East Asian Journal of Multidisciplinary Research (EAJMR)
Vol.2, No.2, 2023: 839-850

Science Laboratory Environment and Attitude Towards Chemistry Lessons of Senior High School Students

John Mart Elesio
Holy Cross of Davao College
Corresponding Author: John Me Elesio john@gmail.com

A R T I C L E I N F O

Keywords: STEM,Lessons, Attitude

Received : 03, December
Revised : 12, January
Accepted: 22, February

A B S T R A C T

This study determined which domain of science laboratory environment best influenced the attitude towards chemistry lessons on senior high school Science, Technology, Engineering and Mathematics (STEM) students. The research design used in this study are non-experimental quantitative and descriptive-correlational technique, utilizing universal sampling procedure. The total respondents were 144 Grade 12 STEM students enrolled in a sectarian school of Davao City. Survey questionnaires on science laboratory environment and attitude towards chemistry lessons were used as the research instrument in data gathering. Utilizing the mean scores; science laboratory environment and attitude towards chemistry lessons among the respondents were both assessed at a high level. Moreover, obtained data revealed that there is a significant relationship between science laboratory environment and attitude towards chemistry lessons among senior high school STEM students. Furthermore, open-endedness and future intention to study science significantly influenced students' attitude towards chemistry lessons, but its open-endedness best influenced among all the domains of science laboratory environment.

DOI prefix:https:// 10.55927/eajmr.v2i2.3027
ISSN-E:2828-1519
https://journal.formosapublisher.org/index.php/eajmr/index

INTRODUCTION

Today, academes are facing challenges due to lesser attention given by the students to science subjects especially chemistry (Yunus & Ali, 2012). Students find chemistry lessons as abstract and mathematical according to Espinosa, Monterola, and Punzalan (2013) and another reason of students' losing interest is that chemistry is very cumulative, because students get lost if they miss an idea. In addition, it was found on numerous studies that students who were attending science classes were not particularly interested with the lessons (Cheung, 2009).

Development of students' positive attitudes to science lessons is very significant due to two main explanations (Cheung, 2011). These are attitudes associated with academic achievement and attitudes that foresee behavior (Glasman & Albarracin, 2006). Thus, positive attitude serves an important role in determining achievement of students' chemistry performance (Chin & Lim, 2016; Xu, 2014). In addition, student attitude towards chemistry acts an important part in a person's determination in searching a chemistry-related career (Xu, 2014).

Learning in the science laboratory environment has been acclaimed for its reputation of fostering positive attitude among students about science and for emerging interest in the subject (Luketic & Dolan, 2013). In addition, students' high performance in science has been enhanced through laboratory activities inside the science laboratory as imaginatively and encouragingly, which could positively impact students' attitude towards science particularly chemistry subjects (Burleson & Myers, 2013). In the local setting, there is a deterioration of interest among Science, Technology, Engineering and Mathematics students in learning chemistry lessons. This is due to lower exposure of students in the utilization of chemistry laboratory and teachers teaching approaches in a chemistry theory lesson.

Learning in the science laboratory environment has been recognized over a decade for its role in fostering positive students' attitudes about science and for the development of students' interest in science subjects. Positive students' attitude allows students to have the ability to manipulate properly the different science or laboratory equipment (Luketic & Dolan, 2013). Moreover, several researches demonstrated the significant influence of the laboratory environment on student learning. Also, science laboratory was good in developing students conceptual understanding and scientific thinking skills as well as fostering positive attitude among students towards science (Kwok, 2015; Opateye, 2014)

Based on the result of the study conducted by Henderson and Fisher (1998) it showed that all five indicators of the Science Laboratory Environment Inventory (SLEI) were related positively on students' attitude, except that open-endedness was related negatively with students' attitudes in some students' samples. But, student cohesiveness and integration were scaled showing particularly strong associations with positive students' attitude. Thus, learning in the laboratory was effective to develop students' conceptual understanding and scientific thinking skills as well as to foster a positive attitude towards science (Kwok, 2015).

