Extent of Knowledge Towards Green Chemistry of Science Teachers

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Abstract — This study aims to find out the extent of knowledge towards Green Chemistry of Science Teachers. Specifically, the study sought answers to provide a comprehensive description of the respondents' profile variables such as age, sex, location of residence, length of teaching experience, number of training/ seminars attended related to Green Chemistry and Environmental Science, and highest educational attainment. It also provided answers to the extent of knowledge of the teachers in Green Chemistry along with content, pedagogy, and attitude. These variables also tested significant relationships and differences between and among the respondents' profiles and their extent of knowledge in Green Chemistry. Analysis of these provided the researcher with an avenue to develop an intervention program to help the respondents strengthen their understanding of Green Chemistry.

The study utilized the descriptive survey as the research strategy. The respondents were 40 public Secondary School Science teachers of Cuyapo District, Schools Division of Nueva Ecija, during the School Year 2020-2021. They were selected based on the total enumeration scheme.

The researcher developed an instrument that five experts validated before being used to collect data. The data was acquired through the tool's administration, completed using Google Forms, and resulted in a 100% retrieval rate. Frequency counts, percentages, weighted averages, One-Way ANOVA, Chi-square test, Pearson-r Moment of Correlation, Point-Biserial Correlation, and Spearman-rho Correlation were all used to analyze the data collected from the respondents.

According to the findings, most of the respondents are under the 31-40 age range, females, living in municipal areas, teaching for 2-6 years, with no seminars/training in Green Chemistry and Environmental Science, and earned units in the master's degree. The majority of the respondents were highly knowledgeable of the field, with the most vital regard on the pedagogy and weakest under content.

Furthermore, the teachers' understanding of Green Chemistry discovered that their pedagogical knowledge varied significantly depending on their age and teaching experience. Along with their sex and training and seminars attended, they were found considerably different in their content knowledge. In contrast, statistical variation was found among them, along with attitudinal knowledge based on the seminars/training they attended.

As to the test of a significant relationship, the respondents' sex and highest educational attainment were correlated with their extent of pedagogical knowledge in Green Chemistry. The training and seminars they attended, on the other hand, were statistically associated with their breadth of expertise in Green Chemistry along with content, pedagogy, and attitude.

According to the findings, most respondents are female-dominated, earning units in the graduate studies programs who have not yet been exposed to green science professional development programs. They were found to have a broad knowledge of Green Chemistry, especially in pedagogy. There were significant differences in their levels of knowledge in Green Chemistry, primarily along with pedagogy and content relative to the respondent's age, sex, teaching experience, and professional development programs attended. A statistically significant relationship was found between the teachers' participation in training and seminars and their knowledge of Green Chemistry.

With these results, the study recommended that the teachers undergo professional development programs and enroll in graduate studies courses to enhance their understanding of the overall paradigm of Green Chemistry. Their superiors may consider the utilization of the proposed intervention program to strengthen their knowledge of Green Chemistry.

Keywords — Knowledge, Green Chemistry, Science teachers, Content, Pedagogy, Attitude

I. Introduction

Environmental problems are now rampant in all parts of the world. This issue is no longer confined to a single country but has evolved into a world's pressing issue concerning the status of ecological systems. The community of nations has realized the importance of good environmental management for the sake of protecting the Earth. Atmospheric changes have been observed dominantly across the areas of the globe, which caused changes in the global climatic system (Roberts, 2017). This change is mainly a result of various human activities such as continuous industrial development, burning of fossil fuel, and malpractices in agriculture. In support, according to Folbert (2016), the global heat index will rise by 3 to 5 °C during the following fifty years as global human energy demand increases and the global industry develops.

These situations show that the temperature rise would significantly affect man and Earth. Other forms of pollution became concerns of the global community, including plastic wastes, mining-related contamination, and poor soil quality (Indigo, 2017). These problems call for man to take action towards environmental conservation.

In the Philippines, pollution, especially in the degradation of air quality, became a concern of the government and the people, posing a threat to human health and significantly impacting the ecosystem and the environment. Its effect on the human body leads to various health-related diseases such as respiratory disease, decreased lung functions, cancers, eye, and throat irritation. Those most particularly vulnerable are the young and the old and those individuals with asthma and cardiopulmonary diseases. The ecosystem and the environment affect vegetation, reducing agricultural yields due to nitrogen dioxide (NO2) and sulfur oxide (SO2). Both elements create acid rain, which reduces products (Tejada, 2017).

Chemical pollutants such as industrial and agricultural chemicals likewise contribute to climate change. Sources of air pollution are anthropogenic and natural sources. Examples of

anthropogenic or artificial sources are chimneys, vehicle emissions, area sources emanating from forest fires, kaingin or burn and slash, and cigarette smoke. Examples of natural sources are those emitted by volcanoes. Air pollution has three levels of impact: local, regional, and global. If local, there is a need to measure pollutant criteria established by the government to determine exposure level every day to a specific limit and certain pollutants within a particular period (Aro, 2017). Particulate Matters (PM) are produced locally by motor vehicle, furnace, chimney combustion, and construction activities. These particulates are categorized into Total Suspended Particulate (TSP), an example of which is the booger that accumulates in the nostrils, PM 2.5, which are particles measuring less than 2.5 μm (micrometers). At the same time, PM 10 are particulate matters 10 micrometers or less in diameter. These particulate matters that affect the body may pass through the nasopharynx and tracheobronchial until the pulmonary system, depending on the pollutant an individual inhales. PM 2.5, often known as fine particles, is a hazardous substance that cannot be removed and instead accumulates in the lungs (Philippine Information Agency [PIA], 2017).

The Philippines, like any other country, views education as a valuable and critical tool for nation-building leading towards general sustainable development. This is stated in the Department of Education's (DepEd) basic values, which include Makatao, Maka-Diyos, Makakalikasan, and Makabansa (DepEd, 2013). With the inclusion of a value for the environment, The Philippine Educational Curriculum was shaped using a spiral progression approach, with some topics related to environmental protection and the use of scientific principles in chemistry to help solve problems related to environmental degradation.

As a significant learning area in the country's basic education level, Science is a valuable tool to advocate problem-based learning activities in solving daily environmental topics (Oloruntegbe, 2018). As an enabling field of knowledge, it allows people's initiatives for environmental problems to be realized. Thus, Science plays a critical role in displaying and executing various mechanisms to address environmental concerns and issues.

At present, there is already a growing campaign worldwide relevant to the need to achieve environmental sustainability and development. In the Philippine educational sector, all public and private schools in the elementary and secondary levels are encouraged to participate in responsible conservation of the environment, which is why academic supervisors and administrators enjoined their teachers to incorporate environmental principles into curricula and co-curricular executions (Hernando, 2017).

In particular, the Schools Division of Nueva Ecija supports this goal-driven activity from the national level. The Division hosts its annual Youth for Environment in Schools Organization (YES-O) Summit. These highlights various activities to promote environmental education and friendly competitions such as waste recycling, ecological video presentations, quiz bees, poster and slogan contests, public speaking, etc. Through these initiatives, the Division appreciated the Philippine Society for Youth Science Clubbers, Inc. as one of its pioneering schools, Dr. Ramon De Santos, brought home an award as Most Outstanding Science Club for Environment. However,

despite this recognition, the Division encounters several environmental problems such as a high plastic use rate, weak waste management program implementation, and localized poor air quality among selected areas (Schools Division of Nueva Ecija, 2019).

At the school level, the Calancuasan National High School, as the researcher's station of appointment, consistently implements the significant facets of curricular instruction and co-curricular activities aligned to broaden the students' understanding of protecting the environment. Along the co-curricular area, the school, through its YES-O Club, is implementing its annual action and innovative work plans to disseminate essential programs needed to intensify the students' participation towards environmental sustainability. Some of the programs implemented by the organization include "Mag-4R Tayo," "Basura Ko, Iuuwi Ko," "Conserve Electricity, More Money," "May Pag-asa sa Basura," and "Tayo Na, Galila: Alay sa Mundong Ina." However, the implementation of the stated projects is still at the developing level. This indicator showing the extent of effectiveness of the school's plans towards environmental protection supported the fact that the school has an enervated waste management program, high consumption of electricity, and frequent burning of waste materials.

In terms of curriculum implementation, science subjects at all grade levels incorporate environmentally-based concepts, such as solutions and renewable and non-renewable resources in Grade 7, the flow of energy and the impact of human activities in the ecosystem in Grade 8, a variety of carbon compounds, and global climate phenomena in Grade 9, and biodiversity and stability and chemical reactions in Grade 10. (DepEd, 2020). Within these curricular contents, teachers were observed at the on-time implementation of learning competencies as evidenced by the results of curriculum auditing conducted by the School Head and Master Teachers. However, effects of the administration of summative tests concerning those learning contents during School Year 2019-2020 recorded mean percentile scores of 57.75% and 54.55% in Grade 7, 59.95% and 59.00% in Grade 8, 63.25%, and 61.25% in Grade 9, and 60.10% and 59.35% in Grade 10, respectively. In addition, the delivery of those learning as mentioned earlier contents across the given areas and grade levels during School Year 2017-2018 resulted in the mean percentile scores of 57.45% and 54.35%, 65.35% and 58.75%, 59.95%, and 61.20%, and 60.25% and 60.00%, respectively. These performances of the students are way below the set target level of proficiency in the School Improvement Plan of the school, along with curriculum instruction at 75% (Calancuasan National High School [CNHS], 2019). And this means that the students' competency levels towards the given learning competencies show a non-desirable degree of proficiency and mastery. However, the teachers were able to implement the allocated budget of the curriculum entirely. This result had resulted in an alarming situation by which the academic unit of the school considered it a problem that needed an immediate solution. As a result of observations conducted to clarify the issue being raised by the low performances of the students in the administered tests, the leaders of the academic department of the school noted that teacher's competency in the teaching of the delivered curricular contents in Science is a factor affecting the said situation.

In this time of rapid development, the call for Green Chemistry becomes significant advocacy to combat the global environmental crisis problems. Dr. Luis Banua, National Economic and Development Authority Regional Director for CALABARZON, emphasized that establishing proper infrastructure for green chemistry and sustainable energy and pursuing sustainable energy solutions are two key strategies to realize the Philippines Environment vision. Pineda (2019) also agrees, stating that the country has a wide range of opportunities to focus on sustainable energy and Green Chemistry. With people's exposure to opportunities in pursuing sustainable energy and Green Chemistry, people can be inspired to highlight the reliable protection and preservation of the environment (Lapitan, 2019).

With a thorough analysis of the abovementioned discussions, the schools' practices relevant to the concepts and principles of Green Chemistry are evident to the curricular and co-curricular areas in terms of implementation. However, strategies and activities conducted by the school with the teachers' involvement and the students' performances as observed in the results of the administered tests show a gap. With this prevailing situation, the researcher felt compelled to study teachers' and students' attitudes, practices, and knowledge towards the principles of Green Chemistry.

The researcher's goal for this study is to involve herself in an investigation parallel to giving a clearer picture and explanation on the extent of knowledge of the teachers in applying the facets of Green Chemistry concerning green chemistry-based learning contents in the K to 12 Basic Education Curriculum. It is also expected to promote an information dissemination advocacy to learners, teachers, and stakeholders, resulting in a greater understanding of the community about Green Chemistry.

Moreover, this research will also provide Science teachers with a wide range of ideas on Chemistry and the environment. Also, ensuring that Green Chemistry is consistently integrated into education and daily life, promoting green-based principles and practical ideas that meet everyday needs without negatively impacting the environment or the Earth's ability to support life. This study will also showcase imperative reflections regarding the teachers' awareness of the growing field of Green Chemistry. It gears towards promoting this emerging field of chemistry in any aspect of life. Hence, this study aims to develop a new scheme for providing the academic community with a program to strengthen the faculties of Green Chemistry in education, industry, and scientific research.

Review of Related Literature

As to age, Miemban (2015) stated that the present profiling of teachers is mainly composed of teachers belonging to the young and old age brackets. Studies in Science Education also found that Science teachers are primarily composed of females who nurtured children (Obillo, 2014). The young teachers were observed to have idealistic perceptions towards them, and the old teachers utilized teacher-directed teaching. Meanwhile, Halili (2016) stressed that age, gender, and

educational background are irrelevant factors in teachers' pedagogical development along with the areas of Environmental Science and its related fields of study.

Along with the length of practice of the teachers in dealing with their profession, Heneroso (2017) found that teaching experience is one of the leading indicators that support teachers' engagement in the delivery of Science curricular contents and that pedagogical practices and content knowledge could be developed over time. Yanto (2016) also provided that science teachers become more knowledgeable and practical in applying science content as they spend more prolonged involvement in the field.

Gregorio's (2016) exposure to seminars and training, on the other hand, boosts teachers' awareness and understanding by providing them with practical exercises and circumstances to deal with. Also, according to Freyman (2017), teachers should be exposed to development programs such as seminars and training that increase their knowledge and skills on environmental campaigns and issues. This is especially true when integrating ecological concepts such as environmental protection and responsible natural and artificial resources to produce new output.

As to the residential locations, Oroseros (2013) found that barrio schools provide equal opportunities for male and female teachers to acquire plantilla positions in the government. In addition, barrio schools were studied by Generoso (2017) and found out that the majority of the teachers are residents of rural areas and stationed in a home-based plantilla. Further, it disclosed that the teachers' levels of educational attainment are concentrated on the minimal requirement in applying for entry in the public system of education at the basic education level. However, teachers are encouraged to undergo post-graduate studies to attain higher item classifications through equivalency reclassification systems and ranking schemes. In addition, Caranto (2017) emphasized that the residential status of teachers does not bear importance as to their level of acquisition of valuable practices and values concerning the protection of the environment.

Corollary to Generoso (2017), Michtelle (2017) revealed that educational attainment significantly impacts teachers' capability to become more specialized in their knowledge about science content. Teachers' beliefs, views, and practices become more objective and substantially affect their professional and personal lives. This discovery is likewise comparable to that of Valdez (2016) when he discovered that specialized degrees of educational attainment from bachelor's to post-graduate studies help teachers gain more technical ingenuity when dealing with the conceptual basis of environmental education. Hence, it resolved that education is positively correlated to widening teachers' pedagogical and practical knowledge, dispositions, and skills in acquiring and acculturating various environmental philosophies.

The investigation discovered that teachers' perception of Green Chemistry became an essential aspect of today's science curriculum. It involves interrelated discussions on Environmental Science, Chemistry, Biology, and Earth and Space Science, as Dela Cruz (2019) emphasized. This observation is backed up by Wully (2017) highlighted that green-based Science is becoming a prominent topic of scientific conversation among teachers and environmental

advocates as both groups try to increase proscience teachers' expertise and avoid the use of dangerous materials and substances in the environment. This led the investigation to stress the importance of focusing group discussion within the academic level to develop further a technical and practical approach towards elevating the environmental protection and preservation campaign.

Adding to the abovementioned discussion, Auliah, Muharram, and Mulyadi (2018) found that teachers of the Sauri District of Israel have minimal knowledge of the principles of Green Chemistry. Their agreement in integrating Green Chemistry into the learning process is related to derivative reduction, waste prevention, design for degradation, and safer solvent and auxiliaries. In addition, they found that teachers' philosophy of Green Chemistry impacts students' learning. This relative observation on the impact of the teacher's manner and approach in the delivery of the Green Chemistry lessons is a predictor of a turning point for the school's curricular program in Science to intensify its theoretical paradigm on science education based on multi-focal environmental principles. As a result, Burmeister and Ingo (2012) stated that embracing science education will increase sustainability difficulties in chemistry education.

Meanwhile, Ancheta (2015) found that government schools at the secondary level have strengthened their environmental awareness and initiatives by conducting school-based and divisional classes of YES-O programs. Teachers and students have higher actions in applying ecological materials and products. Indigenous materials have been adopted widely in joining competitions. However, Montaon (2015) encouraged renewable energy sources through solar-powered electricity generation. It is not utilized commonly in schools since public schools have lower financial capabilities to avail the materials for solar energy generation.

On the other hand, Promenante (2017) found that Science teachers highly regard Environmental Science concepts. This is due to their exposure in college and university classrooms, participation in Environmental Chemistry training and seminars, and other teaching experiences such as technical assistance from supervisors and other instructional coaches and mentors. The study also found out that teachers' level of application of the different environmental principles on the use of substances is observed at a moderate practice where principles relative to solar energy, recycling of waste materials, school gardening, and advocacy on waste minimization are commonly done at the school level and applied even at their homes. Teachers' high esteem for the principles of Green Chemistry focuses on the responsible use of synthetic processes in the generation of substances, the prevention of waste, and the avoidance of auxiliary chemicals.

Furthermore, Marquez (2019) discovered that teachers' esteem for several Green Chemistry principles and concepts across knowledge areas was high. Analysis of their performances in testing their knowledge on Green Chemistry concentrated mainly on techniques and historical background. Also, the study stressed that teachers emphasized their strong agreement on the minimization of wastes, environmentally-based processes on the processing of chemicals, and maximum utilization of synthetic methods and materials. Further, it concluded that the teachers have high practice in modeling and applying the principles of waste classification and recycling, classroom composting, water conservation, use of natural cleaning materials, and school

environmental program and committee organization. There was a significant relationship between teachers' knowledge and attitudes and an insignificant relationship between teachers' knowledge and practices. With another point of interest in Green Chemistry, Mendijar (2018) revealed in her study that teachers could effectively deliver the principal concepts of Green Chemistry in science classroom settings by integrating its concepts in issues that primarily involve environmental preservation and conservation. Assessment methods or tools must also be integrated with the ideas of Green Chemistry to see how students process information of their learning in ecological science concepts that engage them to apply the facets of responsible utilization of chemicals and resources.

Also, Dukgar (2017) stressed in his investigation of teachers' pedagogical skills in Green Chemistry that lecture-based discussions with laboratory applications can be a powerful medium to help students find the significance of studying this emerging field in Chemistry. Requiring students to do article reviews of research related to green chemistry is also considered a reflective form of learning for the students to see the scientific and real-world dimensions of the field. Likewise, Redentor (2019) gave another effective means of integrating green chemistry in actual science instruction by allowing students to do project-based performance tasks that require them to present tangible outputs of their learning. Furthermore, immersing the students in training avenues such as participation in environmental camps, forums, and other places of scientific convergence.

II. Methodology

This study was carried out and completed using the descriptive design of research to determine the extent of knowledge of the teacher-respondents towards the principles in green chemistry as to the content, pedagogy, and attitude. According to Fraenkel and Wallen (2012), descriptive design in education research is an effective way for a researcher to summarize the characteristics of individuals or groups such as abilities, preferences, behaviors, perceptions, and values. Similarly, Serrano (2016) stressed that descriptive research is an efficient investigation design. It is concerned with the researcher providing a clear image of the current aspects of the subjects under study. Specifically, the investigation was conducted using the facets of the descriptive survey method. Using this specific descriptive design of research, the researcher gathered the collective data dealing with the personal knowledge of the target respondents as to the different principles of green chemistry and the profile variables that are assumed to have significance on the study. Through this method, the researcher can have a greater understanding and a holistic view of the quantitative description of the teachers' perspectives in the aforementioned emerging field of modern chemistry.

In addition, this study utilized descriptive - correlational and comparative methods to allow the researcher to examine the relationship and difference between the profile variables of the teachers and their responses towards the principles of green chemistry and their knowledge, specifically on the areas of content and pedagogy, and attitude. Considering these processes involved in the study, the utilization of the descriptive design served as the basis in the formulation

of the Output of the study, highlighting an intervention program focused on supporting the teachers to become highly knowledgeable of the various aspects of green chemistry in science instruction.

Population and Locale of the Study

The participants in this study were the Junior and Senior High School teachers of the six public secondary schools of Cuyapo District, Cuyapo, Nueva Ecija. Total enumeration was utilized to determine the number of respondents in this study. Hence, as stated in the table on the next page, this study had 40 teacher-respondents.

Table 1

Distribution of Teacher-Respondents by School and High School Level

School	Junior High School Teachers	Senior High School Teachers	F	%
Baloy National High School	1	1	2	5.00
Calancuasan National High School	2	2	4	10.00%
Cuyapo National High School	10	3	13	32.50%
Dr. Ramon de Santos National High School	9	3	12	30.00%
Paitan National High School	3	1	4	10.00%
Salagusog National High School	3	2	5	12.50%
Total	28	12	40	100.00%

Data Collection Instruments

In gathering data, the researcher developed an instrument in the form of a questionnaire needed to collect the pertinent information relative to the respondents' profile variables and their extent of knowledge towards the principles of green chemistry.

The questionnaire developed is composed of two parts. Part I of the questionnaire comprises items relative to the teachers' profile variables. On the other hand, Part II of the questionnaire focuses on gathering data from respondents on their understanding of green chemistry, which is divided into three categories: content, pedagogy, and attitude. Each section had a total of ten (10) indicators. They covered the basic principles that serve as the foundation of green chemistry as an emerging field of Natural Science along with chemistry and Environmental Science. Indicators provided were answered by the respondents using a 5-point scaling system, as shown below.

Point Value	Description	Interpretation
5	Very Highly Knowledgeable (VHK)	The respondent has a full and comprehensive understanding of the meaning, essence, and emergence of the principle founded on green chemistry along with content, pedagogy, and attitude.
4	Highly Knowledgeable (HK)	The respondent has enough knowledge of the meaning, essence, and existence of the principle relating to green chemistry.
3	Moderately Knowledgeable (MK)	The respondent has a minimum concept relative to the given principle related to the content, pedagogy, and attitude.
2	Slightly Knowledgeable (SK)	The respondent has a limited background of the given content, pedagogy, and attitude.
1	Not Knowledgeable (NK)	The respondent has no idea of the given content, pedagogy, attitude related to green chemistry.

The researcher's tool went through a content validation process in instrument validation. The validation process was carried out with the help of experts with a broad understanding of green chemistry's fundamental and advanced principles. Two (2) university instructors in Environmental Science and chemistry, and three (3) high school teachers teaching Environmental Science, will be invited to validate the process' content. A separate evaluation sheet in the content validation of the instrument was used. Suggestions and recommendations for improvement provided by the validators will be intensively applied in the tool.

Data Collection Procedure

In administering the data-gathering instruments, the researcher secured a permit from the Office of the Schools Division Superintendent of the Schools Division of Nueva Ecija to help the tools to the target respondents. After obtaining permission from the Schools Division Superintendent, the researcher personally administered the instruments to the teacher-respondents by ensuring full cooperation with the school heads of the schools where the targets respondents are presently stationed.

Furthermore, the researcher informed the respondents that their personal information would be confidential. However, they were assured that the findings of the investigation would be presented to the Graduate School of Urdaneta City University's Oral Examination Committee on Thesis Writing. The instruments given to the respondents were all retrieved 100 percent of the time. Lastly, the teachers' responses were tallied and examined using appropriate statistical measures.

Treatment of Data

To ensure that the aims of this study will be achieved, the researcher utilized appropriate statistical tools to analyze the data pertinent to the research questions using the Statistical Packages for Social Science (SPSS) version 25 software.

The first specific question of this study, as it deals with the profile variables of the respondents, was treated with frequency count and percentage. The second specific question, which concerns the extent of knowledge of teacher-respondents in Green Chemistry, was treated with a weighted mean using the given point value - statistical limit-description scaling system of the breadth of understanding of Science teachers towards the principles of Green Chemistry.

Point Value	Statistical Limit	Description
5	4.21 - 5.00	Very Highly Knowledgeable (VHK)
4	3.41 - 4.20	Highly Knowledgeable (HK)
3	2.61 - 3.40	Moderately Knowledgeable (MK)
2	1.81 - 2.60	Slightly Knowledgeable (SK)
1	1.00 - 1.80	Not Knowledgeable (NK)

ANOVA and Chi-square test for the third question deals with significant differences between the extents of knowledge of the Science teachers in Green Chemistry across their profile characteristics. The significance level was .05.

For the significant relationship test as indicated in the fourth question, data were statistically analyzed using Pearson-r Moment of Correlation, Point-Biserial Correlation, and Spearman-rho Correlation at 0.05 level of significance. Also, the Pearson Correlation Coefficient Value was considered to interpret further whether there is a correlation between the variables. Lastly, the specific question concerning developing an intervention program to strengthen teachers' knowledge of Green Chemistry was answered based on the first four particular questions.

III. Results and Discussion

Problem 1: Profiles of the Junior and Senior High School Teachers of Cuyapo District

Table 2 shows the respondents' profiles' data, including age, sex, domicile, length of science teaching experience, number of training and seminars attended, and highest educational attainment.

Age. As observed in Table 2 on the next page, 42.50% of the Science teachers are within the 31 - 40 age bracket. Four of them were observed to indicate an age of 51 and above. The given finding shows that most of the science teachers in the secondary level of the Cuyapo District, both at the junior and senior high school levels, are composed of individuals preparing for the middle adulthood stage of life. Moreover, this also shows that these teachers still have a long way to go professionally in teaching, considering their willingness for professional development and other avenues for teacher enhancements.

Table 2
Distribution of the Respondents According to their Profile

Profile Variables		F(N=40)	%
A. Age	30 and below	10	25.00
	31- 40	17	42.50
	41 – 50	9	22.50
	51 and above	4	10.00
B. Sex			
	Male	7	17.50
	Female	33	82.50
C. Location of Residence			
	Municipality	40	100.00
	City	0	0.00
D. Length of Science Teaching Experience	1 year and below	2	5.00
	2 to 6 years	14	35.00
	7 to 11 years	11	27.50
	12 to 16 years	7	17.50
	17 to 21 years	4	10.00
	22 years and above	2	5.00
E. Number of Seminars/ Training Attended Related to Green Chemistry and Environmental Science	None	17	42.50
	1	10	25.00
	2	9	22.50
	3 and above	4	10.00
F. Highest Educational Attainment	B.S./A.B.	0	0.00
	M. A. / M. S. units	26	65.00
	M.A. / M.S.	8	20.00
	Ph. D. / Ed. D.	3	7.50
	Post-doctoral	3	7.50

According to Miemban (2015), teacher profiling consists primarily of instructors in the young and senior age groups. Also, Gehrt, Louie, and Osland (2015) supported the findings, stating that teachers preparing for late adulting dominate the teaching profession and have the better capability in modern teaching and executing non-conventional modes.

Sex. Eighty-three percent of the teacher-respondents are females, while 17.50% are males. The given findings show that female curriculum implementers dominate the population of the Public Secondary School Science teachers of Cuyapo District. Obillo's (2014) study confirms this

finding as he also stated in his research that female teachers populate science classes. Fispatrick (2018) went on to say that the fact that teaching covers the majority of the benefits women require supports a more significant proportion of female instructors in the field.

Location of Residence. One hundred percent of the Public Secondary School teachers of Cuyapo District are residents of municipalities in Nueva Ecija. This data indicates that all respondents reside in rural areas where agriculture is the primary mode of livelihood and industrialization is uncommon.

Length of Science Teaching Experience. Thirty-five percent of the respondents have 2- 6 years of teaching experience in implementing the science curriculum, and 27.50% of them were able to attain 7-11 years of science teaching experience in the field. This finding shows that a significant number of Science teachers in the Public Secondary Schools of Cuyapo District are still young in science curriculum implementation.

Number of Seminars/Training Attended Related to Green Chemistry and Environmental Science. Forty-three percent of the respondents have responded that they have not yet attended any professional development programs intended to intensify their understanding of the concepts involving Green Chemistry and Environmental Science. This finding only shows that the science teachers in the secondary schools of Cuyapo District have limited access to seminars and training focused on upskilling teachers in Green Chemistry and Environmental Science.

Highest Educational Attainment. Sixty-five percent of the respondents have earned academic units in the master's level for graduate studies program for teacher education. In contrast, 7.50% of them have attained post-doctoral studies in the field. This finding implies that many science teachers need to undergo immersion in a higher level of education by enrolling in graduate studies programs that could lead to their professional growth.

Problem 2: Extent of Knowledge of the Public Secondary School Science Teachers of Cuyapo District Towards Green Chemistry

Tables 3 to 6 of this section show the data gathered from the science teachers regarding their extent of knowledge towards Green Chemistry along with content, pedagogy, and attitude. Each tabular presentation shows the various indicators that precisely define the teachers' extent of expertise along with the areas of Green Chemistry.

Extent of Knowledge of the Science Teachers in Green Chemistry along Content. As indicated in Table 3 on the next page, the teacher-respondents described their understanding of Green Chemistry as moderately knowledgeable. (OWM 3.31).

With this finding, it can be concluded that the Science teachers of Cuyapo have shown a minimal level of content knowledge regarding the theoretical and conceptual dimensions of Green Chemistry as an emerging field of Physical Science. This indicates that the teachers must be built with further introduction and immersion in the concepts that make up the foundations of Green Chemistry.

Table 3
Extent of Knowledge of the Science Teachers in Green Chemistry Along with Content
n=40

As a Science teacher, I know that Green Chemistry …	**WM**	**D.E.**	**Rank**
1. involves the utilization of the principles aligned with the concept of responsible and safe use of chemicals and resources.	3.55	HK	2
2. advocates the attainment of environmental sustainability and the conservation and preservation of the planet Earth.	3.70	HK	1
3. emerges as a new approach requiring the innovative and conservative generation of more safe chemical reactions for workers and the environment.	3.48	HK	3
4. explores the potential of the concept 'Benign by Design' for chemical reactions.	3.18	MK	7.5
5. aim at collecting fundamental information on sustainable chemistry activities, processes, and techniques.	3.33	MK	4
6. does not address the possible implications of using renewable resources.	3.20	MK	5.5
7. involves the basic principles of prevention and safer chemistry for accident prevention.	3.20	MK	5.5
8. targets to help the United Nations in achieving its sustainable development goals.	3.15	MK	9.5
9. provides technologies and alternatives that are economically competitive for and advantageous to industry.	3.15	MK	9.5
10. operates according to the three pillars of sustainable development along with social, economic, and environmental areas.	3.18	MK	7.5
Overall Weighted Mean	**3.31**	**MK**	

Legend:
4.21 – 5.00	Very Highly Knowledgeable (VHK)
3.41 – 4.20	Highly Knowledgeable (HK)
2.61 – 3.40	Moderately Knowledgeable (MK)
1.81 – 2.60	Slightly Knowledgeable (SK)
1.00 – 1.80	Not Knowledgeable (NK)

Specific analysis of the given data shows that the respondents have provided their strongest points for their content knowledge in Green Chemistry, which are described as highly knowledgeable along the ideas of environmental sustainability emphasizing the importance of the preservation and conservation of Earth's natural resources (WM=3.70), responsible and safe use of chemicals and help in the fields of instruction, industrialization and other economically-related areas (WM=3.50), and the integration of new approach that is innovative and conservative in the utilization and generation of substances from chemical reactions being done at the laboratory and in the environment (WM=3.48).

The given findings show that Secondary Science teachers in Cuyapo District have a broad background and understanding of Green Chemistry principles, which promote the responsible and safe use of substances for a variety of purposes, environmental sustainability and development, and the use of inclusive approaches that include the safety of individuals working in laboratories and experimental fields. Considering such observations, it is possible to conclude that the teachers have displayed a desirable level of content knowledge of these concepts, emphasizing the significance of using substances and experimental procedures responsibly.

On the contrary, the respondents rated the rest of the table's indicators "moderately knowledgeable," which shows that the teachers have shown a limited background and understanding of the other foundation principles that make up green chemistry as a body of knowledge.

The specific analysis of those indicators described as moderately knowledgeable on the part of the teachers has shown some points where they were found at the weakest extent. These include their knowledge of green chemistry integrating the concepts of supporting the advocacies and campaign of the United Nations along with its development goals (WM=3.15), provision of technologies and alternatives with economic advantages (WM=3.15), exploration on the emerging concept of “Benign by Design” (WM=3.18), and the attainment of the three pillars of sustainable development (WM=3.18).

Extent of Knowledge of the Science Teachers in Green Chemistry along with Pedagogy. Table 4 below shows the teachers' level of knowledge in green chemistry along with pedagogy.

Table 4
Extent of Knowledge of the Science Teachers in Green Chemistry Along with Pedagogy
n=40

As a Science teacher, I know that teaching Green Chemistry…	WM	D.E.	Rank
1. can be done through integration of its concepts in the discussion using traditional and authentic methods of teaching.	4.15	HK	1.0
2. requires the application of science laboratory works.	4.13	HK	2.0
3. should be integrated into the teaching of environmental sustainability in science education.	4.08	HK	4.0
4. must be delivered using controversial issues for purposes of collaborative analysis and discussions.	3.70	HK	9.0
5. requires students to do a project-based performance that enables them to present outputs of understanding.	3.68	HK	10.0
6. is enhanced through the conduct of science investigatory projects.	3.78	HK	8.0
7. can be well-delivered through reviews of existing researches.	3.85	HK	7.0
8. involves exploratory field experiences such as visits to institutes and laboratories with an intensive focus on environmental sustainability.	4.10	HK	3.0
9. fosters the conduct of student training programs that focus on the wise and responsible utilization of resources in the environment.	3.95	HK	6.0
10. can be sustained through the administration of authentic assessments integrating concepts of resource utilization and environmental sustainability.	4.05	HK	5.0
Overall Weighted Mean	**3.95**	**HK**	

Legend:
4.21 - 5.00	Very Highly Knowledgeable (VHK)
3.41 - 4.20	Highly Knowledgeable (HK)
2.61 - 3.40	Moderately Knowledgeable (MK)
1.81 - 2.60	Slightly Knowledgeable (SK)
1.00 - 1.80	Not Knowledgeable (NK)

Teachers have rated themselves with a "highly knowledgeable" extent of knowledge on the pedagogical principles that make up the instruction of Green Chemistry, as supported by OWM 3.95. In general, this demonstrates that the teachers have already acquired a variety of pedagogical orientations concerning the delivery of content knowledge that encompasses the scope of Green Chemistry as an associated field of competence closely related to Environmental Science.

In a specific analysis of the data provided, it can be concluded that all the indicators relating to the pedagogical aspect of the extent of knowledge of the teacher-respondents in Green Chemistry were all rated as highly knowledgeable. Nonetheless, the teachers were found most substantial in terms of delivering Green Chemistry principles using traditional and authentic ways

of teaching (WM=4.15), applying concepts using science laboratory activities (WM=4.13), and immersing students in environmental sustainability field experiences (WM=4.10).

The given finding implies that the teachers of Cuyapo District already have a vast knowledge of pedagogy in the instruction of Green Chemistry and selection and utilization of appropriate instructional methodologies catering to the bulk of concepts that govern the discipline. They were found to showcase a great extent of knowledge in allowing their students to master Green Chemistry concepts by performing laboratory activities that would enable learners to discover the rationale behind each theory, principle, or law supporting Green Chemistry. Also, they were very aware of using a pedagogical guide in teaching Green Chemistry using field trips or experiences, making the students directly encounter the workings prevailing in the conceptual foundations of the field from the works of various institutes and laboratories.

However, the teachers were weakest in terms of their pedagogical knowledge in Green Chemistry along with the development and utilization of performance-based tasks for the presentation of outputs (x=3.68), delivery of contents using controversial issues for purposes of collaborative discussions (WM=3.70), and the conduct of research-based projects (WM=3.78). These indicators have shown that teachers need further strengthening mechanisms to develop themselves using other methods, especially requiring learners to do project-based learning.

Extent of Knowledge of the Science Teachers in Green Chemistry along with Attitude.

Table 5 below shows the level of knowledge of the science teachers in Green Chemistry along with attitude. The attitudinal indicators examined in the data provided were generally rated as "highly knowledgeable" by the teachers, with an overall weighted mean of 3.76, which shows that the teachers highly regard the indicators relating to the attitude aspect regarding Green Chemistry as a field. This denotes a desirable valuing of the teachers that emphasize individuals' regard for the area and various principles and theories.

Table 5
Extent of Knowledge of the Science Teachers in Green Chemistry Along with Attitude
n=40

As a Science teacher, I believe that Green Chemistry involves the concept that…	WM	D. E.	Rank
1. it is better to prevent waste than to treat or clean up waste after it has been created.	4.23	VHK	1.0
2. synthetic methods should be designed to maximize the incorporation of all materials used in the process into the final product.	4.10	HK	2.0
3. wherever practicable, synthetic methods should be designed to use and generate substances that possess little or no toxicity to human health and the environment.	4.08	HK	3.0
4. chemical products should be designed to affect their function while minimizing their toxicity.	3.85	HK	4.0
5. the use of auxiliary substances (e.g., solvent, separation agents, etc.) should be made unnecessary wherever possible and is harmless when used.	3.53	HK	8.0
6. energy requirements of chemical processes should be recognized for their environmental and economic impacts and should be minimized.	3.70	HK	6.0
7. chemicals should be renewable rather than other, equivalent chemicals originating from petrochemical sources.	3.60	HK	7.0
8. utilization of derivatives should be minimized or avoided, if possible because such steps require additional reagents and can generate waste.	3.40	HK	9.0
9. catalytic reagents should be used instead of stoichiometric reagents in reactions to reduce reaction times and energy demand.	3.35	MK	10.0
10. chemical products should be designed that can degrade and can be discarded easily.	3.80	HK	5.0
Overall Weighted Mean	**3.76**	**HK**	

Legend: 4.21 - 5.00 Very Highly Knowledgeable (VHK)
3.41 - 4.20 Highly Knowledgeable (HK)
2.61 - 3.40 Moderately Knowledgeable (MK)
1.81 - 2.60 Slightly Knowledgeable (SK)
1.00 - 1.80 Not Knowledgeable (NK)

Specific analysis of the given data reveals that the teachers were very highly knowledgeable, and the attitudinal indicator of Green Chemistry relates to the preference for the prevention of waste (WM=4.23). Also, they were found highly knowledgeable in designing synthetic methods in terms of their maximum utilization (WM=4.10) and the generation of non-toxic substances using artificial methods (WM=4.08).

Considering the given findings shows that the teachers are highly knowledgeable of the attitudes prevailing in the foundational principles of Green Chemistry, especially on developing ways to prevent the generation of a volume of wastes brought about by the consumption of resources. The teachers were also noted to showcase desirable attitudinal knowledge regarding promoting alternative methods of experimentation and processes that would lead to the maximum creation of final products that are not toxic to humans, the workplace, and the environment.

On the other hand, the teachers have rated themselves moderately knowledgeable with the utilization of catalytic reagents superior to other stoichiometric agents (WM=3.35). Also, they were found to be weakest in terms of having an attitudinal knowledge of green chemistry and minimization of unnecessary derivatization (WM=3.40) and the utilization of auxiliary substances (WM=3.53).

The findings reveal that the teachers need further to improve their affective understanding of some Green Chemistry principles to support the given field fully. These include having higher regard for the substances that provide a better level of changes in the reaction and avoiding using additional reagents that would generate a greater volume of waste materials.

Summary of the Extents of Knowledge of the Science Teachers in Green Chemistry.

Table 6 below summarizes the extent of knowledge in the field of Green Chemistry. The teachers' entire understanding of Green Chemistry was determined to be highly knowledgeable, as confirmed by the computed mean of 3.67. Even though the total extent is high, it still requires teachers to increase their knowledge of Green Chemistry, especially along with content.

Table 6
Summary of the Extents of Knowledge of the ScienceTeachers in Green Chemistry

Aspects	OWM	D. E.	Rank
Content	3.31	MK	3
Pedagogy	3.95	HK	1
Attitude	3.76	HK	2
Overall Weighted Mean	**3.67**	**HK**	

Legend: 4.21 - 5.00 Very Highly Knowledgeable (VHK)
3.41 - 4.20 Highly Knowledgeable (HK)
2.61 - 3.40 Moderately Knowledgeable (MK)
1.81 - 2.60 Slightly Knowledgeable (SK)
1.00 - 1.80 Not Knowledgeable (NK)

Along with the specific analysis of the given data, it can be gleaned from the table that the teachers were highly knowledgeable towards Green Chemistry along with pedagogy (x=3.95) and attitude (3.76). This finding implies that the teachers have relatively high regard and awareness of

the pedagogical approaches and attitudinal principles that govern the existence of Green Chemistry as a field under natural sciences.

Problem 3: Difference in the Extent of Knowledge of the Science Teachers in Green Chemistry Across their Profile Variables

Tables 7 to 11 are provided on the following pages to show the inferential analysis of the data relative to the test of difference in the extent of knowledge of the science teachers of Cuyapo District across their profile variables. However, the difference test along their residence location was no longer conducted since the data revealed similar characteristics.

The null hypothesis that " there isn't a significant difference between the extent of knowledge of science teachers across their profile variables" had been accepted in terms of their educational attainment. Meanwhile, the null hypothesis was rejected for the profile variables age, sex, length of teaching experience, and the number of Green Chemistry and Environmental Science training/seminars attended.

Table 7 below provides the analyzed data regarding the difference in science teachers' knowledge of Green Chemistry and their age variable.

As shown in the table, a p-value of .031 (F=1.320, df=39) was statistically computed along with the teachers' pedagogical knowledge towards Green Chemistry concerning their age variable. Since the calculated p-value is less than the .05 level of significance, it can be said there isn't a significant difference in the extent of knowledge of the science teachers on the pedagogical aspect of Green Chemistry as to their age. This demonstrates that respondents' understanding of the methodology and approaches of Green Chemistry instruction varies significantly depending on their age groups.

Table 7
Significant Difference in the Extent of Knowledge of Science Teachers in Green Chemistry According to their Age

Profile Variable	Aspects of Green Chemistry		Sum of Squares	df	Mean Square	F	Sig.
Age	Content	Between Groups	9.991	23	.434	1.320	.287
		Within Groups	5.265	16	.329		
		Total	15.256	39			
	Pedagogy	Between Groups	4.994	23	.217	2.509*	.031
		Within Groups	1.385	16	.087		
		Total	6.379	39			
	Attitude	Between Groups	5.186	23	.225	2.160	.058
		Within Groups	1.670	16	.104		
		Total	6.856	39			

Note: * - significant at .05 level of significance

On the other hand, the test of differences in the extents of science teachers' knowledge along the areas of content and attitude toward their age groups yielded p-values .287 (F=1.320, df=39) and.058 (F=.058, df=2.16), respectively. These data will support the observation that respondents did not show significant variation in their content and attitudinal knowledge of Green Chemistry when classified according to their age groups. Thus, those teachers belonging to the young, middle, and late adulthood stages have presented nearly similar awareness of Green Chemistry's thematic and behavioral aspects.

Findings imply that the age categories of the respondents have shown an essential observation that they differ significantly in terms of their ideas and utilization of the various pedagogical principles that best match their instruction of science concepts aligned with Green Chemistry. This meaningful variation in pedagogical knowledge of Green Chemistry has shown an essential indication that age is a contributory factor that influenced the teachers to gain greater awareness in the instructional delivery of Green Chemistry using effective teaching methodologies as they traverse the course of life.

Provided below is Table 8 showing the data regarding the test of significant difference in the extent of knowledge of the science teachers in Green Chemistry according to their sex.

Table 8
Significant Difference in the Extent of Knowledge of Science Teachers in Green Chemistry According to their Sex

Profile Variables	Aspects of Green Chemistry		Sum of Squares	Df	Mean Square	F	Sig.
	Content	Between Groups	.753	23	.753	5.084*	.030
		Within Groups	5.626	16	.148		
		Total	6.379	39			
Sex	Pedagogy	Between Groups	.306	23	.306	.779	.383
		Within Groups	14.950	16	.393		
		Total	15.256	39			
	Attitude	Between Groups	.116	23	.116	.656	.423
		Within Groups	6.740	16	.177		
		Total	6.856	39			

Note: * - significant at .05 level of significance

It can be gleaned from the provided table that calculated a p-value of .030 (F=5.084, df=39) on the test of difference in the extent of science teachers' knowledge towards Green Chemistry along the content area about their sex. The obtained p-value is less than.05, meaning that the respondents have supplied an implying difference in their understanding of the Green Chemistry learning contents. This means that male and female Science Teachers have significant variation

relative to their content knowledge of the various science concepts that promote wise selection and utilization of substances and resources and environmental sustainability.

On the other hand, p-values of .383 (F=.779, df=39) and .423 (F=.656, df=39) were computed referring to the test statistics on the inferential analysis of the difference of the pedagogical and attitudinal knowledge of the teacher-respondents on the principles of Green Chemistry. Since the p-values relative to the tests of difference in the extents of expertise of the teachers on Green Chemistry along pedagogy and attitude about their sex are higher than .05 level of significance, there is no significant difference among the data being tested. This means that male and female teachers have provided nearly similar knowledge on Green Chemistry's pedagogical and attitudinal aspects.

The provided findings imply that the sex of the respondents is a contributory factor in the observed difference relative to their content knowledge in Green Chemistry. However, the sex variable did not provide any evidence of influence in categorizing the male and female teachers with varying extents of expertise in Green Chemistry along with pedagogies and attitudinal principles.

On the other hand, Table 9 below shows the inferential analysis on the difference in the extent of respondents' knowledge towards Green Chemistry according to their length of teaching experience.

Table 9
Significant Difference in the Extent of Knowledge of Science Teachers in Green Chemistry According to their Length of Teaching Experience

Profile Variable	Aspects of Green Chemistry		Sum of Squares	Df	Mean Square	F	Sig.
Length of Teaching Experience	Content	Between Groups	9.308	17	.548	2.025	.060
		Within Groups	5.948	22	.270		
		Total	15.256	39			
	Pedagogy	Between Groups	4.232	17	.249	2.551*	.020
		Within Groups	2.147	22	.098		
		Total	6.739	39			
	Attitude	Between Groups	3.324	17	.190	1.155	.370
		Within Groups	3.623	22	.165		
		Total	6.856	39			

Note: * - significant at .05 level of significance

The test of difference in the level of pedagogical knowledge of the science teachers in green chemistry as referred by their length of teaching experience yielded a p-value of.020, as shown in

the table above. Considering that the computed p-value is less than the .05 level of significance, the teachers' knowledge of their teaching experience in Science on Green Chemistry shows a significant difference. This means that teachers with short, average, and long years of service in teaching science have observed that they vary in showcasing their knowledge in selecting and applying pedagogical principles that are important in the instruction of Green Chemistry.

On the other hand, p-values of .060 (F=2.025, df=39) and .370 (F=.377, df=1.155) were statistically computed relative to the tests of difference in the extents of knowledge of the respondents in the content and attitudinal areas of Green Chemistry, respectively, based on their length of teaching experience. These test statistics observe an insignificant difference in the science teachers' knowledge and the pedagogy and attitude aspects of Green Chemistry when their length of teaching experience is considered a reference for an inferential test of variation. This shows that the teachers, regardless of their experience in teaching Science, have similar knowledge in Green Chemistry and attitudinal views and pedagogical perspectives.

Table 10 below shows the considerable difference in teachers' knowledge in Green Chemistry based on the number of training and seminars related to Environmental Science.

Table 10
Significant Difference in the Extent of Knowledge of Science Teachers in Green Chemistry According to Number of Training/ Seminars they Attended Related to Green Chemistry and Environmental Science

Profile Variable	Aspects of Green Chemistry		Sum of Squares	df	Mean Square	F	Sig.
Number of Seminars/ Trainings Attended Related to Green Chemistry and Environmental Science	Content	Between Groups	3.532	4	.883	2.636*	.050
		Within Groups	11.724	35	.335		
		Total	15.256	39			
	Pedagogy	Between Groups	.952	4	.238	1.534	.214
		Within Groups	5.427	35	.155		
		Total	6.379	39			
	Attitude	Between Groups	2.370	4	.592	4.621*	.004
		Within Groups	4.486	35	.128		
		Total	6.856	39			

Note: * - significant at .05 level of significance

It can be gleaned from the table provided above that the p-values calculated for the tests of difference in the extents of knowledge of the teachers in Green Chemistry along content and attitude are .050 (F=2.636, df=39) and .004 (F=4.621, df=39), respectively, when their training and seminars in Green Chemistry and Environmental Science are considered as a basis for the inferential analysis of the variables being targeted. Considering that the given p-values are within

the area of .05 level of significance, it can be said that the teachers, when differentiated in terms of their participation in training and seminars related to Green Chemistry and Environmental Science, have shown significant differences relative to their content and attitudinal knowledge of the principles and concepts of Green Chemistry. This also indicates that these professional development programs they have attended can be considered a significant factor in gaining a package of regulations that would further enhance their regard for the content and attitudinal aspects of the given field of Chemistry.

On the other hand, a p-value of .241 (F=1.534, df=39) was computed relative to the test of difference in the extent of pedagogical knowledge of the teachers in Green Chemistry according to their immersion and involvement in training and seminars focused on Green Chemistry and Environmental Science. Since the computed p-value is less than .05 level of significance, it can be further said that the teachers did not significantly vary in terms of possessing a level of awareness on the aspects of acquiring teaching approaches and practices relative to Green Chemistry instruction when they are differentiated according to their participation in Green Chemistry-based professional enhancement programs.

Table 11 on the next page shows the significant difference in teachers' knowledge of Green Chemistry based on their highest educational level.

Table 11

Significant Difference in the Extent of Knowledge of Science Teachers in Green Chemistry According to their Highest Educational Attainment

Profile Variable	Test Statistics	Aspects of Green Chemistry		
		Content	Pedagogy	Attitude
Highest	Chi-square	.565	5.478	5.645
Educational	Df	3	3	3
Attainment	Asymp. Sig.	.904	.140	.130

Note: * - significant at .05 level of significance

The use of the chi-square test in analyzing the difference in the extent of knowledge of the science teachers towards Green Chemistry according to their highest educational attainment resulted in p-values such as .904 (x^2=.565, df=3), .140 (x^2=5.478, df=3), and .130 (x^2=5.645, df=3) along with content, pedagogy, and attitude, respectively. Given that all of the computed p-values are greater than the.05 levels of significance, it can be concluded that when the teachers were grouped according to their highest educational attainment, there was no significant difference in terms of their content, pedagogical, and attitudinal knowledge of Green Chemistry.

The provided findings further show that the teachers, regardless of their attainment in graduate studies, have presented nearly similar level of awareness that best represents their understanding of the conceptual, pedagogical, and behavioral aspects of Green Chemistry. Educational attainment, in this case, cannot be considered a contributory that influenced the

teachers to possess varied extents of knowledge of Green Chemistry relative to the aspects being investigated.

Problem 4: Relationship between the Extent of Knowledge of the Science Teachers in Green Chemistry and their Profile Variables

Tables 12 to 16 presents the data for the test of a significant relationship between Science teachers' Green Chemistry knowledge and their profile variables. The difference test was not conducted on the data about the extent of teachers' knowledge in Green Chemistry according to their residential location since they were observed to be in the same group.

The null hypothesis that "there is no significant correlation between the extent of knowledge of science teachers and their profile variables" has been accepted in terms of their age and length of teaching experience. Meanwhile, the null hypothesis was rejected for the profile variables sex, the number of Green Chemistry and Environmental Science training/seminars attended, and educational attainment.

Table 12 below shows the test results showing a significant relationship between the teachers' extent of Green Chemistry knowledge and their age.

Table 12
Significant Relationship Between the Extent of Knowledge of Science Teachers in Green Chemistry and their Age

Profile Variable	Aspects of Green Chemistry	r_{xy}	Sig.
Age	Content	.176	.277
	Pedagogy	.172	.290
	Attitude	.224	.165

Note: * - significant at .05 level of significance

It can be gleaned from the given table that the p-values referring to the test of the relationship between the extent of knowledge of the science teachers in Green Chemistry along content, pedagogy, and attitude with their age are .277, .290, and .165, respectively. Since all the computed p-values are greater than .05, it can be said that there is no relationship between the age and the extent of knowledge of these science teachers in terms of content, pedagogy, and attitude. Also, the r values of .176, .172, and .224 showed very weakly or no association or correlation. Further, the teacher's age has no bearing on their level of Green Chemistry competencies. This is supported by the findings of Halili (2016), who found that age is an irrelevant factor in teachers' pedagogical development in Environmental Science and related fields of study.

Table 13 below shows the data referring to the significant relationship between the teachers' extent of knowledge in Green Chemistry and their sex.

As shown in the given table, a p-value of .030 was statistically computed relative to the test of the relationship between the teachers' extent of pedagogical knowledge in Green Chemistry and their sex. Since the given p-value is less than .05, it can be said that the sex of the science teachers shows a significant relationship with pedagogy. However, it indicates a weak association as supported by the r-value of .344.

Table 13
Significant Relationship Between the Extent of Knowledge of Science Teachers in Green Chemistry and their Sex

Profile Variable	Aspects of Green Chemistry	r_{pb}	Sig.
Sex	Content	-.142	.383
	Pedagogy	-.344*	.030
	Attitude	-.130	.423

Note: * - significant at .05 level of significance

Alternatively, tests of the relationship between teachers' knowledge in Green Chemistry along content and attitude and their sex resulted in p-values such as .383 and .423, respectively. These computed p-values reveal no relationship or connection between these variables. This is also supported by the r values -.142 and -.130, which show a weak association based on the Pearson Correlation coefficient value.

The findings imply that sex has an imperative connection with the teachers' instructional delivery of the contents of Green Chemistry. The provided values show that males tend to have more excellent knowledge of the pedagogical principles of Green Chemistry as an emerging field of Natural Science.

Table 14 below contains the data from the test of the significant link between the teachers' level of Green Chemistry knowledge and their length of teaching experience.

Table 14
Significant Relationship Between the Extent of Knowledge of Science Teachers in Green Chemistry and their
Length of Teaching Experience

Profile Variable	Aspects of Green Chemistry	r_s	Sig.
Length of Teaching Experience	Content	-.087	.593
	Pedagogy	.188	.245
	Attitude	-.080	.622

Note: * - significant at .05 level of significance

The tests evaluating the relationship between the teachers' content, pedagogy, and attitude knowledge of Green Chemistry and their length of teaching experience yielded p-values of .593, .245, and .622, respectively. Because all p-values are greater than the .05 level of significance, it affirms that the respondents' length of teaching experience is not related or associated with the extent of knowledge and content, pedagogy, and attitude. This only shows that two (2) variables mentioned do not support or complement each other, have a low correlation, and have no bearing on the overall aspects of Green Chemistry. Further, it illustrates that teaching experience is not an essential element that defines the teachers' extent of knowledge in dealing with the fundamental facets of Green Chemistry.

In addition, the table also shows the computed test statistics representing the correlation coefficients between the length of teaching experience of the teachers and their extent of knowledge in Green Chemistry. These correlation coefficients include -.087, .188, and -.080 for the length of teaching experience of the teachers and their content, pedagogical, and attitudinal knowledge of the field, respectively. The coefficients have shown a weak association between the tested variables.

On the other hand, the data referring to the significant relationship between the teachers' extent of knowledge in Green Chemistry and the training/ seminars they attended related to Green Chemistry and Environmental Science, Table 15, is shown below.

Table 15
Significant Relationship Between the Extent of Knowledge of Science Teachers in Green Chemistry and Training/ Seminars they Attended Related to Green Chemistry And Environmental Science

Profile Variable	Aspects of Green Chemistry	r_s	Sig.
Number of Seminars/ Trainings Attended Related to Green Chemistry and Environmental Science	Content	.370*	.019
	Pedagogy	.373*	.018
	Attitude	.515*	.001

Note: * - significant at .05 level of significance

As shown in the given table, the tests of the relationship between the teachers' participation in training and seminars related to Green Chemistry and Environmental Science and their extent of knowledge in the abovementioned field along content, pedagogy, and attitude resulted in p-values such as .019, .018, and .001, respectively. Because all p-values are less than.05, it indicates

that the respondents' profile variable, as mentioned, shows a significant relationship. As a result, the training/seminars substantially impacted their ability to teach Green Chemistry.

Further analysis of the given table also shows that the correlation coefficients between the content and pedagogical knowledge of the teachers and their participation in seminars and training with .370 and .373, respectively, are both described as positively weak associations. However, the correlation between the teachers' profile and their attitudinal knowledge of Green Chemistry shows a value of .515 relating to positive and moderation correlation.

Findings imply that the participation of the teachers in professional development programs related to Green-based Chemistry and Environmental Science is an essential attribute to their present knowledge about the given field. Hence, greater exposure to seminars and training is likely to increase the science teachers' extent of knowledge towards Green Chemistry.

Lastly, the data referring to the test of the significant relationship between the teachers' extent of knowledge in Green Chemistry and their highest educational attainment, Table 16, is provided below.

Table 16
Significant Relationship Between the Extent of Knowledge of Science Teachers in Green Chemistry and their Highest Educational Attainment

Profile Variable	Aspects of Green Chemistry	r_s	Sig.
Highest Educational Attainment	Content	-.010	.953
	Pedagogy	.335*	.035
	Attitude	.227	.158

Note: * - significant at .05 level of significance

It is seen in the given table the p-values of .953 and .158 along with the relationship between the teachers' educational attainment and their content and attitudinal knowledge of Green Chemistry, respectively. The finding indicates that there isn't a significant relationship exist among these variables. However, a significant relationship is exhibited with the extent of knowledge in pedagogy and the highest educational attainment, revealing that the respondent's educational attainment contributes to their instructional expertise. Hence, the delivery of content is said to be effective and efficient. Moreover, the computed value of .335 based on the correlation coefficient table shows moderately associated, which only means that these two variables complement each other.

Problem 5: Proposed Intervention Program to Strengthen the Knowledge of the Teachers Towards Green Chemistry

The study's final goal was to improve teachers' knowledge of green chemistry. As a result, a Green Chemistry training seminar was established to help teachers draw up a greater understanding of Green Chemistry along with content, pedagogy, and attitude.

The intervention plan for the enhancement seminar entitled "Strengthening the Knowledge of Science Teachers towards Green Chemistry" comprised the key result area, objectives, strategies, persons involved, funding source, time frame, and success indicators. The topics to be tackled were on the weakest points of the respondents, Science Teachers, towards Green Chemistry along with content, pedagogy, and attitude.

Supportive to this, Hereterio (2019) stated that an intervention program is an effective avenue for teachers to get acquainted with science education trends and a key to improving their teaching capabilities, which offers a more significant learning opportunity. Teachers will encounter insufficient subject knowledge and pedagogical abilities to teach a specific subject and offer the learner with the required knowledge if they do not obtain proper training because they are the first decision-makers in their classes.

Boudersa (2016) likely also emphasized the necessity of teacher development programs in any educational institution, whether at a primary, middle, high, or even university level. Teachers at all levels need to be regularly supported with strengthening programs in their fields and subject matter specialization to change their teaching beliefs, attitudes, and daily life practices in classroom instruction of Green Chemistry-based concepts. Such programs will help teachers sharpen their teaching skills and deepen and improve their knowledge in the subject matter they teach, improving students' learning and school education.

IV. Conclusion

From the salient findings, conclusions drawn are as follows:

1. 1.The majority of the respondents are young, still earning units in their graduate studies, and need to participate in Green Chemistry and Environmental Science seminars/webinars and training further.
2. 2.The respondents are competent and effective in teaching Green Chemistry uses various pedagogical approaches alongside their attitude that promotes values orientation towards environmental protection and environmental sustainability. Content knowledge in Green Chemistry, on the other hand, shows reasonably proficient shown in the efforts of the respondents' enrolment in the graduate programs.
3. Differences exist between age and pedagogy, sex and content, length of teaching experience and pedagogy, number of seminars, and training with content and attitude. The variations could impact the competence of respondents in teaching Green Chemistry.

4. The profile variables show little association to the extent of knowledge along with content, pedagogy, and attitude. However, some exhibited significance in the relationship, it still indicates that the variables are indistinguishable from each other.
5. The proposed intervention program can further strengthen the teachers' knowledge of Green Chemistry along with content, pedagogy, and attitude.

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