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Attributes that affect the level of analysis and logical knowledge of stem learners in general chemistry: Basis for action plan

Viernes Arlene G. [1,*] and John Rey B. Quiñones [2]

[1] *Department of Education, Pantabangan National High School, Pantabangan, Nueva Ecija 3124 Philippines.*
[2] *Department of Science Education, Graduate School, Nueva Ecija University of Science and Technology, Cabanatuan City 3100,Philippines.*

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Abstract

This study aimed to identify the factors that influence the level of analysis and logical knowledge of STEM learners in the subject of General Chemistry and propose an intervention plan based on the findings. The ability to analyze and think logically is crucial for the success of STEM learners, as it directly impacts their future academic pursuits. The study employed a researcher-made survey questionnaire to assess the main attributes affecting the level of analysis and logical knowledge among STEM learners in six secondary public schools in congressional district II. The results revealed that the learning environment has a significant impact on the students' ability to focus and improve their analysis and logical knowledge, with a weighted mean of 3.37 for the statement "I can focus in class when the classroom is conducive to learning." Additionally, the students' favorite subject was found to be significantly related to the availability of instructional resources, indicating a negative correlation with a value of (-0.150) and a very low positive correlation with a value of (0.002). Furthermore, learner's motivation demonstrated a significant interrelationship (correlation coefficient of 1.000) with students' cognitive ability (0.419**), medium of instruction (0.159**), learning environment (0.304**), and instructional resources (0.180**), suggesting that students who recognize the impact of learner's motivation on analysis and logical knowledge are more likely to acknowledge the influence of cognitive ability, medium of instruction, learning environment, and instructional resources as well. These findings provide valuable insights for the development of an intervention plan to enhance the level of analysis and logical knowledge among STEM learners in General Chemistry.

Keywords: STEM Learners; Logical Knowledge; Analysis; General Chemistry; Action Plan

1. Introduction

Science and technology inhabit a dominant position in the growth and progress of the nation. It helps in developing progress that leads to the advancement and success of a country. The Department of Education (DepEd) in the Philippines implemented the new K-12 Curriculum, which started in the school year 2012-2013 by virtue of Republic Act No. 10533 or the Enhanced Basic Education Law of 2013. The new science curriculum program includes much modernization in terms of planning competencies, integrating each branch of science in every grade level, mode of instruction, and learning pedagogies. Despite the positive feedback of studying science education, it has been observed that learners are fearful of studying the subject which will lead to low levels of critical thinking and logical knowledge. This implies the negative attitude and poor performance of learners in learning science and technology specifically the general chemistry subject.

* Corresponding author: Viernes Arlene G.

The General Chemistry subject is an essential part of the Senior High School (SHS) science, technology, engineering, and mathematics (STEM) curriculum. It provides students with a foundation in chemical concepts and principles that are critical for success in a wide range of STEM disciplines. However, despite its importance, many Senior High School STEM learners face difficulties in developing the necessary to analyze and logically evaluate chemical concepts.The low level of analysis encountered by senior high school learners in the General Chemistry subject is a critical issue that has a significant impact on their understanding of the subject and their future success in related fields. Many students struggle to navigate and understand concepts from the onset. With that being the case, with a weak foundation or overall negative impact of student outcomes at the onset of General Chemistry, this can begin to cause a down ripple effect further on throughout one's studies and overall career aspirations. General Chemistry is often regarded as being too quantitative; a quality that may deter students who do not have strong math skills. (Department of Education, 2016).

Finally, it does not address variances in students' high school chemistry preparation. Understanding General Chemistry details the fundamentals of general chemistry through a wide range of topics, relating the structure of atoms and molecules to the properties of matter will help to improve your intellectual needs, (Korchef, 2022).

Based on the (Department of Education, 2016), for students to be successful in General Chemistry Subject. They need to develop analytical thinking skills including the logical knowledge of the learners involves critical thinking skills in evaluation and application, since the General Chemistry competencies example indicated in MELCS are more on problem-solving, concepts that need to analyze and evaluate. The Subject Description of General Chemistry Subject according to K to 12 BASIC EDUCATION CURRICULUM SENIOR HIGH SCHOOL – SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS (STEM) SPECIALIZED SUBJECT is General Chemistry pertains to Composition, structure, and properties of matter; quantitative principles, kinetics, and energetic of transformations of matter; and fundamental concepts of organic chemistry. The competencies like Using the ideal gas equation to calculate pressure, volume, Temperature, or the number of moles of a gas and using Dalton's law of partial pressures to relate mole fraction and partial pressure of gases in a mixture.

According to a study by Sadera et al., 2020, his study regarding the Challenges Encountered by Junior High School Students in Learning Science: Basis for Action Plan. The study sought to ascertain the different challenges in learning science among Grade 9 students in junior high school under the K to 12 curriculum in the Philippines. The study found that the greatest challenge encountered by junior high school students in learning science is on the instructional resources and medium of instruction, the least is on the teacher characteristics and student motivation. The 9 students do not encounter challenges in learning science based on the survey results. However, the interview transcripts revealed that junior high school students encounter a myriad of challenges ranging from curriculum, cognitive ability, instructional resources, and learning environment.