In addition, student's success in science has been improved through laboratory activities inside the science laboratory as excitingly and encouragingly, which can positively influence students' attitude towards science particularly in the chemistry subject (Burleson & Myers, 2013). To develop interest, curiosity, and positive attitude toward chemistry, creativity and problem-solving ability in science and to improve students' understanding of science concepts and scientific process, laboratories are essential (Azizoglu & Uzuntiryaki, 2006). However, they also stated that not all students have viewed laboratory experiments as an interesting and exciting activity.

Lastly, the importance of laboratory environment on the effectiveness of learning is a result of students' perception on preferred laboratory learning environment to have a positive effect on the attitudinal and cognitive learning outcomes of the students (Kwok, 2015). This is supported by the study of Olubu (2015) that showed a link between positive attitude towards science and the classroom environment. He also added that positive attitudes were found in science classrooms which had high levels of involvement, teacher support, student-student affiliation (student cohesiveness), order and organization (rule clarity), and teacher use of innovative teaching strategies.

It is in the above context that the researcher would like to find out if there is a domain of science laboratory environment such as student cohesiveness, open-endedness, integration, rule clarity, material environment, and future intention to study science (Rogers, 2013) could significantly influence the attitude towards chemistry lessons of the senior high school science, technology, engineering and mathematics students since existing studies are only focused on the main variables of the study. Thus, the researcher has not come across with a similar study in the local setting because of insufficient empirical studies and most researches were conducted abroad. Therefore, there is an urgency to conduct the study for a contribution to the existing body of knowledge.

Research Objective

The purpose of this study is to determine which domain of science laboratory environment best influences the attitude towards chemistry lessons of senior high school students. Specifically, this study has the following objectives:

1. To find out the significant relationship between science laboratory environment and attitude towards chemistry lessons of senior high school students.
2. To determine which domain of science laboratory environment best influences the attitude towards chemistry lessons of senior high school students.

Theoretical and Conceptual Framework

This study is anchored on the proposition of Luketic and Dolan (2013) that science laboratory learning environment has been recognized over a decade for its role in fostering positive student's attitudes about science and for the development of students' interest in science subjects. Positive students' attitude allows students to have the ability to manipulate properly the different science or laboratory equipment inside the science laboratory.

In addition, this study is supported by the proposition of Burleson and Myers (2013) that student's success in science has been improved through laboratory activities inside the science laboratory as excitingly and encouragingly, which can positively influence students' attitude towards science particularly in the chemistry subject. Furthermore, it was affirmed by Opateye (2014) suggesting that laboratory was effective to develop students' conceptual understanding and scientific thinking skills as well as to foster a positive attitude towards science. This study is also anchored to the proposition of Gupta et al. (2015) that students' attitude towards science can be attributed to the science laboratory environment and thus the better the laboratory environment the more positive are the students' attitudes towards science.

Presented in Figure 1 is the conceptual framework showing the variables of the study. The first variable is the Science Laboratory Environment according to Rogers (2013) with the following indicators: *student cohesiveness, open-endedness, integration, rule clarity, material environment* and *future intention to study science. Student cohesiveness* is the extent to which students know, help and are supportive of one another; *open-endedness* is the extent to which the laboratory activities emphasize an open-ended, divergent approach to experimentation; *integration* is the extent to which the laboratory activities are integrated with non- laboratory and theory classes; *rule clarity* is the extent to which behavior in the laboratory is guided by formal rules; *material environment* is the extent to which the laboratory equipment and materials are adequate (Moeed, 2015); and lastly is *future intention to study science* is the extent of the students to pursue further studies in science.

