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ORIGINAL ARTICLE

Competency of Teachers and Laboratory Environment in an Online Setting as Predictors of Science Process Skills of Students: A Convergent Design

Girlie Mae Zabala*, Avee Joy Dayaganon

College of Pharmacy and Chemistry, University of the Immaculate Conception, Davao City, Philippines

***Corresponding Author:** girliemaepastor@gmail.com

ABSTRACT

This study determined the influence of the competency of teachers and the laboratory environment in an online setting on the students' science process skills using mixed methods approach-convergent design. Participants of the study were 2nd year students from different Higher Education Institutions in Region XI, Philippines. Further, to gather data relative to the research questions, the researcher used adapted survey tools and an interview guide. Results showed that students always observed the competence of their teachers, with a favorable laboratory environment in an online setting leading to the acquisition of science process skills. Furthermore, regarding the relationship of variables, the study revealed that the competency of teachers did not have a significant relationship with students' science process skills. At the same time, there was a considerable correlation between the laboratory environment in an online setting and students' science process skills. The students' lived experiences in acquiring science process skills formed essential themes. Moreover, there was a merging-converging nature of the competency of teachers and the laboratory environment in an online setting and a merging-diverging character on students' science process skills and significant influence of the variables under study. Results of the study will help the teachers identify the factors that can affect the acquisition of science process skills of students in an online learning environment and develop intervention programs to ensure globally competitive graduates. It is further believed that this study will benefit the institution, teachers, and most especially the students who were the main reason for the teaching and learning process. Hence, future studies may be conducted by academic scholars or researchers based on the information gathered from this research. Areas of interest can be other factors that affect the students' acquisition of science process skills and utilize a comparative study involving different courses with chemistry laboratory subjects.

KEY WORDS: Competency of teachers; convergent design; education; laboratory environment in online setting; Philippines; science process skills

INTRODUCTION

Science process skills are one of the 21st century skills that need to be developed by undergraduate Chemistry students. These skills involve solving problems through theories, concepts, laws, and facts (Rusmansyah et al., 2021). They include basic and integrated science process skills: observing, experimenting, measuring, communicating, and inferring. However, in the new normal of education brought about by the COVID-19 pandemic, acquiring science process skills has become a challenge due to the closure of schools and the prohibition of face-to-face classes. Hence, there is a high probability of producing graduates engaged in online learning with inadequate skills and practice, which could become a disadvantage as they enter the labor market in the future (Gamage et al., 2020).

In the Philippines, the acquisition of science process skills revealed that many students have low mastery levels to no mastery level that need immediate attention despite many students with a master's level of education (Maranan, 2017). The study by Derilo (2019) supported the finding that students have an average level of basic science process skills and a low level of integrated science process skills. Herewith, the government, through the Commission on Higher Education (CHED) (2012) with the issuance of CHED Memorandum Order No. 46, which ensures quality assurance in Philippine Higher Education through an outcomes-based education (CMO-No.46-S2012). With this, higher education institutions (HEIs) produce graduates with high academic, thinking, behavioral, and technical skills/competencies that fit the industry and national and international standards.

Purpose Statement

This convergent design study described the influence of the competency of teachers and laboratory environment in an online setting on the science process skills of students in HEIs in Region XI, Philippines where adapted survey questionnaires were used to gather quantitative data and through the in-depth interview (IDI) and focus group discussion (FGD) for the qualitative data.

Research Questions

This study determined the influence of the competency of teachers and the laboratory environment in an online setting on students' science process skills.

Specifically, it sought answers to the following questions:
1. What is the status of the competency of teachers, laboratory environment in an online setting, and students' science process skills?
2. Do the competency of teachers and the laboratory environment in an online setting significantly predict students' science process skills?
3. What are the lived experiences of students as regards the science process skills of students?
4. How do these experiences shape the beliefs, attitudes, and science process skills of the participants?
5. To what extent do qualitative data corroborate with quantitative data?

LITERATURE REVIEW

Competency of Teachers

As defined by Adikwu et al. (2018), competence is attitudes and aptitudes learned and manifested in the form of capabilities in dealing with life problems using cognitive and social skills. One important factor in evaluating the success of teaching is the teacher's competency in the teaching and learning process. In particular, affective competence describes the affective traits of teachers or the attitudinal aspects such as interest, motivation, incentives, diligence, obedience, honesty, and punctuality. Meanwhile, cognitive competence denotes the cognitive behavior of teachers and describes the aspect of knowledge and psychomotor competence is about the psychomotor skills or process skills of teachers in teaching practical chemistry.

Affective competence

Halberstadt et al. (2001) defined affective social competence as the effective communication of one's own affect, one's successful interpretation and response to other's affective communications, and the awareness, acceptance, and management of one's own affect. Teaching is an emotional endeavor that requires passion and commitment. Moreover, Korotaj and Mrnjaus (2021) highlighted that emotional competence is important in the teaching and learning process. In the study, 144 teachers had a high overall assessment of teachers' emotional competence. This means that the teachers to be able to manage their students in an online setting must show students the affective traits such as motivating students and assisting them to truthfully conduct the laboratory activities. It is also important to show the students regularity in attending the class and punctuality to be able to influence the students positively and elicit in them their interest and enthusiasm in learning the subject.

Cognitive competence

Cognitive competence as defined by Piaget and cited by Sun and Hui (2012) means critical thinking and creative thinking. It does not settle alone on the ability to manipulate and strategize information but is also concerned with the ability to adapt, self-regulate, and construct knowledge based on the acquired cognitive skills. The cyclical processes of assimilation and accommodation wherein people can manipulate, organize, and adopt thought and personal experiences to guide their behavior constitute it. In education, critical thinking plays an important role in the students' self-regulatory learning by influencing their mastery of learning goals and deep information processing that will significantly predict their academic performance. Cognitive competence can be considered a basic survival skill, which is characterized by rapid change and knowledge explosion in various fields (Shek and Yu, 2016).

Psychomotor competence

According to Fadzil and Saat (2017), manipulative skills are psychomotor skills that relate individual cognitive function with corresponding physical movement. In 21st century education specifically, the importance of science education, acquisition of scientific knowledge, and development of scientific skills through active teaching and learning approach to develop students' proficiency in scientific inquiry is emphasized. Research showed that students' interest in learning science is enhanced if they can play an active role in "doing" science such as collecting scientific data through observation and experimentation. This means that the teaching and learning process involves activities that will provide them the opportunity to have experiential learning. The interest and enthusiasm of students will be further enhanced by performing experiments and creating concepts firsthand in the laboratory aside from the theories learned.

Laboratory Environment

The science laboratory is a unique learning environment where the students can work cooperatively in small groups to investigate scientific phenomena (Olubu, 2015). This will promote a more positive social interaction that will lead to a constructive and positive learning environment. Thus, the chemistry laboratory-learning environment can affect the motivation of students in achieving their goals. The safety and comfort of students and the attitudes of students in learning the subject will depend on the physical environment of the laboratory such as the facilities, space, lighting, ventilation, and working areas. This will influence the extent to which students learn and retain knowledge.

Student cohesiveness

As defined by Olubu (2015), student cohesiveness is the relationship between students in terms of how well they know each other and supports one another. The findings of the study revealed that student cohesiveness is the least favored dimension of the chemistry laboratory environment with a percentage of 17.30% among 690 students.

Open-endedness

Open-endedness is defined as the opportunities given to students to design their own research and pursue individual interests to enhance their personal constructions of scientific knowledge (Olubu, 2015); the freedom given to students to develop their own experiments (Allanas, 2021), and an environment that fosters learning of complex science topics and assess in science inquiry skills (Jiang, 2018). Open-endedness measures the extent to which laboratory activities emphasize an open and different experimental approach.

Integration

Integration is defined as the dimension that characterizes how laboratory activities are connected to theoretical material taught in the lecture portion of the science classroom (Olubu, 2015) and a dimension that measures the extent to which the theory that has been learned in the classroom is integrated with laboratory activities (Allanas, 2021). It is about applying the theories learned in the classroom to laboratory activities. Integration measures the extent of laboratory activities that are integrated with the theory taught in class. In the study of Olubu (2015), integration was the most favored dimension of the science laboratory environment with a percentage of 21.90%. This means that chemistry students believe that there is greater integration between theory and practice. This is further supported by the study of Ahmad et al. (2010) that integration had the highest mean score among the dimensions at 3.91 and the study of Aladejana and Aderibigbe (2007) revealed that 49.58% of students believed that the laboratory activities were integrated with theory classes. This implies that what they are doing in the laboratory is related to the theories learned in the lecture class.

Rule clarity

Rule clarity is the formal rule structure and how it is followed in the classroom (Olubu, 2015) and the dimension that measures the extent of regulations in the laboratory during laboratory activities (Allanas, 2021). Rules in the laboratory are necessary to prevent accidents while experimenting. Therefore, it is important to follow rules in the laboratory to create safe conditions. The rules applied in the laboratory and the clarity in the laboratory environment are positively correlated. Teachers need to be strict in enforcing safety regulations to anticipate laboratory accidents (Allanas, 2021); the rule clarity that students preferred was on the area wherein their safety was ensured and there was proper handling and care of equipment (Akinbobola, 2015). In the study of Olubu (2015), the rule clarity scale showed a 13.90% of its contribution to the performance of students. Students also agreed that the laboratory class is guided by clear rules with a percentage of 69.33%. This means that the teacher had outlined and imposed a clear rule to be followed by students in the laboratory class (Aladejana and Aderibigbe, 2007).

Material environment

Material environment as described by Olubu (2015) is the adequacy of the laboratory materials and equipment. It is the area of science laboratory environment inventory in online class that measures tools and materials in the laboratory. In the study, the material environment had the highest contribution to the performance of students in chemistry with a percentage of 34.50%. This suggests that the tools and materials in the laboratory will improve the performance of students. This only shows how important the hands-on experiences of students are to improve their performance.

Science Process Skills

In the context of learning chemistry, science process skills involve the development of cognitive, affective, and psychomotor skills (Kurnianingsih, 2017). Specifically, cognitive skills are about student learning using the mind, psychomotor skills involve hands-on experiences of students using the tools and materials, measurement, preparation, or assembly tools, and affective skills focus on the interaction of students with each other. Science process skills are known as procedural skills and experimental and scientific inquiry abilities. These skills are classified into basic skills (observing, measuring, inferring, classifying, predicting, and communicating) and integrated skills (controlling variables, hypothesizing, experimentation, and data interpreting) (Zeidan and Jayosi, 2014).

Experimentation skills

Science experimental skills are classified as psychomotor skills consisting of the sensual part of the reaction to any stimuli; the intellectual part or skill realization and the kinetic part of the direction and extent of movement (Trnova and Trna, 2006). Furthermore, experimenting will lead to obtaining information from ideas derived from facts (Kurnianingsih, 2017). In the study, 86.81% or 20 students could identify the tools and materials to be used in an experiment and 88.89% or 21 students had skills in using the tools and materials previously identified. Thus, most of the students possessed experimentation skills. In addition, the study of Akani (2015) revealed that the experimentation skills of students have a grand mean of 2.58, which was described as high. The 200 students involved in the study exhibited a high level of skills in terms of their acquisition of experimentation skills. In addition, the study by Rohaeti (2018) suggested that the experimentation skills of chemistry and chemistry education students are at 46.22% which means that students can acquire these integrated science process skills.

Measurement skills

Measurement is a fundamental skill in science (Huary, 2003). It is considered the basis of quantitative observation (Kurnianingsih, 2017). It is interpreted as the comparison of measured units and is expressed as the quantitative amount of an object or substance (Zeidan and Jayosi, 2014). In addition, Ekon and Eni (2015) defined measurement as the standard and non-standard approximations to describe an object or substance. The skills involved consist of the measurement ability the students possess namely determination of values, knowledge, and use of measuring instruments.

Communication skills

Communication skills are the essential skills or basic skills that scientists must possess to communicate the findings and ideas gathered in a certain phenomenon (Spektor-Levy et al., 2009). These skills involve the processes of speaking, listening, writing, and reading. Students must acquire this skill to be able to communicate their knowledge and ideas in the teaching and learning process of science. Communicating involves words, symbols, and graphics to describe an object (Zeidan and Jayosi, 2014). It also includes the use of graphs, maps, charts, symbols, diagrams, mathematical equations, and written or spoken words to express perceived knowledge and ideas about science (Kurnianingsih, 2017). In the study, the communication skills of students were at 86.81% (20 students) which was described as good meaning students are involved in the discussion and collaboration is evident.

Inference skills

Inference is defined as the skill of interpreting information to give meaning to a certain idea. Science inference skill is utilized in doing investigations and needs higher-order thinking skills (Teo and Goh, 2019). In other words, inferring is about how ideas are explained to make interpretations or in arriving at a certain conclusion about a specific phenomenon or event. Similarly, Zeidan and Jayosi (2014) defined inferring skills as the explanations given to a specific object or substance quantitatively. The explanations, interpretations, and conclusions made were aligned to the data and observations gathered (Ekon and Eni, 2015). In addition, Akani (2015) showed in his study the level of inference skills possessed by 200 students where the grand mean of 2.46 suggests that students had a low level of inference skills. It was also evident in the study of Rohaeti (2018) that the inferring skills of chemistry and chemistry education students were 51.59%. The skills in making assumptions and drawing conclusions will be measured in the study to know the level of inference skills of students.

Competency of Teachers and Science Process Skills of Students

The teacher factor is considered critical in the teaching and learning process. Affective, cognitive, and psychomotor competence will influence the transmission of knowledge and skills to students, leading to enhanced academic performance and acquisition of science process skills. In the study of Rustan et al. (2020), students' science process skills were relatively low because teachers rarely conducted experiments in science teaching. This finding implies that teachers' approaches in the teaching and learning process influence the students' low levels of science process skills. The challenges faced by the teachers affect the teaching styles and strategies in the classroom that use old methods.

Further, the study by Ab Halim et al. (2021) emphasized the importance of science teachers equipped with the necessary knowledge and skills to address issues related to acquiring science process skills for students. Science education aims to increase scientific literacy among students. Through science learning approaches, there will be an enhanced acquisition of science process skills. These approaches include constructivism, inquiry-based learning, problem-solving or project-based learning, mastery learning, contextual learning, and scientific research.

Furthermore, Irwanto et al.'s (2018) study revealed that the level of understanding and mastery of teachers' science process skills were also associated with the level of understanding and mastery of students' science process skills. This result means that teachers who lack the knowledge of science process skills will likely not emphasize science process skills in teaching and learning, resulting in unprepared students facing 21st century challenges in science education.

In addition, Ango (2002) posited that the sure way for students to attain mastery of science process skills was by having adequate teachers. The mastery of teachers in science process skills as well as the use of effective teaching practices will result in effective learning of science process skills. Thus, any institution needs to ensure that its teachers possess the qualifications, knowledge, and competence to transmit learning to students.

Laboratory Environment in an Online Setting and Science Process Skills of Students

A laboratory learning environment in an online setting is a challenge since the contextual purpose of laboratory learning is hands-on experiences. Hence, due to the unprecedented effects of the COVID-19 pandemic, the physical laboratory is inaccessible. The study of Uche and Eze (2018) showed that enhanced acquisition of science process skills was evident in students exposed to laboratory activities because this enabled them to experience the theories learned in the lecture class. The challenge now is allowing students to experience the same learning and acquisition of skills in an online setting.

In addition, Feyzioğlu (2009) posited that the students' acquisition of science process skills has a positively significant and linear relationship with the efficient use of the laboratory and taught using laboratory applications. This finding suggests that the hands-on experience of the students in the laboratory will improve their science process skills. Technology and applications must be used in teaching laboratory experiments for students to see and observe the theories learned in the lecture class.