The low level of analysis encountered by senior high school learners in the General Chemistry subject is a critical issue that has a significant impact on their understanding of the subject and their future success in related fields. The purpose of this study is to identify the main attributes that affect the level of analysis and logical knowledge of senior high school STEM learners in Pantabangan and to develop a comprehensive action plan to address this issue. The ultimate goal of this study is to empower senior high school learners with the skills and knowledge they need to succeed in general Chemistry subject and beyond.

2. Methodology

The research design used by the researcher is the descriptive survey method using the questionnaire as main instrument in gathering needed data.

2.1. Sampling Procedure

The researcher used the total enumeration which were composed of 23 from 11 STEM learners and 12 learners from 12 STEM in Carranglan national High school, 44 in 11 STEM learners and 27 in 12 STEM learners in Donya Juana Chioco National High School, 27 in 11 STEM learners and 6 in 12 STEM learners in Llanera National High School, 40 in 11 STEM learners and 19 in 12 STEM in Pantabangan National High School, 88 in 11 STEM learners and 93 in 12 STEM in Rizal National High School, 50 in 11 STEM learners and 17 in 12 STEM in Talugtog National High School.

The researcher made use of census or total enumeration procedure to determine the sample size. This is due to the small size of populations of the Science Technology Engineering and Mathematics strand or know as STEM. A census survey is a study of every unit, everyone or everything, in a population. It is known as a total enumeration, which means a complete count.

2.2. Respondents

The participants of the study were the Grade 11 STEM learners with total population of 272 and Grade 12 with the total population of 174, with the overall population of 446 learners that currently taking up and already took the General Chemistry Subject.

The researcher used the total enumeration which were composed of 23 from 11 STEM learners and 12 learners from 12 STEM in Carranglan national High school, 44 in 11 STEM learners and 27 in 12 STEM learners in Donya Juana Chioco National High School, 27 in 11 STEM learners and 6 in 12 STEM learners in Llanera National High School, 40 in 11 STEM learners and 19 in 12 STEM in Pantabangan National High School, 88 in 11 STEM learners and 93 in 12 STEM in Rizal National High School, 50 in 11 STEM learners and 17 in 12 STEM in Talugtog National High School.

The researcher made use of census or total enumeration procedure to determine the sample size. This is due to the small size of populations of the Science Technology Engineering and Mathematics strand or know as STEM. A census survey is a study of every unit, everyone or everything, in a population. It is known as a total enumeration, which means a complete count.

2.2.1. Research Site

This study was conducted in six (6) Public Secondary School in Congressional District II that has a STEM (Science Technology Engineering and Mathematics) Strand including Carranglan National High School, Donya Juana Chioco National High School, Llanera National High School, Pantabangan National High School, Rizal National High School, and Talugtog National High School during the S.Y. 2022-2023.

Table 1 Public secondary schools in congressional district ii that has a stem strand

Legend	School	Location
1	Carranglan National High School	Carranglan, Nueva Ecija
2	Donya Juana Chioco National High School	Lupao, Nueva Ecija
3	Llanera National High School	Llanera, Nueva Ecija
4	Pantabangan National High School	Pantabangan, Nueva Ecija
5	Rizal National High School	Rizal, Nueva Ecija
6	Talugtog National High School	Talugtog, Nueva Ecija

3. Results and Discussion

Table 2 Profile of the STEM learner-respondents

	Frequency	***Percentage***
Sex		
Male	204	45.7
Female	242	54.3
Total	446	100.0
Age		
16-17	305	68.4
18-19	140	31.4
20-21	1	0.2
22 and above	0	0
Total	446	100.0

Favorite Subject		
Earth and Life	65	14.6
General Mathematics	31	7.0
General Chemistry	140	31.4
Oral Communication	58	13.0
Calculus	78	17.5
Physical Science	5	1.1
Statistics and Probability	6	1.3
Personal Development	59	13.2
Others	4	0.9
Total	446	100.0
General Weighted Average		
98-100	1	0.2
95-97	18	4.0
90-94	328	73.5
85-89	99	22.2
Total	446	100.0

Table 2 presents the description of the profile of the STEM learners in terms of sex, age,Favorite Subjects and General Weighted Average,.

Table 2 shows the distribution of the learner-respondents according to sex. As shown in the table, 242 or 54.3% of them are females while 204 or 45.7 % of the learner-respondents are males. It is noticeably a female-dominated pool of learners in STEM strand. The findings imply that majority of the respondents were females, the STEM strand is female dominated strand with 54% of the population were females. It is supported by one of the verbatim of the STEM learner.

"I choose STEM as my strand since I'm qualified to enrol, and most of my classmates and friends are females and they are also in STEM strand."

According to (Philippine Commission on Women, 2014), recorded that women's education in the Philippines started way back in the 70s when there were more professionals in the field of education, natural sciences, and medical sciences, while on the other hand, humanities, social sciences, engineering, and agriculture were dominated by men. It is observed that majority of the women excel in terms of their career and education. Like the STEM learners majority of them is female that has 54.3% percent of the population.

They evaluate the longitudinal career outcomes of STEM doctoral women using numerous data sources, including the Survey of Earned Doctorates and the Survey of Doctoral Recipients. After receiving a Ph.D., they consider three types of careers: academic, academic non-tenure-track, and non-academic. They discover that STEM women are more likely than men to hold academic non-tenure-track posts, which are associated with worse job satisfaction and lower income. Differences in field of study, graduate school preparedness, and family structure only account for 35% of the gender disparity in non-tenure-track academic posts. (Rennane et al., 2022)

It may be observed in the Table 2 that out of 446 learner-respondents, 305 of them or 68.4% belong to 16-17 years old age bracket, 140 or 31.4% are aged 18-19 years old and only one or 0.2% belongs to 20-21 years old, and 0 % were recorded in the aged of 22 and above.The findings shows that majority population of the learners in senior high STEM is in the age group (16-17 years old) which is the right age for the grade 11 and grade 12 Senior high school learners.

Ducanes and Ocampo (2020) investigated how the Senior High School program, which added two more years to the basic education system, affected the school participation rates of 16 to 17-year-olds. They found that the program

increased the participation rate of this age group by at least 13 percentage points overall. Moreover, the program reduced the disparity in school participation between the poorest and richest quintile by about 10 percentage points, indicating that it benefited students from economically disadvantaged backgrounds more. They concluded that the Senior High School program was an effective education reform initiative that improved both the accessibility and equity of basic education. The current study builds on their research by exploring the factors that influence the enrollment of 16 and 17-year-old students in the Senior High School STEM curriculum. It is observed that STEM learners are in the right age of 16-17 years old and it is very minimal that there is an over age on their group.

Table 2 shows that majority of the STEM learners favorite subject is General Chemistry that has 140 or 31.4%, followed by Calculus with 78 or 17.5%, third is Earth and life with 65 or 14.6%, next is Personal Development with 59 or 13.2%, followed by Oral communication subject with 58 or 13.0&, General Mathematics has 31 or 14.6%, Statistics and Probability has 6 or 1.3%, next is Physical Science with 5 or 1.1% and last is the other subject like immersion with 4 or 0.9%. It means that most of the STEM learners like General Chemistry as their favorite subject in Senior High school based on the results of the study,it is rank one in their favorite subject with the total number of 140 which is 31.4%. These findings are supported by one of the verbatim statements of the respondent:

"General chemistry is one of my favorite subject because I'm good in computation and analysis."

Based on the result of the study, it proved that the learners of STEM like General Chemistry subject because it is more on computations and analysis.General Chemistry primarily concerned with imparting a technical understanding of chemistry ideas and principles to pupils (Lewis, 2020). They also promote problem-solving skills based on mathematics and logical thinking. Exams or quizzes are typically used to measure students' factual memory and problem-solving abilities in general chemistry topics. Some pupils may prefer oral communication.

Table 2 presents the profile of learners with respect to General Weighted Average shows that most of the STEM learners has 90-94 general weighted average with 328 or 73.5%, 85-89 has 99 or 22.2%,and 18 or 4.0 of them has an average of 85-89 and 1 or 0.2% has a general weighted average of 98-100.Based on the results, majority of the general weighted average of the STEM learners is 90-94 with the average of 73.5% or 328 of the population out of 446.These findings are supported by one of the verbatim statements of the respondent.

"I am making sure that my average will be 85 and above to maintain or keep STEM as my strand in Senior High."

The paper defines, explains, and discusses numerous aspects of classroom assessment, such as its definition, principles, aims, kinds, techniques, expectations, grading system, reporting system, and rules for promotion and retention. One of the document's goals for student achievement is a grade average of 85 or above for STEM students, highlighting the need for success in science, technology, engineering, and mathematics sectors. The publication also includes instructions for doing successful and ethical classroom assessments. (Department of Education, 2016).

Table 3 Attributes that affect the Level of Analysis and Logical knowledge of Senior High School STEM learners in General Chemistry

	Weighted Mean	**Verbal Description**
Learner's Motivation		
I enjoy learning chemistry when my teacher uses variety of teaching strategies in teaching General Chemistry.	3.23	Affect
My Teacher uses lively game as a motivation in the beginning of the lesson in General Chemistry to make it enjoyable.	2.69	Affect
My Teacher integrate other subject like English using riddle in General Chemistry subject to make it more interesting.	2.66	Affect
I enjoy learning General Chemistry concepts especially during laboratory activities.	3.06	Affect
I feel fulfillment when they answer the teachers question correctly during recitation or discussion in General Chemistry Subject. General weighted mean	3.18	Affect

	2.96	Affect
Student Cognitive Ability		
I Face difficulty sometimes in solving problems even when similar examples are given.	2.70	Affect
I Perform well in General Chemistry during experimentation and laboratory works.	2.62	Affect
I am Challenge in Analyzing the concepts in matters and its properties in General Chemistry.	2.84	Affect
I Learn things quickly in General Chemistry Subject when the examples given are based on experience.	2.89	Affect
I can easily remember lessons in General Chemistry Subject during hands on activity. General weighted mean	2.76 2.76	Affect Affect
Medium of Instruction		
It is easy for me to communicate my thoughts in Chemistry using Native language that leads to understanding the lesson.	2.76	Affect
My learning is positively affected by the use of language as a medium of instruction.	2.85	Affect
I have no problem in understanding some scientific terms and processes even my teacher did not translate it in Filipino or native language.	2.63	Affect
My teacher speaks most of the time in English in explaining our General Chemistry lessons so it is easy for me to analyze.	2.70	Affect
I face problems in expressing myself in English sometimes, since I am not allowed to speak in Filipino so I can share my thoughts in English to the class. General weighted mean	2.48 3.03	Moderately Affect Affect
Learning Environment		
I can focus to the class when the **c**lassroom is conducive for learning.	3.37	Highly Affect
My Classroom atmosphere nurture and inspire my participation in our chemistry class.	3.05	Affect
My classmates behavior in the classroom affects my learning in General Chemistry.	2.97	Affect
My classmates help me to concentrate and analyze the lesson in General Chemistry Subject.	2.92	Affect
I am not afraid in participating in the class and share my thoughts because of the good approach of my teacher.General weighted mean	2.81 3.03	Affect Affect
Instructional Resources		
Our school has an adequate laboratory facilities in conducting our laboratory experiments.	2.71	Affect
Our school have enough laboratory apparatuses and tools so the experimentation is possible to conduct.	2.66	Affect
My teacher uses unlimited instructional aids in teaching chemistry which makes chemistry teaching easy to understand.	2.65	Affect
Our school has sufficient learner's materials and other reference materials that leads to the availability of the content of the lesson.	2.78	Affect

My school support in purchasing other instructional resources in General Chemistry .	2.61	Affect
General Weighted mean	2.68	Affect

Scale	Range	Verbal Description	Verbal Interpretation
4	3.25-4.00	Highly Affect	Highly Affected
3	2.50-3.24	Affect	Affected
2	1.75-2.49	Moderately Affect	Moderate Affected

Table 3 shows the Attributes that affect the Level of Analysis and Logical knowledge of Senior High School STEM learners in General Chemistry Subject. In the attributes number 1 which is learners motivation, statement 1.1 I enjoy learning chemistry when my teacher uses variety of teaching strategies in teaching General Chemistry with the weighted mean of 3.23 or affect, in statement 1.2 My Teacher uses lively game as a motivation in the beginning of the lesson in General Chemistry to make it enjoyable with weighted mean of 2.69 or affect, the third statement in learners motivation is My Teacher integrate other subject like English using riddle in General Chemistry subject to make it more interesting with weighted mean of 2.66,next statement is I enjoy learning General Chemistry concepts especially during laboratory activities with weighted mean of 3.06 or affect and last statement under learners motivation is I feel fulfillment when they answer the teachers question correctly during recitation or discussion in General Chemistry Subject with weighted mean of 3.18 or affect the average mean of the attribute number one is 2.96 which means affect. The attributes number 2 is Students cognitive Ability, the statement number one is I Face difficulty sometimes in solving problems even when similar examples are given with weighted mean of 2.70 or affect, second statement under student cognitive ability is I Perform well in General Chemistry during experimentation and laboratory works with weighted mean of 2.62 or affect,statement number three is I am Challenge in Analyzing the concepts in matters and its properties in General Chemistry Subject with the weighted meaan of 2.84 or affect, statement number 4 is I Learn things quickly in General Chemistry Subject when the examples given are based on experience with weighted mean of 2.76 or affect and last statement under student cognitive ability is I can easily remember lessons in General Chemistry Subject during hands on activity with weighted mean of 2.76 with the average weighted mean if 2.76 or affect in attributes number 2. In the attributes number 3 which is medium of instruction, statement number one is It is easy for me to communicate my thoughts in Chemistry using Native language that leads to understanding the lesson with weighted mean of 2.76 or affect, statement number two under attributes number three is My learning is positively affected by the use of language as a medium of instruction with weighted mean of 2.85 or affect. Statement number three is I have no problem in understanding some scientific terms and processes even my teacher did not translate it in Filipino or native language with weighted mean of 2.63 or affect, statement number four is My teacher speaks most of the time in English in explaining our General Chemistry lessons so it is easy for me to analyze with weighted mean of 2.70 or affect, and last statement under attributes number three is I face problems in expressing myself in English sometimes, since I am not allowed to speak in Filipino so I can share my thoughts in English to the class with weighted mean of 2.43 or moderately affect, the total average weighted mean of attributes number three is 2.68 or affect. The attributes number four is learning environment,the statement number one is I can focus to the class when the **c**lassroom is conducive for learning with weighted mean of 3.37 or highly affect, statement number two is My Classroom atmosphere nurture and inspire my participation in our chemistry class with weighted mean of 3.05 or affect, statement number 3 is My classmates behavior in the classroom affects my learning in General Chemistry with weighted mean of 2.97 or affect, next statement number four is My classmates help me to concentrate and analyze the lesson in General Chemistry Subject with weighted average of 2.92 or affect, last statement is I am not afraid in participating in the class and share my thoughts because of the good approach of my teacher with weighted mean of 2.82, average weighted mean of 3.03 or affect under learning environment. Last attributes is Instructional Resources, statement number one is Our school has an adequate laboratory facilities in conducting our laboratory experiments with weighted mean of 2.71 or affect, statement number two is Our school have enough laboratory apparatuses and tools so the experimentation is possible to conduct with weighted mean of 2.66 or affect, third statement is My teacher uses unlimited instructional aids in teaching chemistry which makes chemistry teaching easy to understand with weighted mean of 2.65 or affect,fourth statement is Our school has sufficient learner's materials and other reference materials that leads to the availability of the content of the lesson with weighted mean of 2.78 or affect and last statement is My school support in purchasing other instructional resources in General Chemistry with weighted mean of 2.61 or affect, the average weighted mean of the attributes number five is 2.68 or affect.

Based on the findings of the study the attributes that mainly affect the level of analysis and logical knowledge of STEM learners in General Chemistry is the Learning environment in the statement 4.1 I can focus to the class when the **c**lassroom is conducive for learning that has a weighted mean of 3.37, that has a highly affect with verbal interpretation of Highly affected which means that the learning environment greatly affect the level of analysis and logical knowledge of STEM in general chemistry. The learners can learn and focus more to improve their level of analysis and logical knowledge if the classroom is conducive in learning. These findings are supported by one of the verbatim statements of the respondent:

"I can focus to the class or lesson if it is not too hot inside the classroom, if there is proper ventilation like enough electric fan for the learners and the lightning is good so I can read and see what is on the board."

Based on (Xu et al., 2022), the learning environment is defined in the article as the interaction between the instructor, students, material, learning process, and learning circumstance. The report also examines several learning theories and their application in educational settings. The results of the study states that a conducive learning environment is important in everyone's life and recommends several ways to make the learning environment more productive and competitive, such as enough financing, effective supervision, and frequent training.

According to the DepEd Order No. 037,s.2022, the reiteration of the implementation of Modular Distance Learning. This order said that the School Heads have the authority and responsibility to suspend in-person classes and use modular distance learning in cases of unfavorable weather and environment such as, but not limited to, extremely high temperature which may considerably affect the conduct of classroom learning and put the learners' health and well being at risk. This was important for the reason that conducive learning and the safety of the students were their top priorities.

Table 4 Significant Relationship between the Profile of the Respondents and the Attributes that Affect the Level of Analysis and Logical knowledge of Senior High School STEM Learners in General Chemistry.

			Gender	**Age**	**Favorite Subject**	**General Weighted Average**
Spearman's rho	Learner's Motivation	Correlation Coefficient	-0.040	-0.077	-0.083	0.012
		Sig. (2-tailed)	0.398	0.106	0.081	0.800
		N	446	446	446	446
	Student Cognitive Ability	Correlation Coefficient	0.045	-0.064	-0.060	-0.034
		Sig. (2-tailed)	0.342	0.180	0.206	0.470
		N	446	446	446	446
	Medium of Instruction	Correlation Coefficient	0.015	-0.050	-0.090	-0.010
		Sig. (2-tailed)	0.760	0.294	0.058	0.833
		N	446	446	446	446
	Learning Environment	Correlation Coefficient	-0.089	-0.067	-0.048	-0.069
		Sig. (2-tailed)	0.060	0.159	0.315	0.145
		N	446	446	446	446
	Instructional Resources	Correlation Coefficient	-0.001	-0.087	**-0.150****	0.072
		Sig. (2-tailed)	0.979	0.066	0.002	0.127
		N	446	446	446	446

The table below shows that the profile of the respondents in terms of gender has no significant relationship with the Learner's motivation [r=-0.040, Sig. (2 tailed)=0.398].The profile of the respondents in terms of gender has no significant relationship with the Student cognitive ability [r=-0.045, Sig. (2 tailed)=0.342].The profile of the respondents in terms of gender has no significant relationship with the Medium of instruction [r=0.015, Sig. (2 tailed)=0.760].The profile of the respondents in terms of gender has no significant relationship with the Learning environment [r=-0.089, Sig. (2 tailed)=0.060].The profile of the respondents in terms of gender has no significant relationship with the Instructional resources [r=-0.001, Sig. (2 tailed)=0.979].

It shows that the profile of the respondents in terms of age has no significant relationship with the Learner's motivation [r=-0.077, Sig. (2 tailed)=0.106].The profile of the respondents in terms of age has no significant relationship with the Students cognitive ability.[r=-0.064, Sig. (2 tailed)=0.180].The profile of the respondents in terms of age has no significant relationship with the Medium of instruction [r=-0.050, Sig. (2 tailed)=0.294].The profile of the respondents in terms of age has no significant relationship with the Learning environment [r=-0.067, Sig. (2 tailed)=0.159].The profile of the respondents in terms of age has no significant relationship with the Instructional resources [r=-0.087, Sig. (2 tailed)=0.066].

The table below shows that the profile of the respondents in terms of Favorite subject has no significant relationship with the Learner's motivation [r=-0.083, Sig. (2 tailed)=0.081].The profile of the respondents in terms of favorite subject has no significant relationship with the Students cognitive ability [r=-0.060, Sig. (2 tailed)=0.206].The profile of the respondents in terms of favorite subject has no significant relationship with the Medium of Instruction [r=-0.090, Sig. (2 tailed)=0.058].The profile of the respondents in terms of favorite subject has no significant relationship with the Learning environment [r=-0.048, Sig. (2 tailed)=0.315].The profile of the respondents in terms of favorite subject has a significant relationship with the Instructional Resources [r=-0.150, Sig. (2 tailed)=0.002].

It shows that the profile of the respondents in terms of General weighted average has no significant relationship with the Learner's motivation [r=0.012, Sig. (2 tailed)=0.800].The profile of the respondents in terms of General weighted average has no significant relationship with the Students cognitive ability [r=-0.034, Sig. (2 tailed)=0.470].The profile of the respondents in terms of General weighted average has no significant relationship with the Medium of Instruction [r=-0.010, Sig. (2 tailed)=0.833].The profile of the respondents in terms of General weighted average has no significant relationship with the Learning environment [r=-0.069, Sig. (2 tailed)=0.145].The profile of the respondents in terms of General weighted average has no significant relationship with the Instructional Resources [r=-0.072, Sig. (2 tailed)=0.127].

It means that the Favorite subject of students is significantly related with the instructional resources that has -0.150** as an attribute that affect the Level of Analysis and Logical knowledge of Senior High School STEM Learners in General Chemistry Subject. It is identified based on the results that general chemistry subject is first in the rank as their favorite subject, the more science teachers work with their instructional resources the more likely they boost their students interest to choose chemistry as their favorite subject that will lead to the improvement of their analysis and logical knowledge.These findings are supported by one of the verbatim statements of the respondent:

"My teacher in General Chemistry uses variety of instructional resources that make the lesson more interesting."

It means that the teacher in General Chemistry uses a lot of instructional materials in teaching that caught their learners attention to learn more about the lesson.The profile and other attributes are not significantly related.

The result of the study was supported by Wambui, 2013.Participation involve

s working with a partner or in a small group and brainstorming in order to create a stimulating learning environment. The role of instructional materials is to glue information into learners mind as what is seen is understood more than what is heard. During the formative years, learners add increasing qualities of knowledge to what is already learn through explorations as they grow and expand horizon on the quality of content mastered. To widen mastery of concepts, rich learning environment which is filled with a variety of instructional materials tend to foster faster acquisition of requisite skills for sustained learning and development. Such an environment should be enticing learners to observe, actively participate, make choices and experiment which in the process results in acquisition of additional knowledge.

Table 5 Significant interrelationships among the attributes that affect the Level of Analysis and Logical knowledge of Senior High School STEM Learners in General Chemistry Subject

			Learner's Motivation	**Student Cognitive Ability**	**Medium of Instruction**	**Learning Environment**	**Instructional Resources**
Spearman's rho	Learner's Motivation	Correlation Coefficient	1.000	0.419**	0.159**	0.304**	0.180**
		Sig. (2-tailed)	0.0	0.000	0.001	0.000	0.000
		N	446	446	446	446	446
	Student Cognitive Ability	Correlation Coefficient	0.419**	1.000	0.296**	0.302**	0.114*
		Sig. (2-tailed)	0.000	0.0	0.000	0.000	0.016
		N	446	446	446	446	446
	Medium of Instruction	Correlation Coefficient	0.159**	0.296**	1.000	0.264**	0.292**
		Sig. (2-tailed)	0.001	0.000	0.0	0.000	0.000
		N	446	446	446	446	446
	Learning Environment	Correlation Coefficient	0.304**	0.302**	0.264**	1.000	0.253**
		Sig. (2-tailed)	0.000	0.000	0.000	0.0	0.000
		N	446	446	446	446	446
	Instructional Resources	Correlation Coefficient	0.180**	0.114*	0.292**	0.253**	1.000
		Sig. (2-tailed)	0.000	0.016	0.000	0.000	0.0
		N	446	446	446	446	446