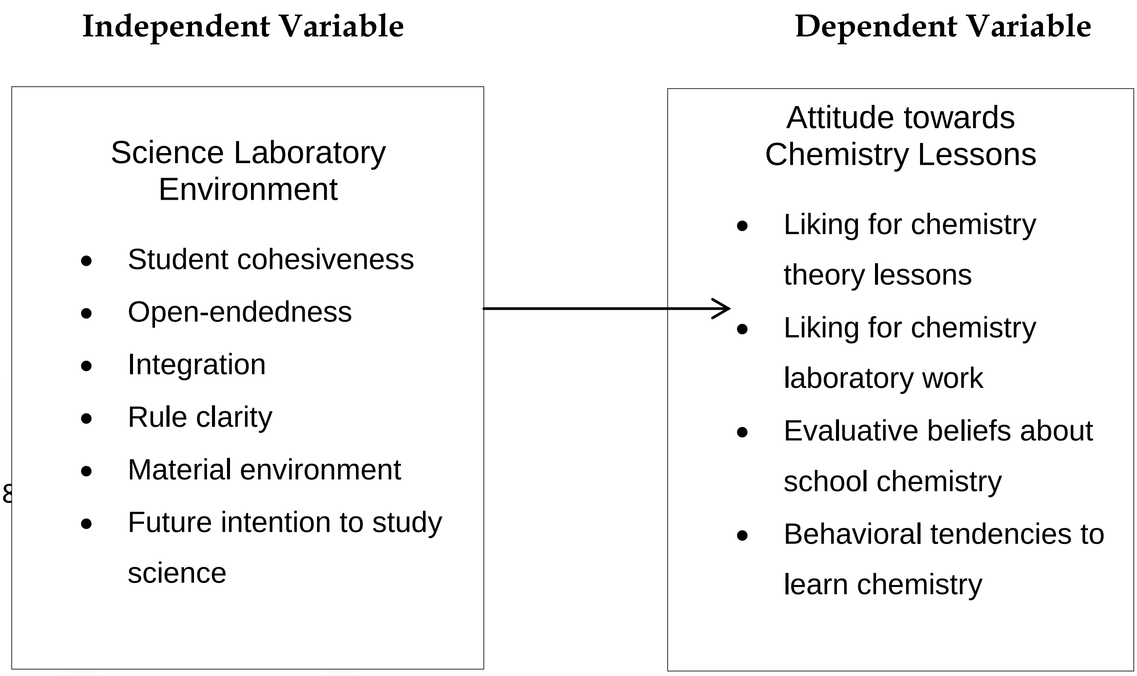

Figure 1. The Conceptual Paradigm Showing the Variables of the Study

Student cohesiveness is the extent to which students know, help and are supportive of one another; *open-endedness* is the extent to which the laboratory activities emphasize an open-ended, divergent approach to experimentation; *integration* is the extent to which the laboratory activities are integrated with non- laboratory and theory classes; *rule clarity* is the extent to which behavior in the laboratory is guided by formal rules; *material environment* is the extent to which the laboratory equipment and materials are adequate (Moeed, 2015); and lastly is *future intention to study science* is the extent of the students to pursue further studies in science.

The second variable is attitude towards chemistry lessons according to Cheung (2011) with the following indicators: *liking for chemistry theory lessons* which refers to students' interest on chemistry lessons taught in the school; *liking for chemistry laboratory work* refers to students' interest on different laboratory experiments; *evaluative beliefs about school chemistry* is the extent of students' beliefs of chemistry lessons as how these affect their lives; and *behavioral tendencies to learn chemistry* refers to students' willingness to spend time learning chemistry lessons.

METHODOLOGY

This study used non-experimental quantitative research design utilizing descriptive-correlational techniques. It was non-experimental because the independent variable of the study will not be manipulated and there will be no random assignment to groups (Johnson & Christensen, 2008). Descriptive research was used to obtain information concerning the status of the phenomena to describe "what exists" with respect to variables or conditions in a situation (Creswell, 2013). The data of this study describe the science laboratory environment and attitude towards chemistry lessons of senior high school students. Likewise, this study was also correlational because it determined whether the single independent variable and the single dependent variable have a significant relationship. This research design is appropriate for this kind of study.

The research respondents of this empirical endeavor were the Grade 12 senior high school STEM students enrolled in the first semester of the academic year 2018-2019. A universal sampling method was utilized by the researcher in the conduct of this study. The researcher preferred to use the universal sampling method since all Grade 12 STEM students has a chemistry subject, thus they can provide the useful information to test the hypotheses of this research.

The Grade 12 STEM students were chosen as the respondents of the study because the researcher wanted to investigate their observation on the science laboratory environment and their attitude towards chemistry lessons that were shaped by the charism and the transformative education that given to them by the school. Further, the respondents understood the content of the survey questionnaire and they had the capacity to interpret based on their experience in the school setting.

The research instruments used by the researcher in the gathering of data were adapted from Rogers (2013) and Cheung (2011) but some modifications were made to suit the study. The first instrument was used to measure the level of science laboratory environment. This comprised of 41 items that measure the six indicators namely student cohesiveness with seven items; open–endedness with seven items; integration with seven items; rule clarity with seven items; material environment with seven items also; and lastly, future intention to study science with six items. Pilot-testing the scale to 33 respondents yielded a Cronbach's alpha value of 0.937, suggesting that the items had relatively high internal consistency which is higher than the required 0.70 for a reliable scale.

On the other hand, the second instrument comprised of 12 items measuring the student attitudes towards chemistry lessons with four indicators namely liking for chemistry theory lessons; liking for chemistry laboratory work; evaluative beliefs about school chemistry; and behavioral tendencies to learn chemistry each with three items. Pilot-testing the scales to the same 33 respondents yielded a Cronbach's alpha value of 0.854, which is also higher than the required 0.70 for a reliable scale. During the administration of the research questionnaire to the chosen respondents, the researcher did not experience any form of trouble because of a well-coordinated action plan. The researcher interpreted the result given by his statistician and continued the formulation of chapters three and four.

RESULT

Based on the preliminary Pearson r test conducted among the indicators of each variable, the overall correlation was determined, having a computed overall r-value of 0.517 with a p-value of 0.000 which is lesser than α .05 considered being statistically significant. This means that the science laboratory environment is significantly related to attitude towards chemistry lessons of senior high school STEM students. Moreover, doing a pairwise correlation among the measures of both variables, computed r-values ranged from 0.190 to 0.432.

This implies that there is a positive correlation between science laboratory environment and learning towards chemistry lessons of senior high school STEM students. As it is evident in Table 1, *integration*, *open-endedness*, *future intention to study science, rule clarity*, and *material environment* have the same p-value of .000 signifying a positive relationship towards chemistry lessons and have an r-value of 0.432, 0.421, 0.382, 0.331 and 0.324 respectively. However, *student cohesiveness* has a computed r-value of 0.190 and a p-value of 0.025 though lower than the alpha of 0.05, this is because, student cohesiveness showed no significant relationship with liking for chemistry theory lessons with r-value of 0.131 and p- value of 0.125, and with behavioral tendencies to learn chemistry with r-value of 0.074 and p-value of 0.386 which are greater than the α of 0.05.

Table 1. Significance on the Relationship Between Science Laboratory Environment And Attitude Towards Chemistry Lessons

Nature of Science Laboratory Environment	**Learning Attitude towards Chemistry Lesson**				
	Liking for Chemistry Theory Lessons	Liking for Chemistry Laboratory Work	Evaluative Beliefs about School Chemistry	Behavioral Tendencies to Learn Chemistry	**Overall**
Student Cohesiveness	.131	.250**	.212*	.074	**.190***
	(.124)	(.003)	(.012)	(.386)	**(.025)**
Open-endedness	.396**	.345**	.288**	.355**	**.421****
	(.000)	(.000)	(.001)	(.000)	**(.000)**
Integration	.325**	.430**	.406**	.305**	**.432****
	(.000)	(.000)	(.000)	(.000)	**(.000)**
Rule Clarity	.209**	.341**	.442**	.173*	**.331****
	(.013)	(.000)	(.000)	(.041)	**(.000)**
Material Environment	.254**	.342**	.343**	.177*	**.324****
	(.002)	(.000)	(.000)	(.037)	**(.000)**
Future Intention to Study Science	.281**	.352**	.372**	.288**	**.382****
	(.001)	(.000)	(.000)	(.001)	**(.000)**
Overall	**.399****	**.507****	**.509****	**.345****	**.517****
	(.000)	**(.000)**	**(.000)**	**(.000)**	**(.000)**

Taking into consideration that all indicators of science laboratory environment and attitude towards chemistry lessons showed significant relationship as the overall p-value of .000, multiple regression analysis was employed to confirm the result.

Shown in Table 2 is the regression analysis showing the predictive ability of science laboratory environment on the attitude towards chemistry lessons of senior high school STEM students. The analysis showed that when factors in attitude towards chemistry lessons were regressed on science laboratory environment, it produced an F-value of 10.965 with p-value of 0.000. This means that the indicators of science laboratory environment significantly influence the learning attitude towards chemistry lessons in their combined capacity. The R^2 of 0.331 or 33.1% was attributed to the nature of science laboratory which means that the 66.9% of the variation can be attributed to the other variables not involved in the study.

