. (2018). Improving creative thinking skills and scientific attitude through inquiry-based learning in basic Biology lecture toward students of Biology education. *Indonesian Journal of Biology Education, 4(1), 23-28.*

[25] Schreiner, C., & Sjøberg, S. (2004). Sowing the seeds of ROSE. Background, Rationale, Questionnaire Development and Data Collection for ROSE (The Relevance of Science Education) - a comparative study of students' views of science and science education (pdf) (Acta Didactica 4/2004). Oslo: Dept. of Teacher Education and School Development, University of Oslo.

[26] Cohen, J. (1988). Statistical Power Analysis for the Behavioral Sciences (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers.