



Online Learning Through Google Classroom: Effects on Students Critical Thinking Skills in Chemistry

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ABSTRACTS

This study determined the effectiveness of the self-learning module and online learning through google classroom in the improvement of grade 9 students' critical thinking skills in chemistry. This study employed the experimental research design to the identified grade 9 students of two public schools, in which the test was done from 2020 to 2021 using a purposive sampling technique. Findings revealed that the level of critical thinking skills in problem-solving of students who are exposed to online learning through google classroom is higher than those of students who are exposed to self-learning modules. On the other hand, both methods of learning resulted in an average in the level of critical thinking skills in the Analysis of students with the online learning through google classroom gained a higher mean compared to that with the self-learning module. The study also revealed that there was a significant difference between problem-solving and analysis of critical thinking skills of the self-learning module and online learning through google classroom. The level of critical thinking skills in students' learning increases as they used online learning compared to the modular approach.

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1. INTRODUCTION

Chemistry was considered one of the most difficult subjects in school. Many students especially from secondary to tertiary levels in many countries struggle to learn chemistry and unfortunately many do not succeed. The fact that together with physics, instructions were out of synchrony which was not realistic making it irrelevant and boring. Learning should not only comprise listening to the teachers but also being able to model the learning process. To address these issues, teaching methods need to be improved and appropriate teaching strategies must be developed and technologically advanced. In the study conducted by Wachanga et al. (2005) concluded that each Chemistry topic requires different approaches depending on the complexity and structure of each sub-topic.

The lecture method was probably the oldest and most commonly used approach for students where they have assumed a passive, non-thinking, information-receiving role in which their process of learning can be quite low. Since the beginning of the twenty-first century, there have been many changes in the development of national and world education, especially in teaching methods.

Online learning through Google Classroom was one of the innovative teaching methods that allow students and teachers to connect, work together, organize and create assignments. A paperless online, digital tool, Google Classroom was accessible to all. These are a free collaborative set of tools that includes web tools like Google Docs, Google Drive, Gmail, etc. (Hussaini et al., 2020).

The Department of Education (DepEd) in the Philippines merges another method of learning called the Self-Learning Module (SLM) as the pandemic arises. DepED Order No. 018, s. 2020 issues the enclosed Policy Guidelines for the Provision of Learning Resources in the Implementation of the Basic Education Learning Continuity Plan (BE-LCP) which indicate that SLMs become an ideal learning resource and a priority in remote or distance learning where a teacher is unable to provide the constant instructional supervision and guidance in a classroom setting. SLMs have been used by DepEd for its Alternative Delivery Modes (ADMs) during disasters or in situations where learners have difficulty with daily school attendance. COVID-19 has compelled the use of SLMs on a large scale.

According to Yacoubian (2015), assistant professor of education and the chair of the faculty of Social & Behavioral Sciences at Haigazian University higher educational institution in Beirut, Lebanon, during his interview "there are some reasons for addressing the Nature of Science (NOS) in school science linked to critical thinking". We agree that formal instruction in critical thinking skills is necessary for the appreciable development of the skills (Snyder & Snyder, 2008). However, a range of views about which instructional approaches and strategies should be used. Therefore, understanding chemistry in its representational and symbolic nature is one of the basic skills students must have to develop critical thinking skills.

We pursue this study to determine the effective approach to teaching critical thinking skills to students in learning chemistry subjects. This will be beneficial both to students and teachers. It helps students in improving their learning skills specifically in chemistry as well as for the teachers in providing powerful teaching methods that will enhance their proficiency in teaching chemistry to their learners.

The purpose of this study was to determine the effectiveness of the Online Learning through Google Classroom and Self-Learning Module towards Critical Thinking Skills of students learning Chemistry.

Specifically, we answered the following questions:

- (i) What is the level of Critical thinking skills in the chemistry of students who are exposed to self-learning modules and online learning through google classroom?
- (ii) Is there a significant difference in the critical thinking skills of students who are exposed to Online learning through Google Classroom and Self-Learning Module?
- (iii) Based on the findings of the study, what efficient and effective intervention should be developed to raise the level of students' critical thinking skills in chemistry?

This study of Online Learning through Google Classroom and Self-learning Module for students learning in chemistry would be beneficial to the following:

- (i) School Administrations. The results of this study will be significant to school administrators/ heads to plan and create effective learning methods for students which can surely be applied to meet their goals of producing outstanding graduates.
- (ii) Teachers. The results of this study will provide a better teaching method for teachers for they will surely enhance their proficiency in teaching chemistry to their students.
- (iii) Students. The students will serve as the main beneficiaries of this study as the result will enhance and improve their learning skills, especially in chemistry subjects.
- (iv) Researchers. The results of this study enable us to know the efficient teaching method in chemistry as some future science teachers. It will give them an idea of what teaching strategies and approaches they will apply to the learning of their students in the future.
- (v) Future research. This study will provide baseline data needed for the future research and it serves as their guide in making their research.

2. METHODS

2.1. Research design

This study utilized experimental research in the survey method. A rating scale survey was used to measure the skills of students which mainly focus on the two elements of critical thinking skills, problem-solving and analysis.

This design is used to determine the most effective teaching method for Online learning through Google Classroom and Self-learning Module on critical thinking of students in learning chemistry.

2.2. Research location

Barangay Bai Saripinang is a large area under the municipality of Bagumbayan, Sultan Kudarat, and has geographical coordinates 6° 32'15" North, 124° 33'45" East. On the other hand, another place found in the Province of Sultan Kudarat is the Villamonte. This place is the farthest hinterland and 3rd from the biggest area of Lebak, Sultan Kudarat. It is situated 42 kilometers away from the Poblacion of Lebak. On its North is Mafran South Upi, Maguindanao, South is Keytodac and New Calinog, East is Salumping, Esperanza, and the North is Capilan.

2.3. Respondents of the study

The respondents of this study were the Grade 9 students of Bai Saripinang NHS and Lebak NHS- Villamonte who were currently enrolled in the academic year 2020-2021. A total of seventy-two (72) respondents were considered in the study wherein there were thirty-eight (38) students from Bai Saripinang NHS and thirty-four (34) students from Lebak NHS- Villamonte. Both schools were heterogeneous, so to establish the normal distribution, we selected the respondents based on students' average in science. The respondents should have an average of 85-90 to answer the survey questionnaire.

2.4. Sampling technique

The study utilized purposive sampling from students enrolled in Grade 9 in Lebak National High School - Villamonte and Bai Saripinang National High School, in the School Year 2020-2021. Sampling approach as a strategy where we select their individuals as part of their study and applying their criteria when defining their sample. In this study, we selected the respondents based on students' average in science in which students should have an average of 85-90 to answer the survey questionnaire. A total of seventy-two respondents are considered in the study wherein there were thirty-four students from Lebak NHS-Villamonte and thirty-eight students from Bai Saripinang NHS. Therefore, there were two groups of respondents in this research. Respondents from Lebak National High School - Villamonte were exposed to online learning through google classroom while the Bai Saripinang National High School was exposed to the self-learning module approach.

2.5. Data gathering instruments

Instrument used in their study about determining the Critical thinking ability of students at Mandaue City, Senior High School. Few words are being revised by us as corresponds to the main focus of the study.

This survey questionnaire helped in investigating the critical thinking skills of students, particularly in problem-solving skills and analysis as well as to know which among these two methods the Online Learning through Google Classroom and Self-learning Module are effective to enhance student's critical thinking skills in Chemistry subject. We established the validity and reliability of the rating scale survey first as well as critiqued English experts to check the grammar and sentence structure before distributing it to the respondents.

We also used an adopted DepEd Grade 9 Science Module that discusses chemical bonding, a variety of carbon compounds, and mole concepts. These lessons were used to conduct activities and interventions to test the critical thinking skills of students in chemistry using two different teaching approaches Online learning through Google Classroom and Self-Learning Module.

The following were the interpretation based on the verbal description that we used to analyze the data.

- (i) Survey questionnaire on Self-Learning Module focused on Problem Solving of Critical Thinking Skills. It was made up of fifteen-item survey questions in problem-solving with four options to choose from which namely stated as Strongly Agree, Agree, Disagree, and Strongly Disagree (See **Table 1**).
- (ii) Survey questionnaire on Self-Learning Module focused on Analysis of Critical Thinking Skills. This instrument was designed to gather data about students' critical thinking skills focused on analysis. The survey questions were made up of fifteen items with four options to choose from which namely stated as Strongly Agree, Agree, Disagree, and Strongly Disagree (see **Table 2**).
- (iii) The survey questionnaire on Online Learning through Google Classroom focused on Problem Solving of Critical Thinking Skills. It was made up of fifteen items survey questions in problem-solving with four options to choose from which namely stated as Strongly Agree, Agree, Disagree, and Strongly Disagree (see **Table 3**).
- (iv) Survey questionnaire on Online Learning through Google Classroom focused on Analysis of Critical Thinking Skills. This instrument was designed to gather data about students' critical thinking skills focused on analysis. The survey questions are made up of fifteen items with four options to choose from which namely stated as Strongly Agree, Agree, Disagree, and Strongly Disagree (See **Table 4**).

Table 1. Students' level of critical thinking skills in problem solving who are exposed to self-learning module interpretation of the verbal description.

Numerical Rating	Range of Score	Verbal Description	Interpretation
4	3.26 - 4.00	Strongly Agree	Students' level of Critical thinking skills in Problem-solving who are exposed to the Self-Learning Module is High.
3	2.51 - 3.25	Agree	Students' level of Critical thinking skills in Problem-solving who are exposed to the Self-Learning Module is Average.
2	1.76 – 2. 50	Disagree	Students' level of Critical thinking skills in Problem-solving who are exposed to the Self-Learning Module is Below Average.
1	1.00 – 1.75	Strongly Disagree	Students' level of Critical thinking skills in Problem-solving who are exposed Self-Learning Module is Low.

Table 2. Students' level of critical thinking skills in analysis who are exposed to self-learning module interpretation of the verbal description.

Numerical Rating	Range of Score	Verbal Description	Interpretation
4	3.26 - 4.00	Strongly Agree	Students' level of Critical thinking skills in Analysis who are exposed to the Self-Learning Module is High.
3	2.51 - 3.25	Agree	Students' level of Critical thinking skills in Analysis who are exposed to the Self-Learning Module is Average.
2	1.76 – 2. 50	Disagree	Students' level of Critical thinking skills in Analysis who are exposed to the Self-Learning Module is Below Average.
1	1.00 – 1.75	Strongly Disagree	Students' level of Critical thinking skills in Analysis who are exposed Self-Learning Module is Low.

Table 3. Students' level of critical thinking skills in problem solving who are exposed to online learning through google classroom interpretation of the verbal description.

Numerical Rating	Range of Score	Verbal Description	Interpretation
4	3.26 - 4.00	Strongly Agree	Students' level of Critical thinking skills in Problem-solving who are exposed to Online learning through Google Classroom is High.
3	2.51 - 3.25	Agree	Students' level of Critical thinking skills in Problem-solving who are exposed to Online learning through Google Classroom is Average.
2	1.76 – 2. 50	Disagree	Students' level of Critical thinking skills in Problem-solving who are exposed to Online learning through Google Classroom is Below Average.
1	1.00 – 1.75	Strongly Disagree	Students' level of Critical thinking skills in Problem-solving who are exposed to Online learning through Google Classroom is Low.

Table 4. Students' level of critical thinking skills in analysis who are exposed to online learning through google classroom interpretation of the verbal description.

Numerical Rating	Range of Score	Verbal Description	Interpretation
4	3.26 - 4.00	Strongly Agree	Students' level of Critical thinking skills in Analysis who are exposed to Online learning through Google Classroom is High.
3	2.51 - 3.25	Agree	Students' level of Critical thinking skills in Analysis who are exposed to Online learning through Google Classroom is Average.
2	1.76 – 2. 50	Disagree	Students' level of Critical thinking skills in Analysis who are exposed to Online learning through Google Classroom is Below Average.
1	1.00 – 1.75	Strongly Disagree	Students' level of Critical thinking skills in Analysis who are exposed to Online learning through Google Classroom is Low.

These items are positively and negatively stated. The respondents were requested to indicate their honest answers to every item. They were assured that their answers will be kept confidential and their anonymity will be strictly observed.

2.6. Data gathering procedure

In the gathering of data, a letter of permission to the administration of the two secondary high schools was provided (See **Figure 5**). The schedule and procedure of data gathering were done accordingly. We gathered the respondents for the data collection procedure. The adapted DepEd Grade 9 Science Module was discussed and given to students to answer and to do the activities. The students from Lebak NHS-Villamonte had Online Learning through Google Classroom and the students from Bai Saripinang NHS had Self-learning Modular approach. After the discussion, we administered and distribute the rating scale survey to all Grade 9 respondents to measure their critical thinking skills. Lastly, we collected the survey questionnaires for data analysis and interpretation.

2.7. Statistical Tools

The data obtained scientifically were tallied and computed. The results were interpreted using statistical tools. We used the mean and Independent sample t-test with the help of the Statistical Package for the Social Sciences (SPSS) to calculate the data. All hypothetical questions were analyzed and interpreted at a 0.05 level of significance. Furthermore, mean score distribution was used to determine the level of students' Critical Thinking on Problem Solving Skills and Analytical Skills who were exposed to the self-learning module and online learning through google classroom. Lastly, an Independent sample t-test was used to determine the significant difference in students' Critical Thinking Skills who were exposed to self-learning module and online learning through google classroom.

3. RESULTS AND DISCUSSION

This focuses on the presentation, analysis, and interpretation of the data gathered from Bai Saripinang NHS and Lebak NHS-Villamonte, Sultan Kudarat in response to the problem of the study. This would give a true picture of how the subjects assessed the approaches in teaching Chemistry and Critical Thinking Skills to the Grade 9 students in both schools. The

presentations were done mostly in tabular and textual forms. The order of the presentation was primarily based on the sequence of the statements of the problem.

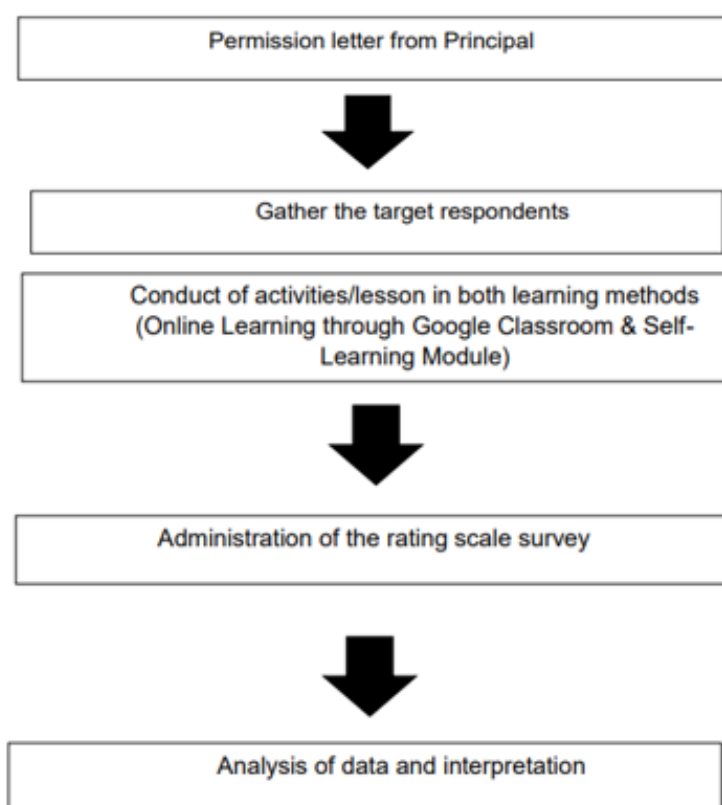


Figure 5. The flow of data gathering.

3.1. Level of Critical Thinking Skills of Students in Problem-solving exposed to Self-Learning Module

Table 5 shows the mean scores of critical thinking skills on Problem-solving. The data was gathered from students of Bai Saripinang NHS who were exposed to the Self-Learning Module approach. As shown in **Table 5**, there were five verbal descriptions for “Strongly Agree”. First is found in item number 1 which has a 3.34 mean score which reveals that the modular approach helps students enhance their problem-solving skills as the module provides quantities and appropriate information for students learning. The second is located in item number 3 which has a 3.26 mean score it turns out that students who are exposed to modular learning have a strong focus on finding accurate solutions to solve a problem as they work and concentrate independently. Third, item number 10 has the result of 3.32 which tells that modular learning students can greatly apply the knowledge that they learned to solve new problems. Fourth, students also strongly agreed that in modular approach strengthens their capabilities to apply necessary information for each stage of problem-solving and decision making, which has a 3.29 mean score found in item number 11. Lastly, **Table 5** also reveals in item number 12 a highest mean score of 3.39 which means that the Self-Learning Module helps students solve real-world problems as the module provides strong basic mathematical skills that can certainly be applicable in every situation. While item number 9 shows the lowest rating base in the table which has a 2.92 mean score that is equivalent to a descriptive rating of "Agree", it states that students somewhat learned complex questions. It shows that

students who are exposed to modular can think and understand difficult questions, good enough to assimilate the information but not intelligently and excellently as possible.

The data above also reveals that students' level Problem-solving of and critical thinking skills obtained a grand mean of 3.17 with a verbal description of "Agree". The result can be interpreted as "Student's level of Critical thinking skills in Problem-solving who are exposed to Self-Learning Module is Average." Based on the result, it denotes that student's level of critical thinking skills when it comes to Problem-solving is somewhat effective on learning of students towards chemistry subject. From that result, it can also be drawn students who are exposed to Self-Learning Modules can somehow be good because it strengthens students' confidence in making decisions or judging, and solves real-world problems.

Table 5. Provides the mean score level of the respondents' critical thinking skills in problem solving exposed to the self-learning module.

Description of Students' Responses on Problem Solving of Critical Thinking Skills	MEAN	Verbal Description
1. The quantities of the presented information were appropriate to enhance my problem-solving skills.	3.34	Strongly Agree
2. I can understand and interpret the meaning of a problem.	3.13	Agree
3. I focus on all the alternatives that may be appropriate to solve the problem.	3.26	Strongly Agree
4. I can use structured and organized ways of analyzing and assessing a problem thoroughly.	3.11	Agree
5. I can analyze all facts and put them in systematic order.	3.03	Agree
6. I can determine the differences in solutions at each stage.	3.08	Agree
7. I have improved my ability to judge the value of new information on the evidence presented to me.	3.21	Agree
8. I have developed a more focused and systematic way of calculating problem-solving.	3.00	Agree
9. I have learned more about how to approach complex questions in a variety of ways.	2.92	Agree
10. I can apply the knowledge that I learned to solve new problems.	3.32	Strongly Agree
11. I can apply the necessary information for each stage of problem-solving and decision-making.	3.29	Strongly Agree
12. I can use basic mathematical skills to help solve real-world problems.	3.39	Strongly Agree
13. My interest in issues and questions related to the subject area has increased.	3.16	Agree
14. The instructors encouraged me to explore the ideas, theories, assumptions, and solutions to the problem.	3.18	Agree
15. The instructor properly used practical examples and tips for a better understanding of problems.	3.11	Agree
GRAND MEAN	3.17	AGREE

These findings are affirmed by Lim (2016) when his study revealed that the use of modules gives the teacher more time to deal with the students on a one-on-one basis. She found out that the performance was better in the experimental group exposed to modular instruction. Additionally, Chisholm et al. (1988) explained that Self-instructional materials develop the self-esteem of learners and give them a confidence boost. This is possible because the learners are given the framework within which to think things out for themselves. Learning with modules has been renewed along with the progress of the time increasing the rate of student learning but not sufficient enough to extend. Yet, still, the Self-Learning Module encourages higher-order thinking skills, one aspect of problem-solving (Karenina et al., 2020).

3.2. Level of critical thinking skills of students in analysis exposed to self-learning module

As shown in **Table 6** are the Grade 9 students from Bai Saripinang NHS responses for Analysis of Critical Thinking skills that were exposed to the Self-Learning module. The data results reveal all mean scores have a verbal description of "Agree". The highest mean score of 3.24 was found in item number 2 which implies students who used the modular method developed good competencies in learning more about how to justify certain procedures that need to analyze in the subject area undertaken. On the other hand, the lowest mean score of 2.82 is found in item number 15 but still with a verbal description of "Agree", which indicates that the assessments in modular learning cannot enhance their abilities and provides sufficient activities to increase students' skills.

Table 6 shows the grand mean of all items is 3.08 which has a verbal description of "Agree" and can be interpreted as "Student's level of Critical thinking skills in Analysis who are exposed to Self-Learning Module is Average". From that result it can be gleaned that using the Self-Learning Module in chemistry subject, students are quite good with modular learning based on the quality in ensuring learning because students learn independently which increased their ability in analyzing and evaluating the information.

Table 6. Provides the Mean score level of the respondents' Critical Thinking Skills in Analysis exposed to the Self-Learning Module.

Description of Students' Responses on Analysis of Critical Thinking Skills	MEAN	Verbal Description
1. I have developed a more open-minded approach to interpreting and analyzing the information correctly.	3.21	Agree
2. I have learned more about how to justify why certain procedures are undertaken in my subject area.	3.24	Agree
3. I have learned more about how to analyze the key issues in my subject area	3.21	Agree
4. I have seldom found myself actively engaged in thinking about complex issues.	3.13	Agree
5. I can gather relevant and sufficient information from different sources.	3.05	Agree
6. I can compare the value or worth of two competing explanations.	3.00	Agree
7. I can thoroughly assess the quality of information.	3.05	Agree
8. I can identify the details that are necessary to answer a science inquiry question.	3.08	Agree
9. I can understand how knowledge or insights might transfer to other situations.	3.11	Agree
10. I can summarize a pattern of information without making inappropriate interference.	3.16	Agree
11. I can evaluate the facts and make an acceptable assumption from the factor.	2.95	Agree
12. I can able to explain one element or factor that is comparable or similar to another.	3.13	Agree
13. Most tutors have encouraged me to explain and analyze the ideas and theories related to the subject area.	3.18	Agree
14. Most tutors have not demonstrated how to think and express myself more reasonably, objectively, and in an evaluative way.	2.89	Agree
15. Most assessments have not stretched my intellectual abilities.	2.82	Agree
GRAND MEAN	3.08	AGREE

According to [Sundari et al. \(2020\)](#), they describe modules as materials that make students work independently. The use of modules plays an important role in the learning process by

increasing the efficiency and effectiveness of learning in schools. Analytical thinking-based modules contain daily phenomena and cases, so students are actively involved in learning.

3.3. Level of Critical Thinking Skills of Students in Problem-solving exposed to Online Learning through Google Classroom

Table 7 shows the results of data gathered from students of Grade 9 Lebak NHS- Villamonte who are exposed to Online Learning through Google Classroom. The data presented are based on students' critical thinking skills when it comes to problem-solving. Most of the responses of students are under into "Strongly Agree" descriptive rating. The highest rating of the mean score is 3.62 described as "Strongly Agree" found in item number 1, it portrays that the Online Learning on Google Classroom increased student's Critical thinking skills based on the quantities of appropriate information presented online because online learning students are allowed to ask vague information and do some discussion to clearly understand the lesson. The second highest mean score is item number 10 which has 3.59 with a "Strongly Agree" descriptive rating.

It indicates that students learning online confidently apply the knowledge that they learned to solve new problems. Exposing students online also increases and improves the ability of students to fathom new information which is shown in item number 7 with a 3.56 mean score that has still a "Strongly Agree" descriptive rating. It reveals that it is easy for students to determine the information presented and provides strong decision-making skills as learning the chemistry subject online.

The lower rating of 3.15 found in item number 8 with a verbal description of "Agree", implies that developing a more focused and systematic way of calculating problem solving online is good but not good enough because learning online is prone to distraction that distracts students' attention causing them to be unfocused.

Furthermore, the data also reveals the result of the grand mean for students' level problem-solving learning online which obtained of 3.38 rating and was described as "Strongly Agree". The result is interpreted as "Student's level of Critical thinking skills in Problem Solving who are exposed to Online Learning through Google Classroom is high". It means that using Online Google Classroom provides students with adequate information to understand the lesson because there is a collaborative discussion between students and teacher. Data also reveals that using Google Classroom is an effective method of teaching to enhance students' critical thinking skills in the area of problem-solving which increased students' interest in issues and questions related to chemistry subjects.

As supported by [Lee et al. \(2016\)](#) using online learning and an e-collaboration tool could encourage students' scientific inquiries and enhance problem-solving skills as well as set up a healthy communication culture among teachers and students. Collaborative activities help promote the problem-solving skills of participants by enabling them to work together on problems that are difficult to solve individually. In online collaboration, learners can structure their knowledge collaboratively as communications keep articulating, and create knowledge and meanings of learning, enhance higher cognitive thinking abilities, such as critical thinking and communication skills, while attempting to achieve their common goal ([Tutty & Klein, 2008](#)).

3.4. Level of Critical Thinking Skills of Students in Analysis exposed to Online Learning through Google Classroom

Table 8 presented the result of mean scores of students' responses from Lebak NHS-Villamonte for Analysis of critical thinking skills using online learning through the google

classroom method. The highest mean score is found in item number 5. It has 3.53 with a descriptive rating of "Strongly Agree". It means that students who are exposed to online learning on Google Classroom have a high ability to gather relevant and sufficient information from different sources considering that surfing online is an easy way to have access to different information by just clicking and typing words. The second-highest mean score is on item number 1 which has a 3.47 rating with a verbal description of "Strongly Agree". It reveals that online learning develops more students to become excellent in interpreting and analyzing the information correctly as students and teachers do collaborative discussions online. Another result that has a "Strongly Agree" verbal description is revealed on item number 9 with a 3.38 mean score. It provides information that the students who are exposed to Google Classroom have a high level of understanding or knowledge that is being transferred to some situations. It implies that online learning widens students learning because the teacher explains and illustrate applicable situation for the students to understand the lesson deeply.

Table 7. Provides the Mean score level of the respondents' Critical Thinking Skills in Problem Solving exposed to Online Learning through Google Classroom.

Description of Students' Responses on Problem Solving of Critical Thinking Skills	MEAN	Verbal Description
1. The quantities of the presented information were appropriate to enhance my problem-solving skills.	3.62	Strongly Agree
2. I can understand and interpret the meaning of a problem.	3.38	Strongly Agree
3. I focus on all the alternatives that may be appropriate to solve the problem.	3.41	Strongly Agree
4. I can use a structured and organized way of analyzing and assessing a problem thoroughly.	3.24	Agree
5. I can analyze all facts and put them in systematic order.	3.21	Agree
6. I can determine the differences in solution at each stage.	3.18	Agree
7. I have improved my ability to judge the value of new information on the evidence presented to me.	3.56	Strongly Agree
8. I have developed a more focused and systematic way of calculating problem-solving.	3.15	Agree
9. I have learned more about how to approach complex questions in a variety of ways.	3.21	Agree
10. I can apply the knowledge that I learned to solve new problems.	3.59	Strongly Agree
11. I can apply the necessary information for each stage of problem-solving and decision-making.	3.47	Strongly Agree
12. I can use basic mathematical skills to help solve real-world problems.	3.53	Strongly Agree
13. My interest in issues and questions related to the subject area has increased.	3.38	Strongly Agree
14. The instructors encouraged me to explore the ideas, theories, assumptions, and solutions for the problem.	3.50	Strongly Agree
15. The instructor properly used practical examples and tips for a better understanding of problems.	3.24	Agree
Grand Mean	3.38	Strongly Agree

On the other hand, the lowest rating presented in **Table 8** was found in item number 14. It has a 2.91 mean score described as "Agree". It indicates that tutors or teachers online do not allow students to express themselves freely, reasonably, and objectively in answering the question. Rather, instead, teachers allow students to express what is on their minds as they critically analyze the information.

Further, it shows that the student's level in Analysis shows a grand mean of 3.25 with a verbal description of "Agree". It can be interpreted as "Student's level of Critical thinking skills in Analysis who are exposed to Online learning through Google Classroom is Average." It can also be drawn from the findings that for students, online learning is quite effective as to increase student's critical thinking in Analysis because they participate in an online discussion which improves student's ability to interpret and understand the information correctly.

Table 8. Provides the Mean score level of the respondents' Critical Thinking Skills in Analysis exposed to Online Learning through Google Classroom.

Description of Students' Responses on Analysis of Critical Thinking Skills	MEAN	Verbal Description
1. I have developed a more open-minded approach to interpreting and analyzing the information correctly.	3.47	Strongly Agree
2. I have learned more about how to justify why certain procedures are undertaken in my subject area.	3.26	Strongly Agree
3. I have learned more about how to analyze the key issues in my subject area	3.26	Strongly Agree
4. I have seldom found myself actively engaged in thinking about complex issues.	3.32	Strongly Agree
5. I can gather relevant and sufficient information from different sources.	3.53	Strongly Agree
6. I can compare the value or worth of two competing explanations.	3.15	Agree
7. I can thoroughly assess the quality of information.	3.32	Strongly Agree
8. I can identify the details that are necessary to answer a science inquiry question.	3.29	Strongly Agree
9. I can understand how knowledge or insights might transfer to other situations.	3.38	Strongly Agree
10. I can summarize a pattern of information without making inappropriate interference.	3.12	Agree
11. I can evaluate the facts and make an acceptable assumption from the factor.	3.24	Agree
12. I can able to explain one element or factor that is comparable or similar to another.	3.21	Agree
13. Most tutors have encouraged me to explain and analyze the ideas and theories related to the subject area.	3.32	Strongly Agree
14. Most tutors have not demonstrated how to think and express myself more reasonably, objectively, and in an evaluative way	2.91	Agree
15. Most assessments have not stretched my intellectual abilities.	3.00	Agree
Grand Mean	3.25	Agree

These findings are affirmed by [Akyol et al. \(2009\)](#) when they demonstrated that online classes can be designed to achieve high levels of community of inquiry by incorporating assignments and exercises designed to promote communication and collaboration among learners. Students need to have frequent opportunities to interact with their intellectual community to enhance their knowledge construction. Collaborative learning contributes to building a community of inquiry and helps students develop their analytical and communication skills by requiring them to respond to the instructor and each other during group discussions ([Stover & Pollock, 2014](#)).

3.5. Significant Difference of the Critical Thinking Skills on Problem-solving of Online Learning through Google Classroom and Self-Learning Module.

Data in **Table 9** shows that the computed obtained t-test value was 3.85 Tested at a 0.05 level with a degree of freedom (df) equals 28, and the p-value was 0.000 which is less than

the significance level of 0.05. Thus, this leads to rejecting the null hypothesis formulated. It means that the use of Online Learning through Google Classroom is effective in improving the Problem-solving skills of students.

The results indicated that there was a substantial significant difference between levels of students' Critical Thinking Skills in Problem-solving. Thus, Online Learning through Google Classroom gained a higher mean compared to the Control Group. Further, it means that those students who have undergone Online Learning through Google Classroom may likely have better performance to enhance students critical thinking skills in Problem-solving than Self-Learning Module.

Table 9. Results of the T-test Analysis of Students' Critical Thinking Skills on Problem-solving in Online Learning through Google Classroom and Self-Learning Module.

Group (Problem-solving)	Mean	t- value	Degree of Freedom (df)	P- value
Online Learning through Google Classroom	3.38	3.85	28	0.00
Self-Learning Module	3.17			

Note: $p < .05$, significant

According to [Arend \(2009\)](#), identified methods of questioning or interacting with students in online discussions positively influenced critical thinking. As supported by [Malik et al. \(2019\)](#), online learning enhances students' interaction and collaboration in-class activities. Students discussed exercises with each other and shared their ideas about the programming domain. Online learning provided the correct solution for each question which helped students to critically analyze their solutions. Moreover, the online learning was focus-oriented because the students' mistakes (wrong steps) were immediately highlighted in their solution which helped them learn from their mistakes, while modular teaching motivated students to finish exercises at their convenience and time. However, online learning improved students' problem-solving skills, programming understanding, and logic capabilities more than the modular approach.

It is very evident that if students have meaningful and excellent online learning experiences, it reflects that the instructors' teaching strategy and method were effective. Effective teaching indeed has a direct effect and influence on students learning. The level of students learning of critical thinking skills lies in the effectiveness of the methods, strategy, and overall performance of teachers in facilitating learning. Instructors should formulate a learning environment that addresses students' needs and enhances students' engagement and participation which may contribute to increasing students learning and performance in chemistry.

3.6. Significant difference in the critical thinking skills on analysis of online learning through google classroom and self-learning module

Table 10 shows the comparison of the Critical Thinking Skills on Analysis of the two groups which were the Online through Google Classroom and Self-learning Module. As can be seen in table 10, the t-test value was 3.27 Tested at a 0.05 level with a degree of freedom (df) equals 28, and the p-value for the comparison of the two groups is 0.002, which is less than the significance level of 0.05. This indicates that there was a significant difference between the Critical thinking skills of students on Analysis. Thereby, rejecting the null hypothesis.

Further, it signifies that the level of Critical thinking skills on Analysis of students who are exposed to Online Learning through Google Classroom and Self-Learning Module has a

significant difference, therefore methods of teaching greatly affected or influenced the critical thinking skills of students on Analysis.

Table 10. Results of t-test analysis of the students' analytical skills in online learning through google classroom and self-learning module.

Group (Analysis)	Mean	t- value	Degree of Freedom (df)	P- value
Online Learning through Google Classroom	3.25	3.27	28	0.002
Self-Learning Module	3.08			

Note: $p < .05$, significant

"Good teaching" or "effective teaching" as the direction of the learning process so that desirable changes of a relatively permanent nature are brought about within the learner as a result of the instruction. He emphasized that effective instruction should result in the development of desirable attitudes, interests, ideals, appreciations, understandings, habits, and abilities.

Furthermore, good teaching is not only dependent on teaching strategies or their effectiveness but also depends on individual needs and the adequacy of the content. Dyer and Osborne (1995) in their study entitled "Effects of Teaching Approach on Achievement of Agricultural Education Students with Varying Learning Styles" proposed that the selection of an appropriate teaching approach is one of the most important processes to have teaching success and student achievement. students react differently to different teaching methods and that the selection of the proper method is critical to the learning style of those being served by the instruction. There is an assumption that students learn with different styles, at different speeds, with different levels of prior knowledge, and in different environments when the subject matter is given by way of a variety of teaching strategies.

3.7. Discussion

Experts on the education of the youth declared that when a deficit in concept or skill development is found, immediate interventions must be made to ensure that the child continues to make progress on that particular standard. Learning strategies are instructional strategies that have been developed to assist students with learning difficulties. Learning strategies include the use of Videos, Skype or ZOOM, Mimic the Wet Lab, and Instructional Resources, adding enriching activities and assigning a capstone experience.

The importance of the appropriate use of methods and learning strategies has been recognized in the different levels of schooling, (Boruchovitch & Santos, 2015). Research has shown that students who do not use effective methods and learning strategies have little concern for their difficulties, do not adequately manage time, do not know strategies to prepare for tests, and have little metacognitive knowledge.

Recently, a study was conducted to determine the effective methods of teaching to enhance the students' Critical thinking skills in Chemistry. Findings show that Online Learning through Google Classroom has better performance to improve students' Critical thinking skills than Self-learning Module. The intervention variable for the development of self-regulated learning strategies concluded that with this intervention, it would be possible to produce an incremental effect for good academic performance (Zollanvari et al., 2017).

Moreover, the learning intervention strategies tend to re-teach the topics in science that are not so clear to the learners and to help them gain a wide understanding. Intervention

strategies contain four parts such as the use of videos, use of instructional resources, adding enriching activities, and assigning a capstone experience. The parts are:

- (i) The Use Videos. It engages students and reinforces the topic content with audio, video, and images that support the students' myriad learning styles.
- (ii) The Use of Instructional Resources. It reviews the wealth of online instructional resources. These provide great lectures, such as Youtube, TED, Khan Academy, and webcast. Berkeley, etc.
- (iii) The Add Enriching Activities. It provides exercises, drills, or activities that allow pupils to assess their understanding of what they have learned correct errors when appropriate and monitor their learning and use feedback about their progress.
- (iv) Finally, the Assign of a Capstone Experience. It provides students to integrate their skills, methodology, and knowledge learned, and demonstrate it in a project where they analyze and evaluate the experience.

Such purpose of using this strategic intervention in teaching modular is to improve students' critical thinking skills and gain a more comprehensive understanding of studying science. In conclusion, the expected outputs are:

- (i) Learners must be equipped with knowledge, skills, and attitude in process of learning intervention strategies to improve their scores of the students.
- (ii) Produced highly appropriate learning intervention strategies.

The main problem of this study was to determine the effect of the Online Learning through Google Classroom and Self-Learning Module in Critical Thinking Skills in Chemistry on Grade 9 students. The study utilized the Experimental research design. It examined the effect of Online Learning through Google Classroom and Self-Learning Module on students' Critical Thinking Skills. The subject of the study was seventy-two Grade 9 students; wherein there were thirty-eight students from Bai Saripinang NHS and thirty-four students from Lebak NHS-Villamonte. A purposive sampling technique was used in selecting the respondents of the study. A thirty-items survey questionnaire was used to determine the critical thinking skills of students. The survey was divided into two categories, Problem-solving and Analysis. The approaches used in the conduct of the study were Online Learning through Google Classroom and Self-Learning Module. Statistical tools used in the conduct of the study were the Independent sample t-test. The following findings were established based on the analysis of the results of the study. The level of critical thinking skills of Grade 9 students of Bai Saripinang National High School in Problem-solving obtained a grand mean of 3.17 with a verbal description of "Agree". This shows that the student's level of critical thinking skills in Problem-solving who are exposed to the Self-Learning Module is Average. On the other hand, the level of Analytical skills of students the grand mean resulted to 3.08 which still has a verbal description of "Agree". This shows that students' level of critical thinking skills in Analysis who are exposed to Self-Learning Module is Average". The Grade 9 students of Lebak National High School-Villamonte that are exposed to Online Learning through Google Classroom have 3.38 grand mean for Problem-solving which describes as "Strongly Agree". This indicates that the student's level of critical thinking skills in Problem-solving who are exposed to Online Learning through Google Classroom is High. The student's level of critical thinking skills on Analysis obtained a grand mean of 3.25 with a verbal description of "Agree". This means that the student's level of critical thinking skills in Analysis who are exposed to Online Learning through Google Classroom is Average.

There was a significant difference in the level of critical thinking skills in Problem-solving of the students' in Online Learning through Google Classroom and Self-Learning Module. Thus, Online Learning through Google Classroom gained higher mean compared to those under the

Self-Learning Module. This implies that Online Learning through Google Classroom likely have better performance to enhance student's critical thinking skills on Problem-solving.

Similarly, there was also a significant difference in the critical thinking skills in the Analysis of students who are exposed to Online Learning through Google Classroom and Self-Learning Module even though Online Learning through Google Classroom and Self-learning Module both have "Agree" results. This implies that students' level of critical thinking skills is Average yet the Online Learning through Google Classroom was close to the "Strongly Agree" range value and gained a higher mean as compared to those under the Self-Learning Module. This signifies that the methods of teaching greatly affected or influenced the critical thinking skills of students on Analysis in Chemistry.

Findings reveal that the level of students' learning of critical thinking skills lies in the effectiveness of the methods. Thus, we proposed interventions to improve the critical thinking skills of students in the Self-Learning Module.

4. CONCLUSION

Based on the foregoing findings, the following conclusions are hereby formulated. The level of the student's critical thinking skills in Problem-solving using Online Learning through Google Classroom was "High" compared to Self-Learning Module. This implies that Online Learning through Google Classroom is effective to enhance students' critical thinking skills in Problem-solving in Chemistry. For the critical thinking skills on Analysis, both teaching approaches resulted in "Average" yet the grand mean of Online Learning through Google Classroom is close to the range value of "Strongly Agree". It signifies that even though both methods of teaching resulted in an "Average" on the student's level of critical thinking skills, Online Learning through Google Classroom obtained a higher mean compared to Self-Learning Module. There was a significant difference in critical thinking skills in Problem-solving and Analysis of students who are exposed to Online Learning through Google Classroom and Self-Learning Module. Thus, Online Learning through Google Classroom gained a higher mean both on Problem-solving and Analysis as compared to those under the Self-Learning Module. It means that students performed better and enhance their critical thinking skills online. More importantly, this study confirms that the methods of teaching affect the student's level of critical thinking skills. Therefore, an intervention was being proposed and developed to increase students' critical thinking skills in Self-Learning Module. Lastly, the use of various teaching approaches indicates that students can easily acquire knowledge, skills, and insights and could also mean that better learning and greater participation can easily take place.

From the basis of the conclusion derived in this study, the following recommendations are proposed:

- (i) Teachers should expose their students to online learning aside from a modular approach to awaken their interest, thus promoting an effective teaching-learning atmosphere.
- (ii) The effect of switching from modular approaches to online learning on students' critical thinking skills must be monitored by the School Administration. As a consequence, immediate remedies and innovation will be considered and implemented.
- (iii) The findings of the study should be the basis to strengthen the use of effective teaching strategies in Chemistry in the Sultan Kudarat Division.
- (iv) Future we may use the result of this study as a basis to conduct similar research including the remaining elements of Critical thinking skills such as communication, observation, and interference, to better see the effectiveness of online learning approaches in studying science specifically, in the field of chemistry.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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