Furthermore, exploring individuality the p-value of each indicator, *open-endedness* and *future intention to study science* have p-values of 0.001 indicate significant influence on the attitude towards chemistry lessons in their singular capacities. But, *open-endedness* having the highest coefficient came as the best

Table 2. Significance on the Influence of Science Laboratory Environment on The Attitude Towards Chemistry Lessons

Learning Attitude towards Chemistry Lesson					
Indicators		*B*	β	*t*	*Sig.*
Student Cohesiveness		-.163	-.120	-1.354	.178
Open-endedness		.267	.278	3.266	.001
Integration		.228	.205	1.945	.054
Rule Clarity		.108	.099	1.044	.299
Material Environment		.041	.046	.513	.609
Future Intention to Study Science		.228	.263	3.501	.001
R	.575				
R^2	.331				
F	10.965				
ρ	.000				

predictor. On the other hand, *student cohesiveness* with p=0.178, *integration* with p=0.054, *rule clarity* with p=0.299, and *material environment* with p=0.609 which are higher than α=0.05 are also needed in combination for science laboratory environment to significantly influence the attitude towards chemistry lessons.

DISCUSSION

Science laboratory environment was found to have positively and significantly correlated with the attitude towards chemistry lessons of the senior high school STEM students. This signifies that there is a link between the nature of science laboratory and the learning attitude towards chemistry lessons among STEM students. This finding is in consonance with the studies conducted by Opateye (2014) and Kwok (2015), that science laboratory was good in developing students conceptual understanding and scientific thinking skills as well as fostering positive attitude among students towards science.

The result also affirms the proposition of Burleson and Myers (2013) that students' success in science has been improved through laboratory activities inside the science laboratory as excitingly and encouragingly which can positively influence their attitude towards science particularly chemistry subjects. However, the result in Table 1 shows that student cohesiveness has no significant relationship with students' liking for chemistry theory lessons because during their theory classes they were working independently as well as their behavioral tendency to learn chemistry. The result of the study also supports the research findings of Gupta et al. (2015) that there is a relationship between science laboratory environment and the attitude towards chemistry lessons.

Moreover, The link between the dimensions of science laboratory environment and attitude towards chemistry lessons warrants the determination of the domain which best influences students' attitude towards learning. Regression analysis revealed that science laboratory environment was found to significantly cause an incremental effect on attitude towards chemistry lessons of the senior high school STEM students in a combined capacity.

Focusing on the individual determination of the domains of science laboratory environment revealed that open-endedness and future intention to study science significantly influence students learning attitude towards chemistry lessons. This means that among the six domains of science laboratory environment, open-endedness and future intention to study science are the domains that significantly influence the attitude towards chemistry lessons of senior high school STEM students in their single capacities and warrant favorable increase in students' performance in chemistry lessons. The rest of the indicators need support from each other to significantly influence the attitude of students.

The result of the study confirms with the conclusion of Venville and Dawson (2004) that the purpose of practical activities for the students is to provide them with opportunities for the development of their scientific skills and understanding of the very nature of science as supported by Gupta et al. (2015). The result of the study contradicted the postulation of Kwok (2015) that an open-ended inquiry approach seldom takes place in laboratories and on the result of the study conducted by Henderson and Fisher (1998) that all five indicators of the Science Laboratory Environment Inventory (SLEI) were related positively on students' attitude, except that open-endedness was related negatively with students' attitudes in some students' samples. However, student cohesiveness and integration were scaled showing particularly strong associations with positive students' attitude.

Lastly, future intention to study science significantly influences students' attitude towards chemistry lessons because the study is in coherence with the research of Ediger and Bhaskara (1996); Gupta et al. (2015) stating that students develop lifelong scientific interests and learn to appreciate and understand the nature of science and its usefulness to mankind.

REFERENCES

Azizoglu, N., & Uzuntiryaki, E. (2006). Chemistry laboratory*:* Anxiety scale. *Hacettepe University Journal of Education*, 30, 55-62.

Burleson, S. E., & Myers, B. E. (2013). Actual versus preferred laboratory classroom practices: An evaluation of the effectiveness of laboratory classroom teaching at the post-secondary Level 1. *NACTA Journal, 57*(1), 16 23. Retrieved from https://search.proquest.com/docview/1317656360?accountid=31259

Cheung, D. (2011). *Evaluating student attitudes toward chemistry lessons to enhance teaching in the secondary school.* Retrieved from http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S0187-893X2011000200004

Cheung. D. (2009). Studies' attitudes toward chemistry lessons: The interaction effect between grade level and gender. *Research in Science Education*, 39, 75-91.

Chin, S. F., & Lim, H. L. (2016). Validation of an adapted instrument to measure students' attitude towards science. *Asia - Pacific Forum on Science Learning and Teaching*, 17(2), 1 28. Retrieved from https://search.proquest.com/docview/1955988068?accountid=31259

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches. third edition.* Washington DC: Sage. Retrieved from https://granolagradschoolandgoffman.wordpress.com/2015/09/29/creswell-j-w-2013-qualitative-inquiry-and-research-design/

Ediger, M., & Bhaskara, R. (1996). *Science curriculum.* New Delhi, India: Discovery Publishing House.

Espinosa, A. A., Monterola, S. L. C., & Punzalan, A. E. (2013). Career-oriented performance tasks: Effects on students' interest in chemistry. *Asia - Pacific Forum on Science Learning and Teaching*, 14(2), 1-23. Retrieved from https://search.proquest.com/docview/1955901903?accountid=31259

Glasman, L. R., & Albarracín, D. (2006). Forming attitudes that predict future behavior: A meta-analysis of the attitude-behavior relation. *Psychological Bulletin*, 132(5), 778–822.

Gupta, A., Koul, R., & Sharma, M. (2015). Assessing the science laboratory learning environments at the senior secondary level in an Indian school. *Educational Quest,* 6(1), 1 9. Retrieved from https://search.proquest.com/docview/1689387062?accountid=31259

Henderson, D., & Fisher, D. (1998). Assessing learning environments in senior science laboratories. *Australian Science Teachers Journal*, 44(4), 57-61. Retrieved from https://search.proquest.com/docview/194523945?accountid=31259

Johnson, B. & Christensen, L. (2008). *Educational research: quantitative, qualitative, and mixed approaches, third edition.* https://books.google.com.ph/books/about/Educational_Research.html?id=8qoaXPh6E4UC&redir_esc=y

Kwok, P. W. (2015). Science laboratory learning environments in junior secondary schools. *Asia - Pacific Forum on Science Learning and Teaching*, 16(1), 1 28. Retrieved from https://search.proquest.com/docview/1955993335?accountid=31259

Luketic, C. D., & Dolan, E. L. (2013). Factors influencing student perceptions of high-school science laboratory environments. *Learning Environments Research*, 16, 37–47.doi:10.1007/ s10984-012-9107-5.

Moeed, A. (2015). Science laboratory learning environment and learning. *Science Investigation, Springer Briefs in Education*, doi 10.1007/978-981-287-384-2_2.file:///C:/Users/Student/Downloads/9789812873835-c2.pdf

Olubu, O. M. (2015). Effects of laboratory learning environment on students' learning outcomes in secondary school chemistry. *International Journal of Arts & Sciences*, 8(2), 507 525. Retrieved from https://search.proquest.com/docview/1677318506?accountid=31259

Opateye, J. A. (2014). The relationship between emotional intelligence, test anxiety, stress, academic success and attitudes of high school students towards electrochemistry. Ife Psychologia, 22(1), 239-249. Retrieved from https://search.proquest.com/docview/1657555474?accountid=31259

Rogers, J. (2013). *Laboratory classroom environment, sex and frequency of practical work as determinants of middle-school science students' attitudes and aspirations.* Retrieved from https://espace.curtin.edu.au/handle/20.500.11937/2640

Venville, G., & Dawson, V. (Eds.). (2004). *The art of teaching science.* Sydney, Australia: Allen and Unwin.

Xu, X. (2014). *Evaluation and application of instruments measuring spatial ability and attitude for college chemistry students*. Retrieved from https://search.proquest.com/docview/1641965548?accountid=31259

Yunus, F.W., & Ali, Z. M., (2012). Urban students' attitude towards learning chemistry. *ASIA Pacific International Conference on Environment-Behavior Studies*