Similarly, Utami et al. (2017) highlighted the effect of laboratory chemistry experiments in enhancing students' science process skills. This result enabled them to understand the concept and improve their science process skills. Acquiring science process skills will open an opportunity for the students to learn by investigating and generating information and data to solve problems. In other words, students' experiences in a laboratory will allow them to experience the actual situation, which is impossible in an online setting. Thus, using simulations through videos will enable them to see what was supposed to be experienced in the school laboratory. It is essential to consider the content of the videos shown to the students. In addition, demonstrations of the basic facilities in the school could also be an alternative way for students to have an idea of the actual laboratory setup and facilities.

Issues on Science Process Skills of Students

The widespread effect of the COVID-19 pandemic on the education sector poses problems and challenges in maintaining the quality of education provided to students. Research by Maranan (2017) and Derilo (2019) was conducted before the COVID-19 pandemic when face-to-face classes were still allowed. Despite this, students still needed to exhibit higher science process skills. This finding supports the argument that the status of science education in the country needs proper intervention.

Moreover, the study of Rusmansyah et al. (2021) emphasized the effect of integrating ICT in the teaching and learning process. The application provided by Google classroom and Google Meet showed an increase in the acquisition of science process skills of students. This only applies to students who can maintain an internet connection at home. One challenge in online learning is Internet connectivity since the Philippines is still one of the countries in Asia with a slow internet connection (Belgica et al., 2020). The new normal in education is still an ongoing learning process for both students and teachers. It is, therefore, essential to consider the factors that could influence students' acquisition of science process skills in an online setting to provide quality education and prevent the halt of continuous learning.

METHODS

Research Design

This study used a mixed methods approach specifically the convergent design. Mixed methods design involves the collection and mixing or integration of both quantitative and qualitative data in a study (Creswell, 2018). In this research design, qualitative and quantitative data analysis is not enough; hence, analysis of the integrated qualitative and quantitative data will provide additional insight into research problems and questions. Mixed methods design involves the collection of both qualitative and quantitative data in response to research questions or hypotheses. It focuses on collecting, analyzing, and mixing both data to provide a better understanding of research problems than either approach alone since the mixing of methods will enhance the results of the study and will further explain the results of the study (Razali et al., 2019).

Convergent Design is a design in mixed methods wherein a researcher collects both quantitative and qualitative data, analyzes the data separately, and then compares the results to know if the findings confirm or contradict each other (Creswell and Creswell, 2017). The purpose of convergent design is to provide a comprehensive analysis of the research problem by merging the quantitative and qualitative data (Razali et al., 2019). In this study, both quantitative and qualitative data were collected at the same time, giving equal priority to both methods but still ensuring that the data analysis was independently performed. Results of the two data collections were mixed or merged for overall interpretation to identify convergence, divergence, contradictions, or relationships between the two sources of data.

The quantitative phase utilized the descriptive correlational design. Descriptive correlational studies describe the variables and the relationships that occur naturally between and among them (Creswell, 2012). The researcher collected the available data using research instruments such as survey questionnaires, and interviews. The main goal of descriptive correlational research is to describe and analyze data quantitatively and the coefficient correlation index between two prevailing variables (Atmowardoyo, 2018). In addition, a correlation statistical test was used to describe and measure the degree of relationship between two or more variables (Medina, 2010). In this study, the relationship between the competency of teachers, laboratory environment in an online setting, and science process skills of students was investigated.

The qualitative phase used the phenomenological inquiry to determine the lived experiences of the participants. Phenomenology condenses individual experiences to a description of the commonality of the lived experiences. It describes the common experiences of the participants based on a single phenomenon (Creswell, 2014). In this particular study, it was the most appropriate design to address the purpose of the study and the research questions because of the stories and perceptions of the participants enrolled in any Chemistry laboratory subject. Utilizing the convergent design strengthened the results and counteracted the weaknesses of each method. The importance of corroborating the results of the quantitative phase and the qualitative phase was emphasized to understand fully the purpose of the study.

Place of Study

HEIs, with programs offering Chemistry laboratory subjects in Region XI, officially labeled as the DAVAO REGION, served as the place of study. It comprises five provinces: Davao del Sur, Davao del Norte, Davao Oriental, Davao Occidental and Davao de Oro. The region is in the Southeastern part of Mindanao that encloses the Davao Gulf, and its regional center is Davao City as shown in Figure 1.

Participants

Quantitative strand

In the quantitative phase, 384 respondents from HEIs in Region XI with any chemistry laboratory subject became the respondents of this study. The research employed purposive sampling in selecting respondents for the study. Purposive sampling is choosing the study's respondents based on their knowledge of the researcher's required information (Parreno and Jimenez, 2014).

Qualitative strand

In the qualitative phase, the researcher used purposive sampling to choose the 17 participants: ten participants for an online IDI and another seven for the virtual FGD.

Instruments

Quantitative strand

The instruments used in the study were adapted and composed of three parts as follows: In Competency of Teachers, the instrument was from the study of Adikwu et al. (2018) comprising three sections, namely, affective competence questionnaire, cognitive competence questionnaire, and psychomotor competence questionnaire. The tool is a 30-item construct consisting of 10 items in each section with responses on a five-point Likert scale where "1" as the lowest score described as strongly disagree, "2" disagree, "3" moderately agree, "4" agree, and "5" as the highest score describe as strongly agree. In a Laboratory Environment in an Online Setting, the tool was a 35-item construct that is from Olubu (2015) and Aladejana and Aderibigbe (2007), which has five indicators, namely: student cohesiveness, open-endedness, integration, rule clarity, and material environment. The instrument for the Science Process Skills of Students was from Akani (2015), which has five indicators, namely, observation skill, experimentation skill, measurement skill, communication skill, and inference skill, which is a 28-item construct.

Qualitative strand

The qualitative phase used an interview guide and a FGD guide to obtain data virtually from the participants. The researcher informed the informants that the process would be recorded and saved on a memory card. In the IDI, ten participants shared their experiences through an interview at their most convenient time (Garg, 2016). In FGD, seven participants gathered to discuss the topic of interest.

Validation of Instruments

In the quantitative phase, the researcher used standard questionnaires to gather data from the respondents. These tools were subjected to content validity by five experts and were modified, and pilot-tested to fit the present scenario and to obtain reliability. Revisions to the questionnaires were applied based on the suggestions of the expert validators.

Reliability of the Instrument

Cronbach's alpha is a measure of internal consistency, that is, how closely related a set of items are as a group. It is considered to be a measure of scale reliability. As the average inter-item correlation increases, Cronbach's alpha increases as well (holding the number of items constant) (Konting et al., 2009). The construct reliability of the adapted and modified competency of teachers' questionnaire was 0.92 using Cronbach's Coefficient Alpha. The reliability of the laboratory environment in an online questionnaire was 0.84 (alpha coefficient). Further, the instrument for students' science process skills had a reliability coefficient of 0.96.

Data Collection

Quantitative strand

Once approved, the researcher scheduled the data gathering with the help of the representative and faculty members of the identified HEIs. The respondents signed the informed consent form in Google Forms sent through email which specified that participation in the study was voluntary. Those who only signed the consent form were considered part of the study and answered the approved data-gathering instrument online through Google forms for about 10–15 min.

Qualitative strand

The IDIs took place virtually using Zoom meetings at the specified time for 30 min only after the participants signed the consent and knew the study's objective. The link was sent to the participants when both parties agreed on the time and date. The researcher used open-ended questions in conducting an IDI. The researcher recorded the interview to ensure validity and reliability, which were significant in the conduct of the study.

Data Analysis

Quantitative strand

The researcher tallied the data gathered through the survey questionnaires and treated it using the following statistical tools in the quantitative phase. The mean measured and described the levels of teachers' competency, the laboratory environment in an online setting, and students' science process skills. Standard deviation quantified the degree of variability of the scores of the mean. Moreover, Pearson Product-Moment Coefficient of Correlation or Pearson r determined the correlation between the independent and dependent variables. In addition, regression analysis determined the influence of the attributes of the competency of teachers, laboratory environment in an online setting, and students' science process skills.

Qualitative data

Several procedures were involved in the study to understand the overall data analysis that the participants provided through IDI and FGD. First-cycle coding was the initial step; data reduction is where the transcribed data is reduced and organized based on the research questions. In the second coding cycle, the researcher reorganized and reanalyzed the data. The researcher read and reread the transcriptions in thematic analysis to become familiar with them. The organization of data enabled the researcher to generate initial codes. The researcher examined the codes and fitted them together to form a theme, a pattern that captures something significant about the research question. The reviewed data formed themes.

FINDINGS

The presentation of quantitative results starts with the quantitative descriptive results, while the qualitative phase follows, which includes the thematic analysis. The results answered each research question.

Research Question No. 1

What is the status of the competency of teachers, the laboratory environment in an online setting, and students' science process skills?

Based on students' assessment of the competency of teachers as reflected in Table 1, it has an overall mean of 4.26, described as

Table 1: Status of the competency of teachers, laboratory environment in an online setting, and science process skills of students

Variables	Overall mean	SD	Description
Competency of teachers	4.26	0.65	Very high
Laboratory environment in an online setting	4.01	0.62	High
Science process skills of students	4.04	0.67	High

very high, which means that the students always observed the competency of teachers. In addition, its standard deviation of 0.65 showed that students' responses to their chemistry teachers resemble each other. The laboratory environment in an online setting had an overall mean of 4.01, described as high, which means that the laboratory environment in an online setting was often favorable. In addition, its standard deviation of 0.62 showed that students' responses were clustering around the mean. Finally, students' science process skills had an overall mean of 4.04, described as high, meaning students often exhibited the science process skills. In addition, its standard deviation of 0.67 showed that students' responses clustered around the mean.

Specifically, Figures 2-4 show the mean rating of each indicator in the variables involved in the study.

Figure 2 shows that psychomotor competence has the highest mean rating, with a value of 4.32, described as very high. The affective and cognitive competence is also described as very high, with mean ratings of 4.25 and 4.20, respectively.

Figure 3 show that rule clarity was the indicator with the highest mean rating in the laboratory environment in an online setting, with the value of 4.29 described as very high. On the other hand, the least favored domain was open-endedness, with a mean rating of 3.78, described as high.

Figure 4 shows that in students' science process skills, the most exhibited skill was experimentation skills with a mean rating of 4.13 described as high. Meanwhile, measurement and communication skills were the least exhibited, with a mean rating of 4.05, described as high.

Research Question 2

Do the competency of teachers and the laboratory environment in an online setting significantly predict the students' science process skills?

Table 2 shows the results of the multiple regression analysis. It revealed that the laboratory environment in an online setting was a significant predictor of the science process skills of students with a ρ-value that is less than 0.05 level of significance (2-tailed) ($F= 279.45$, $\rho < 0.05$) with a positive standardized beta value of 0.73.

Research Question 3

What are the lived experiences of students as regards the science process skills of students?

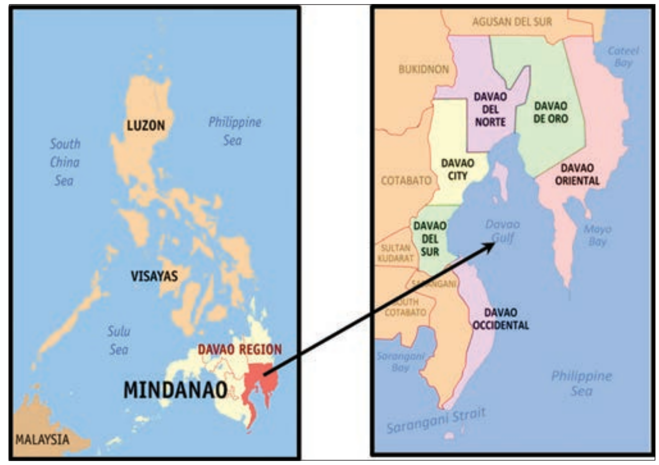

Figure 1: Maps of the Philippines and Davao region

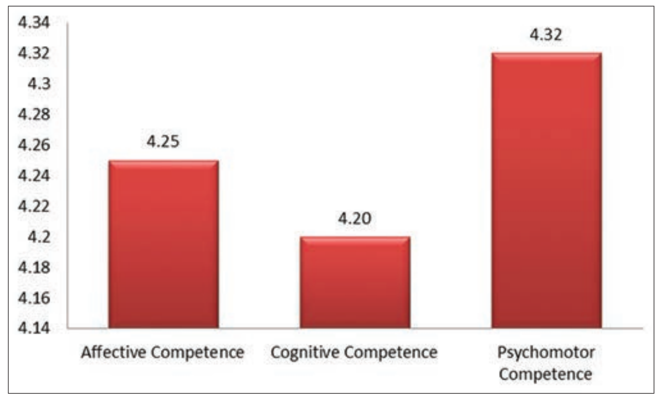

Figure 2: Competency of teachers

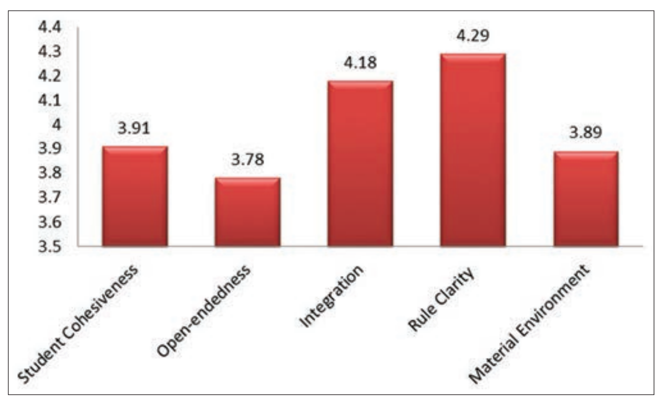

Figure 3: Laboratory environment in an online setting

Table 3 shows the lived experiences of students regarding the competency of teachers, laboratory environment in an online setting, and science process skills of students. The data gathered through IDI and FGD were transcribed, coded, grouped, and organized into themes. In this particular research question on the lived experiences of students regarding the competency of teachers, laboratory environment in an online setting, and science process skills of students, five themes were created and these are: mastery of science process skills, inadequacy of science process skills, dependence on teachers' competence, e-learning software promotes interactive learning and concerns confronting online laboratory classes.

Research Question 4

How do these experiences shape the beliefs, attitudes, and science process skills of the participants?

Table 2: Significance of the influence of the competency of teachers and laboratory environment in an online setting on the science process skills of students

Independent Variables	Science process skills of students			
	Standardized coefficients	t	ρ-value	Remarks
Competency of Teachers	0.06	1.13	0.26	Not significant
Laboratory Environment In an Online Setting	0.73	14.55	0.00	Significant

R=0.77, R-square=0.60, F=279.45, ρ≤0.05

Table 4 shows the role of experiences in shaping the beliefs and attitudes of students towards the acquisition of science process skills. Based on the IDI and FGD conducted, answers were transcribed, coded, grouped, and organized into themes

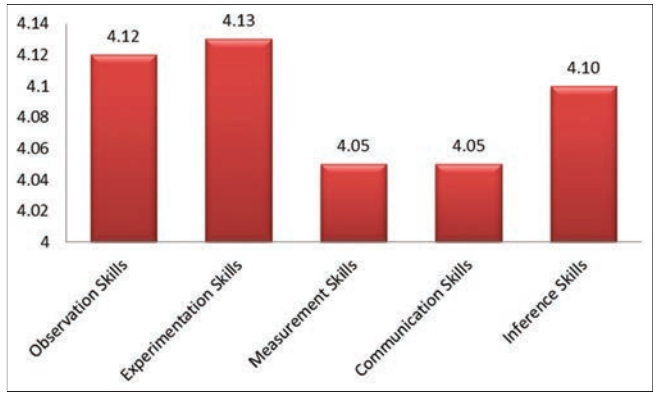

Figure 4: Science process of students

Table 3: Lived experiences of participants as regards to the competency of teachers, laboratory environment in an online setting, and science process skills

Subjects probed	Core ideas	Codes	Essential themes
Perception of acquiring science process skills in an online environment	Acquiring science process skills in an online environment Emphasizing learning science process skills in an online environment	Acquisition of science process skills	Mastery of science process skills
	Acquiring science process skills through laboratory group works Mastering science process skills through return demonstration Learning science process skills through actual laboratory experiment Utilizing web application in lieu of physical laboratory experiments	Practices of acquiring mastery	
	Experiencing difficulty in acquiring science process skills Emphasizing actual skills on science process skills in a face-to-face delivery of classes Lacking mastery of science process skills due to online set-up Lacking skills in handling laboratory equipment Lacking confidence	Challenges in acquiring science process skills in an online environment	Inadequacy of science process skills
Importance of the competency of teachers in the acquisition of science process skills	Being a role model of competence Relying acquisition of science process skills through competence of the teachers Being dependent on the teachers' competence Emphasizing the competence of teacher as it affects acquisition of knowledge Providing additional knowledge or techniques based on high level of experiments not found in the book	Teacher as a role model of competence	Dependence on teachers' competence
Laboratory environment in an online setting	Using software for interactive online laboratory class Having realistic simulation of experiments Considering online laboratory class as engaging like online games	Interactive laboratory learning through software	E-learning software promotes interactive learning
	Emphasizing the limitation of software in the conduct of online laboratory classes Finding online class as interesting, exciting, but difficult, challenging and boring	Mixed emotions	Concerns confronting online laboratory classes
	Experiencing difficulty in following procedures in an online laboratory class Having limited learning and opportunities Being bored since experiments are performed at home Having inadequate skill development since theories are not applied in a skill-based procedure	Limitation	

and the resulting themes include attributes to successful online learning and possession of appropriate learning attitudes

Research Question 5

To what extent do qualitative data corroborate quantitative data?

Table 5 shows that in merging quantitative and qualitative results, a merging-converging nature existed in the competency of teachers and laboratory environment in an online setting. However, there is a merging-diverging nature in the science process skills of students and the significance of the

Table 4: Role of experiences in shaping the beliefs, attitudes of students toward the acquisition of science process skills in an online setting

Subjects Probed	Core Ideas	Code	Essential themes
On Beliefs	Acquiring skills on science process skills through laboratory skills and competent teachers Motivating oneself due to the willingness of the teachers to teach Putting emphasis on instructors to have sufficient science process skills to perform effectively	Significance of instructors' competence	Attributes to successful online learning
	Acknowledging the various opportunities in the field of return demonstration Acquiring science process skills Finding ways to sustain learning	Adaptive Traits	
	Taking initiative in learning	Initiative	
On Attitude	Being open for new knowledge Being able to persevere in learning Being patient in learning Being adaptive to science process skills Maintaining a positive attitude towards learning Being determined in learning science process skills	Learning adaptations	Possession of appropriate learning attitudes

Table 5: Data integration of the salient qualitative and quantitative findings

Aspect of focal point	Quantitative findings	Qualitative findings	Nature of data integration
Competency of teachers	For the Status of the Competency of Teachers specifically on the cognitive competence which talks about indicating mastery of topic by the depth of content discussion and clarity of designs in terms of planned online class activities is rated very high at M=4.27, SD=0.83	Table 3 on the Lived experiences with core ideas being a role model of competence, relying on the acquisition of science process skills through the competence of teachers, being dependent on the teachers' competence, emphasizing the competence of teacher as it affects the acquisition of knowledge, providing additional knowledge or techniques based on a high level of experiments not found in the book with the code Teachers as a role model of competence highlighting the theme, dependence on teachers' competence.	Merging-converging
Laboratory environment in an online setting	For the Status of laboratory environment in an online setting specifically on material environment which talks about demonstrating the importance of doing individual or group work is rated high at M=4.08, SD=0.92	Table 4 on the Role of experiences of students have the core ideas Acknowledging the various opportunities in the field of return demonstration, acquiring science process skills, and finding ways to sustain learning with the code Adaptive traits as highlighted by the theme Attributes to successful online learning.	Merging-converging
	The Status of laboratory environment in an online setting specifically on open-endedness which talks about having a teacher who decides the best online videos of the topic is rated high at M=4.07, SD=0.92	Table 3 on the Lived experiences have the core ideas of using software for interactive online laboratory class, having realistic simulation of experiments, and considering online laboratory class as engaging like online games with the code Interactive laboratory learning through software as highlighted by the theme E-learning software promotes Interactive learning.	Merging-converging
Status of Science Process Skills of Students	For the Status of Science Process Skills of Students specifically on experimentation skills which talks about observing precautionary measure when carrying out an experiment is rated very high at M=4.25, SD=0.80	Table 3 on the Lived experiences with the core ideas experiencing difficulty in acquiring science process skills. emphasizing actual skills on science process skills in a face-to-face delivery of classes, lacking mastery of science process skills due to online set-up, lacking skills in handling laboratory equipment, and lacking confidence with code Challenges in acquiring science process skills in an online environment as highlighted by the theme Inadequacy of science process skills.	Merging-diverging
Significance of the influence of competency of teachers and laboratory environment in an online Setting to the science process skills of students	Table 2 on the Significance of Competency of Teachers and Laboratory Environment in an Online Setting as Predictors of Science Process Skills of Students reveals that the competency of teachers bears no significance with ρ-value 0.26	Table 3 on the Lived experiences with the core ideas being a role model of competence, relying on acquisition of science process skills through competence of teachers, being dependent on the teachers' competence, emphasizing on the competence of teacher as it affects the acquisition of knowledge, providing additional knowledge or techniques based on high level of experiments not found in the book with the code Teachers as role models of competence As highlighted by the theme Dependence on teachers' competence.	Merging-diverging

competency of teachers and laboratory environment in an online setting to students' science process skills.

DISCUSSION AND CONCLUSION

Status of the Competency of Teachers, Laboratory Environment in an Online Setting, and Science Process Skills of Students

The results of the study revealed that the competency of teachers teaching Chemistry laboratories in HEIs in Region XI was evident. The results imply that the teachers' affective, cognitive, and psychomotor competencies were evident and consistently observed. Hence, the teachers teaching chemistry laboratories were considered effective in their competencies. Affective, cognitive, and psychomotor competence influenced the transmission of knowledge and skills to students, leading to enhanced academic performance and acquisition of science process skills. These findings conform to the research conducted by Ab Halim et al. (2021), which found that competent teachers enhance students' science process skills by using different student-centered approaches.

Moreover, the result of this study revealed that the laboratory environment in an online setting in HEIs in Region XI was high. The result indicated that the laboratory environment was often favorable to students. Specifically, the respondents assessed this category based on five dimensions: student cohesiveness, open-endedness, integration, rule clarity, and material environment. This finding corroborates Olubu's (2015) research, which found a positive correlation between the five dimensions of the chemistry laboratory-learning environment and students' academic performance. The result means that the more favorable the laboratory environment is, the more positive the performance and attitude toward chemistry.

In addition, the discussions of science process skills of students focused on the five essential indicators: observation skills, experimentation skills, measurement skills, communication skills, and inference skills. The result indicates a high level of science process skills, meaning that students often exhibited the skills online. The result means that the competency of teachers equipped with affective, cognitive, and psychomotor competence influenced the acquisition of science process skills. The result also signifies that students acquire the science process skills despite being in a laboratory environment in an online setting. The optimization of technology in teaching aids in acquiring these skills. This finding is related to the research conducted by Uche and Eze (2018) that students exposed to laboratory activities showed evident acquisition of science process skills. The result suggests that students can experience the theories learned in the lecture class. The prohibition of face-to-face classes does not affect the acquisition of science process skills. Further, this finding supports the study of Ab Halim et al. (2021), which averred the importance of science teachers equipped with the necessary knowledge or skills to ensure the acquisition of science process skills.

Significance of the Influence of the Competency of Teachers and Laboratory Environment in an Online Setting on the Science Process Skills of Students

The results showed a significant influence of the laboratory environment in an online setting on students' science process skills. The result means that student cohesiveness, the open-endedness of online laboratory class, the integration of lecture and laboratory classes, and the imposition of clear rules and material environment affects the acquisition of science process skills. The result supports the study by Feyzioğlu (2009), which revealed that the efficient use of the laboratory influenced the acquisition of science process skills of students. It also coincides with the study of Uche and Eze (2018) that the acquisition of scientific process skills of students improved with the use of laboratory resources in the teaching and learning of science.

In addition, this finding is cognizant of the Sociocultural Theory that explains that hands-on experiences in the laboratory will lead to helping learners achieve independence by collaborating with a competent teacher in a learning environment that fosters the acquisition of skills (Podolskiy, 2012).

Lived Experiences of Students as regards the Science Process Skills of Students

Mastery of science process skills

The results revealed that students in HEIs in the region have a mastery of science process skills. The result suggests that they have acquired the science process skills in an online environment. Mastery of science process skills requires knowledge and demonstration of what they have learned in their lecture class to evaluate and assess the knowledge and skills they have acquired. The finding coincides with the study of Alkan (2016) that experiential learning is a practical approach to academic achievement and scientific process skills.

Inadequacy of science process skills

This theme emerged when the participants shared their experiences acquiring science process skills. This theme includes challenges in acquiring science process skills. The participants believed they needed help acquiring the science process skills in the online laboratory environment and that face-to-face class delivery is much better than online learning. They need more mastery, skills in handling laboratory equipment, and confidence. The participants disclosed that science process skills could be improved because they needed more resources to do hands-on experiences. The result means that although there is the acquisition of science process skills, the limitations of online learning lead to inadequate science process skills acquisition. This finding conforms to the study of Maranan (2017), wherein although many students are in the "mastered" level, there are also many students at the lower level, especially in the "low mastery" and "no mastery" levels who must need guidance to improve their skills and performance.

Dependence on teachers' competence

When the student participants shared about the importance of the competency of teachers in the acquisition of science process skills, the theme emerged from their responses: dependence on teachers' competence. Under this essential theme is the code teacher as a role model of competence. The participants highlighted the importance of teachers' competency in acquiring science process skills. The result means that teachers served as role models of competence, and their competence yields the acquisition and understanding of knowledge and skills. This finding coincides with Ango's (2002) research that the attainment of students' mastery of basic science skills is through adequate teachers. The teachers must be masters of science process skills and must be masters of effective teaching practices to ensure that students learn the skills.

E-learning software promotes interactive learning

In the interview and discussion regarding how the student participants described their laboratory environment in an online setting, participants revealed, based on their lived experiences, that the e-learning software supports interactive learning. This finding supports the study of Bortnik et al. (2017) that the e-laboratory is an effective pre-physical laboratory-training tool as it allows students to develop skills required for conducting hands-on experiments. E-lab is the only way to teach and learn in this pandemic, where conducting a physical-chemical experiment (lack of equipment, safety concerns, time constraints) is impossible. Thus, an e-lab is an effective pre-class training tool that can be used before physical laboratory experiments as it allows students to practice the necessary skills.

Concerns confronting online laboratory classes

Another essential theme in the participants' description of how they describe their laboratory environment in an online setting was confronting online laboratory classes that emerged from the two codes, namely mixed emotions, and limitations. Students believed that the laboratory environment in an online setting is a mixture of being challenging, tedious, exciting, and quite complex but interesting and fun. In addition, students believed that the procedures in an online laboratory class could be easier to follow, leading to limited opportunities in the demonstration aspect, precisely the return demonstration. This finding conforms to the study of Barrot et al. (2021) that the COVID-19 pandemic had the most significant impact on the quality of student's learning experience as to the limitations in learning space and facilities at home.

Experiences that Shape the Beliefs and Attitudes of Participants on the Acquisition of Science Process Skills

Attributes of successful online learning possession

This theme emerged from the participants' statements about the role of their experiences in shaping their beliefs and attitudes. Under critical elements for the significance of instructors' competence as code, the participants highlighted the acquisition of science process skills through laboratory skills and competent teachers willing to teach and possess sufficient science process skills to perform effectively. The result implies that the participants' experiences with competent instructors helped shape their beliefs on acquiring science process skills. The result supports Ango's (2002) study that the attainment of students' mastery of basic science skills is through adequate teachers.

Possession of appropriate learning attitudes

This theme emerged from the participants' discussions about their attitudes toward acquiring science process skills in an online laboratory class. The result indicates that the participants learned the science process skills with appropriate learning attitudes. The result means that the participants acquired the science process skills through the learning adaptations like being open to new knowledge and patient. Results also imply that the participants' patience during the online laboratory class contributes to acquiring science process skills. This finding corroborates with the research of Shi (2020) that students who have a strong desire to study in the process of online learning are those who can control their learning progress, complete their learning tasks on time, recognize their problems in the learning process and correct them, be familiar with their learning situation and make adjustments at the correct time.

Data Integration of Salient Qualitative and Quantitative Findings Merging-Converging

Competency of teachers

The competency of teachers, the quantitative results corroborate qualitative findings. The item under indicator 2, cognitive competence, reflected a very high mean rating, which reflects that their chemistry teacher possessed a mastery of the topic through the depth of content discussion and clarity of designs in planned online class activities. When this quantitative finding merged with qualitative findings under participants' description of the competency of teachers, a converging of data formed, as shown by the essential theme of dependence on teachers' competence. This finding agrees with the study of Copriady (2014) on the competency of teachers in the teaching and learning of chemistry practical; results showed that students' positive attitude toward Chemistry and their motivation to learn and provide appropriate feedback to the learning activities is significantly depending on how teachers influenced them. As reflected in the qualitative data, participants shared that the ability of the teacher to teach is a crucial component in determining the success of their teaching and the acquisition of science process skills. This finding reflects the role of teachers' competency in acquiring students' science process skills.

Laboratory environment in an online setting

The second focal point was the laboratory environment in an online setting, which showed a converging nature when quantitative and qualitative findings merged. Under the quantitative data of the indicator open-endedness, which talks about having a teacher who decides the best online videos of the topic, is rated high and formed the essential theme e-learning software promotes interactive learning. This finding coincides with the research of Usman et al. (2021) that the use of a virtual laboratory enhances students' science process skills, especially in predicting and measuring. The virtual lab media provide opportunities and flexibilities for students to conduct experiments by the level of ability and pace of learning of each student, anytime and anywhere. Moreover, the virtual laboratory helped students understand the importance of simulation tools as learning aid materials (Ratamun and Osman, 2018). In addition, videos helped illustrate essential aspects of each experiment, with some students commenting that it made them feel like they were performing the experiments themselves (Mojica and Upmacis, 2022).

Merging- Diverging

Science process skills of students

The status of the science process skills of students under indicator experimentation skills, which talks about observing precautionary measures when experimenting, was rated very high. The qualitative finding contradicts the quantitative findings, as shown by the code challenges in acquiring science process skills online, as highlighted by the theme of inadequacy of science process skills. The result supports the study of Shana and Abulibdeh (2020) that laboratory work is vital for studying science. However, the need for more materials for the required experiment affects the teaching process. In addition, students' soft science process skills can lead to a lack of science materials and a low level of science process skills of science teachers affecting students' acquisition of science process skills (Permanasari and Hamidah, 2013).

Significance of Competency of Teachers and Laboratory Environment in an Online Setting to the Science Process Skills of Students

As to the significance of the competency of teachers and laboratory environment in an online setting to the science process skills of students, results revealed that the competency of teachers bears no significance with a ρ-value of 0.26 on the science process skills of students. These quantitative data diverge from the qualitative results with code teachers as role models of competence with the essential theme of dependence on teachers' competence. The participants believed that the acquisition of science process skills is possible through laboratory skills and competent teachers, motivating oneself due to the willingness of the teachers to teach and putting emphasis on instructors to have sufficient science process skills to perform effectively. This finding coincides with Copriady's (2014) study that students' positive attitude toward Chemistry and their motivation to learn and provide appropriate feedback to the learning activities are significant, depending on how teachers influenced them. As reflected in the qualitative data, participants shared that the ability of the teacher to teach is a crucial component in determining the success of their teaching and the acquisition of science process skills. This finding reflects the role of teachers' competency in acquiring students' science process skills.

CONCLUSION

The competency of teachers was rated very high. The finding implies that teachers' affective, cognitive, and psychomotor competence was evident and consistently observed. Hence, the teachers teaching chemistry laboratory subjects in HEIs in Region XI are considered adequate and possess the said competencies. The laboratory environment in an online setting was rated high. This result implies that the laboratory environment in an online setting in HEIs in Region XI was often favorable to students. Further, students' science process skills were high, meaning that students frequently exhibited the science process skills. Findings revealed that students acquire the science process skills despite being in a laboratory environment in an online setting.

Regarding the influence of the data gathered, the results showed that the competency of teachers and the science process skills of students had no significant influence. In contrast, the opposite happened for the laboratory environment in an online setting and students' science process skills. The results revealed that for every unit increase in the value of the level of laboratory environment in an online setting, the level of science process skills of students increases as well. These results implied that the laboratory environment in an online setting plays a significant role in the acquisition of science process skills of students.

Further, five essential themes emerged from the lived experiences of the participants. These themes are mastery of science process skills, inadequacy of science process skills, dependence on teachers' competence, e-learning software promoting interactive learning, and concerns confronting online laboratory classes. Furthermore, the participants' lived experiences shaped their beliefs and attitudes toward students' acquisition of science process skills. The participants believed that science process skills could be learned by possessing the attributes of successful online learning and appropriate learning attitudes.

In addition, when the quantitative results merge with qualitative results, a merging-converging nature was found to exist in the competency of teachers and laboratory environments in an online setting. However, a merging-diverging nature was evident in the science process skills of students and the significance of the competency of teachers and laboratory environment in an online setting to the science process skills of students.

Recommendations

Based on the findings of the study, the following are suggested recommendations:

The results revealed a very high level of competence shown by teachers in the online setting, which the students always observe. With this, school administrators may further enhance the skills of the teachers by providing various training and workshops to develop and improve their teaching competencies. Training and workshops on e-learning software to help engage students in the teaching and learning process. Moreover, training on new trends in the subject matter may contribute to sustaining skills, specifically in cognitive competence, to provide quality education despite being in an online setting. In addition, enhancing teachers' pedagogical knowledge creates effective teaching and learning environments for all students, especially in an online setting.

As to the laboratory environment in an online setting, the study revealed a high level of the laboratory environment, implying that the online setting is often favorable for students. It is strengthening the use of software and web applications to improve the laboratory environment in an online setting to the acquisition of science process skills of students. School administrators may consider procuring software that will strengthen the virtual laboratory experience of students through simulations. The result will enable them to visualize and realistically observe the laboratory experiments.

The results of students' science process skills revealed a high level of skills, which means that students' science process skills are evident. The institution may enhance and improve science process skills by revisiting the present curriculum and ensuring that the curriculum matches the demand of the present educational landscape.

Since the result of the linear regression analysis revealed that only the laboratory environment in an online setting significantly predicts the science process skills of students in HEIs in Region XI, future researchers may explore other factors that may influence the science process skills of students aside from the competency of teachers and laboratory environment in an online setting.

Future studies may be conducted by academic scholars or researchers based on the information gathered from this research. Areas of interest can be other factors that affect the students' acquisition of science process skills and utilize a comparative study involving different courses with chemistry laboratory subjects.

Ethical Statement

The participation of the students in this study was voluntary. Before the study, the researcher secured an Ethical Clearance from the University of the Immaculate Conception-Research Ethics Committee (UIC-REC) dated February 27, 2022. The Informed Consent Form (ICF) was given to the students to ensure they agreed to participate voluntarily in the study after providing information and knowledge about it. This study followed the ethical considerations guidelines that adhered to 10 elements, namely, social value; informed consent; vulnerability of research participants; risks, benefits, and safety; privacy and confidentiality of information; justice; transparency; qualifications of the researcher; adequacy of facilities; and community involvement as stipulated in the ICF.

REFERENCES

Ab Halim, A.S., Osman, K., Aziz, M.S.A.M., Ibrahim, M.F., & Ahmad, A.A.K. (2021). The competency of science teachers in integrating higher order thinking skills in teaching and learning. *Journal of Physics: Conference Series*, 1793(1), 012005.

Adikwu, O., EsmondAtamonokhai, S., & OlaiyaFatoki, J. (2018). Assessment of chemistry teachers' competence in practical chemistry in secondary schools in Makurdi, Benue State, Nigeria. *International Journal of Research and Review*, 5(5), 179-186.

Ahmad, C.N.C., Osman, K., & Halim, L. (2010). Physical and psychosocial aspects of science laboratory learning environment. *Procedia-Social and Behavioral Sciences*, 9, 87–91.

Akani, O. (2015). Levels of possession of science process skills by final year students of colleges of education in South-Eastern States. *Journal of Education and Practice,* 6*(*27), 94-101.

Akinbobola, A.O. (2015). Evaluating science laboratory classroom learning environment in Osun state of Nigeria for national development. *Journal of Resources Development and Management*, 9, 14-19.

Aladejana, F., & Aderibigbe, O. (2007). Science laboratory environment and academic performance. *Journal of Science Education and Technology*, 16(6), 500-506.

Alkan, F. (2016). Experiential learning: Its effects on achievement and scientific process skills. *Journal of Turkish Science Education*, 13, 15-26.

Allanas, E. (2021). Analysis of student perceptions in the learning environment chemical laboratory. *Journal of Physics: Conference Series*, 1876(1), 012066.

Ango, M.L. (2002). Mastery of science process skills and their effective use in the teaching of science: An educology of science education in the Nigerian context. *International Journal of Educology*, 16(1), 11-30.

Atmowardoyo, H. (2018). Research methods in TEFL studies: Descriptive research, case study, error analysis, and R & D. *Journal of Language Teaching and Research*, 9(1), 197.

Barrot, J.S., Llenares, I.I., & Del Rosario, L.S. (2021). Students' online learning challenges during the pandemic and how they cope with them: The case of the Philippines. *Education and Information Technologies*, 26(6), 7321-7338.

Belgica, C., Calugan, J., Dumo, J., & Simber, L. (2020). *Online Distance Learning: Thematic Study on the Challenges Faced By Educare College Inc. Primary Pupils*. Paper Presented at the 3rd International Conference on Advanced Research and Education, Teaching and Learning. Oxford, UK. Available from: https://www.dpublication.com/wp-content/uploads/2020/12/30-10340.pdf [Last accessed on 2023 Jun 09].

Bortnik, B., Stozhko, N., Pervukhina, I., Tchernysheva, A., & Belysheva, G. (2017). Effect of virtual analytical chemistry laboratory on enhancing student research skills and practices. *Research in Learning Technology*, 25. https://api.semanticscholar.org/CorpusID:54945432

Commission on Higher Education (CHED). (2012). *Memorandum Order No. 46s*. Available from: https://ched.gov.ph/wp-content/uploads/2017/10/CMO-47-s-2017.pdf

Copriady, J. (2014). Teachers competency in the teaching and learning of chemistry practical. *Mediterranean Journal of Social Sciences, 5*(8), 312-318.

Creswell, J.D. (2018). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. 5th ed. United Kingdom: SAGE Publications.

Creswell, J.W. (2012). *Qualitative Inquiry and Research Design: Choosing among Five Approaches*. 4th ed. United Kingdom: SAGE Publications.

Creswell, J.W. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. 4th ed. United Kingdom: SAGE Publications.

Creswell. J.W., & Creswell, J.D. (2017). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. 4th ed. United Kingdom: SAGE Publications.

Derilo, R. (2019). Basic and integrated science process skills acquisition and science achievement of seventh-grade learners. *European Journal of educational Studies*, 6(1), 281-294.

Ekon, E., & Eni, E. (2015). Gender and acquisition of science process skills among junior secondary school students in calabar municipality: Implications for implementation of universal basic education objectives. *Global Journal of Educational Research*, 14(2), 93.

Fadzil, H.M., & Saat, R.M. (2017). Exploring students' acquisition of manipulative skills during science practical work. *EURASIA Journal of Mathematics, Science and Technology Education*, 13(8), 4591-4607.

Feyzioğlu, B. (2009). An investigation of the relationship between science process skills with efficient laboratory use and science achievement in chemistry education. *Journal of Turkish Science Education*, 6(3), 114-132.

Gamage, K.A.A., Wijesuriya, D.I., Ekanayake, S.Y., Rennie, A.E W., Lambert, C.G., & Gunawardhana, N. (2020). Online delivery of teaching and laboratory practices: Continuity of university programmes during COVID-19 pandemic. *Education Sciences*, 10(10), 291.

Garg, R. (2016). Methodology for research. *Indian Journal of Anaesthesia*, 60(9), 640-645.

Halberstadt, A.G., Denham, S.A., & Dunsmore, J.C. (2001). Affective social competence. *Social Development*, 10(1), 79-119.

Huary, D.L. (2003). *Fundamental Skills in Science: Measurement*. Available from: https://www.researchgate.net/publication/272238484_fundamental_skills_in_science_measurement [Last accessed on 2023 Jun 09].

Irwanto, I., Rohaeti, E., & Prodjosantoso, A.K. (2018). Undergraduate students' science process skills in terms of some variables: A perspective from Indonesia. *Journal of Baltic Science Education*, 17(5), 751-764.

Jiang, Y. (2018). *Development of Self-Regulated Learning Skills within Open-Ended Computer-Based Learning*. (Unpublished Thesis, Columbia. USA). Available from: https://academiccommons.columbia.edu/doi/10.7916/D8Z62569/download [Last accessed on 2023 Jun 09].

Konting, M., Norfaryanti, K., & Man, N. (2009). Quality assurance in higher education institutions: Exist survey among university Putra Malaysia graduating students. *International Education Studies*, 2(1), 25-31.

Korotaj, B.V., & Mrnjaus, K. (2021). Emotional competence: A prerequisite for effective teaching. *Economic Research-Ekonomska Istraživanja*, 34(1), 39-52.

Kurnianingsih, C.T. (2017). *Analysis on Science Process Skills of Students through Contextual Approach on Science-Chemistry Learning in Taiwan*. Available from https://lib.unnes.ac.id/32228/1/4301413032.pdf [Last accessed on 2023 Jun 09].

Maranan, V.M. (2017). *Basic Process Skills and Attitude Toward Science: Inputs to an Enhanced Students' Cognitive Performance.* (Unpublished Thesis, the Faculty of Graduate Studies and Applied Research, Laguna State Polytechnic University, San Pablo City Campus).

Medina, R. (2010). *Quantitative Descriptive Correlational Research Study on Customer Service Leadership Skills and Customer Satisfaction*. United States: University of Phoenix. Available from: https://www.proquest.com/dissertations-theses/quantitative-descriptive-correlational-research/docview/855628151/se-2 [Last accessed on 2023 Sep 11].

Mojica, E.R.E., & Upmacis, R.K. (2022). Challenges encountered and students' reactions to practices utilized in a general chemistry laboratory course during the COVID-19 pandemic. *Journal of Chemical Education*, 99(2), 1053-1059.

Olubu O.M. (2015). Influence of laboratory learning environment on students' academic performance in secondary school chemistry. *US-China Education Review A*, 5*(*12), 814-821.

Parreno, E.B., & Jimenez, R.O. (2014). *Basic Statistics: A Worktext*. Philippines: C and E Publishing.

Permanasari, A., & Hamidah, I. (2013). The profile of science process skill (SPS) student at secondary high school (Case Study in Jambi). *International Journal of Scientific Engineering and Research*, 1*(*1), 79-83.

Podolskiy, A.I. (2012). Zone of Proximal Development. In: Seel, N.M. (Eds.), *Encyclopedia of the Sciences of Learning*. Germany: Springer, pp. 3485-3487.

Ratamun, M.M., & Osman, K. (2018). The effectiveness of virtual lab compared to physical lab in the mastry of science process skills for chemistry experiment. *Problems of Education in the 21st Century*, 76*(*4), 544-560.

Razali, F.M., Aziz, N.A.A., Rasli, R.M., Zulkefly, N.F., & Salim, S.A. (2019). Using convergent parallel design mixed method to assess the usage of multi-touch hand gestures towards fine motor skills among pre-school children. *International Journal of Academic Research in Business and Social Sciences*, 9(14), 153-166.

Rohaeti, E. (2018). The investigation on university students' science process skills and chemistry attitudes at the laboratory course. *Asia-Pacific Forum on Science Learning and Teaching*, 19(2), 7.

Rusmansyah, Hayati, N., Winarti, A., & Rahmi. (2021). Train students' science process skills and self-efficacy in online learning using the scientific critical thinking (SCT) model assisted by google classroom and google meet. *Journal of Physics: Conference Series*, 1760, 012034.

Rustan, N.A., Winarni, R., & Yamtinah, S. (2020). *Analysis of Science Process Skill on Science Learning in Primary School*. Proceedings of the 3rd International Conference on Learning Innovation and Quality Education (ICLIQE 2019), Solo Baru, Indonesia.

Shana, Z., & Abulibdeh, E.S. (2020). Science practical work and its impact on students' science achievement. *Journal of Technology and Science Education*, 10(2), 199.

Shek, D.T.L., & Yu, L. (2016). Cognitive competence: A key positive youth development construct for university students. *International Journal on Disability and Human Development*, 15(2), 135-142.

Shi, G. (2020). Research on the influence of online learning on students' desire to learn. *Journal of Physics: Conference Series*, 1693(1), 012055.

Spektor-Levy, O., Eylon, B.S., & Scherz, Z. (2009). Teaching scientific communication skills in science studies: Does it make a difference? *International Journal of Science and Mathematics Education*, 7(5), 875-903.

Sun, R.C.F., & Hui, E.K.P. (2012). Cognitive competence as a positive youth development construct: A conceptual review. *ScientificWorldJournal*, 2012, 210953.

Teo, T.W., & Goh, W.P.J. (2019). Assessing lower track students' learning in science inference skills in Singapore. *Asia-Pacific Science Education*, 5(1), 5.

Trnova, E., & Trna, J. (2006). *Science Experimental Skills under Development*. Paper presented at IOSTE 2006. Europe Needs More Scientists. The Role of Eastern and Central European Science Educators. Tartu: University of Tartupp, pp77-84. Available from https://www.researchgate.net/publication/274132579_science_experimental_skills_under_development [Last accessed on 2023 Jun 09].

Uche, O.M., & Eze, S. (2018). Impact of laboratory activities and acquisition of process skills on attitude and academic performance in science among senior secondary school students in Zaria, Kaduna State. *ATBU Journal of Science, Technology and Education*, 6, 20-27.

Usman, M., Suyanta, & Huda, K. (2021). Virtual lab as distance learning media to enhance student's science process skill during the COVID-19 pandemic. *Journal of Physics: Conference Series*, 1882(1), 012126.

Utami, B., Saputro, S., Ashadi, M., Masykuri, M., Yamtinah, S., & Widoretno, S. (2017). Development of the science skills of lower secondary students in a chemistry laboratory experiment. *Pertanik Journal of Social Sciences and Humanities*, 25*(*S), 41-50.

Zeidan, A.H., & Jayosi, M.R. (2014). Science process skills and attitudes toward science among Palestinian secondary school students. *World Journal of Education*, *5*(1), 13-24.