The table 5 shows Student Cognitive Ability has significant interrelationships to Learner's Motivation (r=0.419, P<0.01), interpreted as the correlation is significant at the 0.01 level (2-tailed). Student Cognitive Ability has significant interrelationships to Student Cognitive Ability (r=1.000), interpreted as perfect correlation. Student Cognitive Ability has significant interrelationships to Medium of Instruction (r=0.296, P<0.01), interpreted as the correlation is significant at the 0.01 level (2-tailed). Student Cognitive Ability has significant interrelationships to Learning Environment (r=0.302, P<0.01), interpreted as the correlation is significant at the 0.01 level (2-tailed). Student Cognitive Ability has significant interrelationships to Instructional Resources (r=0.114, P<0.05), interpreted as correlation is significant at the 0.05 level (2-tailed).

The table below shows Medium of Instruction has significant interrelationships to Learner's Motivation (r=0.159, P<0.01), interpreted as the correlation is significant at the 0.01 level (2-tailed). Medium of Instruction has significant interrelationships to Student Cognitive Ability (r=0.296, P<0.01), interpreted as the correlation is significant at the 0.01

level (2-tailed). Medium of Instruction has significant interrelationships to Medium of Instruction (r=1.000), interpreted as perfect correlation. Medium of Instruction has significant interrelationships to Learning Environment (r=0.264, P<0.01), interpreted as the correlation is significant at the 0.01 level (2-tailed). Medium of Instruction has significant interrelationships to Instructional Resources (r=0.292, P<0.01), interpreted as the correlation is significant at the 0.01 level (2-tailed).

Learning Environment has significant interrelationships to Learner's Motivation (r=0.304, P<0.01), interpreted as the correlation is significant at the 0.01 level (2-tailed). Learning Environment has significant interrelationships to Student Cognitive Ability (r=0.302, P<0.01), interpreted as the correlation is significant at the 0.01 level (2-tailed). Learning Environment has significant interrelationships to Medium of Instruction (r=0.264, P<0.01), interpreted as the correlation is significant at the 0.01 level (2-tailed). Learning Environment has significant interrelationships to Learning Environment (r=1.000), interpreted as perfect correlation. Learning Environment has significant interrelationships to Instructional Resources (r=0.253, P<0.01), interpreted as the correlation is significant at the 0.01 level (2-tailed).

Instructional Resources has significant interrelationships to Learner's Motivation (r=0.180, P<0.01), interpreted as the correlation is significant at the 0.01 level (2-tailed). Instructional Resources has significant interrelationships to Student Cognitive Ability (r=0.114, P<0.05), interpreted as the correlation is significant at the 0.05 level (2-tailed). Instructional Resources has significant interrelationships to Medium of Instruction (r=0.292, P<0.01), interpreted as the correlation is significant at the 0.01 level (2-tailed). Instructional Resources has significant interrelationships to Learning Environment (r=0.253, P<0.01), interpreted as the correlation is significant at the 0.01 level (2-tailed). Instructional Resources has significant interrelationships to Instructional Resources (r=1.000), interpreted as Perfect Correlation.

Based on the result of the study, learners motivation is the key to follow the other attributes that affect the level of analysis and logical knowledge of STEM Learners in General Chemistry Subject.These findings are supported by one of the verbatim statements of the respondent:

"Motivation is one of the important factors for the student like me to strive more to study in General Chemistry".

In addition based on the result of the study the Learner's motivation, student's cognitive ability, medium of instruction, learning environment, and instructional resources as attributes that affect the Level of Analysis and Logical knowledge in General Chemistry Subject are significantly interrelated. Students who perceive that learner's motivation can affect the level of Analysis and Logical knowledge of students in General Chemistry are more likely to see that student's cognitive ability, medium of instruction, learning environment, and instructional resources can affect as well.

According to Filgona, (2020).Motivation is an influential factor in the teaching-learning situations. The success of learning depends on whether or not the learners are motivated. Motivation drives learners in reaching learning goals. It is important to recognize the fact that motivating learning is a central element of good teaching. This implies that learners' motivation is probably the single most important element of learning. Learning is inherently hard work; it is pushing the brain to its limits, and thus can only happen with motivation. Students' motivation to learn is of special importance because students' mere presence in the class is of course, not a guarantee that students want to learn. It is only a sign that students live in a society where children are required to attend school. Highly motivated learners are likely to learn readily, and make any class fun to teach, while unmotivated learners may likely learn very little and generally make teaching painful and frustrating.

Student cognitive ability,it encompasses a range of mental skills and capabilities that contribute to learning and overall cognitive functioning. Cognitive abilities are not a single, uniform trait, but rather a combination of different cognitive skills that work together to shape how individuals understand and interact with the world. Students cognitive ability affect the level of analysis and logical knowledge of STEM learners in general chemistry subject, the learners ability to understand, analyze and solve the concept and problem in general chemistry. According to Kory M. Enneking et.al 2019, their study about General Chemistry Laboratory Curriculum: Impact on Students' Cognitive, Affective, and Psychomotor Learning.The laboratory has occupied an important place in the general chemistry curriculum for well over a century, despite the fact that many have voiced concern about its value and utility.

The medium of instruction has a moderately affect on the level of analysis and logical knowledge of STEM (Science, Technology, Engineering, and Mathematics) learners in the general chemistry subject. Different mediums of instruction, such as language, format, and teaching tools, can influence how students engage with the content and develop their analytical and logical thinking skills. According to Floris 2014, He suggest that both students and teachers acknowledge the important role of English in the world. However, both reported a host of problems with the implementation of EMI. In this paper, I would also suggest ways to deal with these from both institutional and curricular perspectives.

The learning environment plays a crucial role in shaping the logical knowledge of STEM (Science, Technology, Engineering, and Mathematics) learners. A well-designed learning environment can greatly enhance students' logical thinking skills, problem-solving abilities, and overall understanding of STEM concepts. An interactive and hands-on learning environment encourages students to actively participate in experiments, projects, and discussions. This engagement fosters critical thinking, as students analyze data, make observations, and draw logical conclusions.Based on (Xu et al., 2022), the learning environment is defined in the article as the interaction between the instructor, students, material, learning process, and learning circumstance. The report also examines several learning theories and their application in educational settings. The results of the study states that a conducive learning environment is important in everyone's life and recommends several ways to make the learning environment more productive and competitive, such as enough financing, effective supervision, and frequent training.

Instructional resources have an impact on the development of logical knowledge among STEM (Science, Technology, Engineering, and Mathematics) learners. These resources can significantly influence how well students understand complex STEM concepts, apply logical reasoning, and solve problems.STEM subjects often involve abstract concepts that can be challenging to grasp. Visual aids such as diagrams, models, and simulations help learners visualize these concepts, making them more accessible and understandable. Visual representations enable students to see the logical connections between different elements of a system or process.A CBLE typically includes different information resources (e.g., texts, illustrations, and help facilities) intended to support understanding and learning. These resources can be functionally differentiated into resources *representing* the subject matter (e.g., principles of geometry) and resources *supporting* the acquisition of the subject matter (Rolf Schwonke a et.al 2013).

Proposed Action Plan in Teaching General Chemistry Subject to Improve their level of Analysis and Logical Knowledge

There were 5 attributes that affect the level of analysis and logical knowledge of STEM learners based on the result of the study.

In respond to the findings of the study, the following Action plan is proposed:

Action plan in General Chemistry				
Concerns/ Strategies	Activities	Persons Involved	Time Frame	Success Indicator
Enhance students' problem-solving skills in complex chemistry scenarios.	Group work, problem solving and concept Activities, Relay activities	Teacher Learners	July and August, Semester break (National Learning camp- NLC)	Identify students skills and knowledge to develop the problem solving knowledge and skills for the learners development
Foster a deeper understanding of chemistry principles through critical analysis.	Revisit on how to construct a comprehensive lesson plan.	Teacher	August	Teachers will be able to create effective learning materials and plan comprehensive lesson delivery.
Promote engagement and motivation among STEM learners in the study of chemistry.	Develop concepts using multi-disciplinary strategies, and create lively activity	Teachers Learners	August to July	Learners may see the connections between science and other subject like English and PE

4. Conclusions

- Majority of the STEM learner-respondents were females, in the young age category of 16-17 years old, their favorite subject is General chemistry, most of the STEM learners has a general weighted average of 90-94.

- The attributes that mainly affect the level of analysis and logical knowledge of Senior High School STEM learners is identified as learning environment, where the learners can focus on class and they can analyze more and improve their logical knowledge if the environment is conducive to learning.
- Favorite subject of students is significantly related with the instructional resources as an attribute that affect the Level of Analysis and Logical knowledge of Senior High School STEM Learners in General Chemistry Subject. The rest of the variables are not significantly interrelated
- In the results it appeared that Learner's motivation, student's cognitive ability, medium of instruction, learning environment, and instructional resources as attributes that affect the Level of Analysis and Logical knowledge in General Chemistry Subject are significantly interrelated. Students who perceived that learner's motivation can affect the level of Analysis and Logical knowledge of students in General Chemistry are more likely to see that student's cognitive ability, medium of instruction, learning environment, and instructional resources can affect as well.
- The proposed action plan could serve as a helpful tool in improving the level of analysis and logical knowledge of Senior High School STEM learners in General Chemistry Subject.

Compliance with ethical standards

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Disclosure of conflict of interest

The author declares no conflict of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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