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RESEARCH ARTICLE

TRAINING PROGRAM PACKAGE FOR CHEMISTRY TEACHERS IN STATE UNIVERSITIES AND COLLEGES IN REGION I

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Abstract

This study aimed to conduct a training program in Chemistry to improve the knowledge level and laboratory skills of Chemistry teachers in the State Universities and Colleges of Region 1. This study used quasi-experimental one group pretest-posttest design to determine the content knowledge performance of the 19 Chemistry teachers of the Colleges of Teacher Education of State Universities and Colleges in Region 1. A researcher-made test was used to assess the level of performance of the participants along with the following areas of Chemistry: Inorganic, Organic, Analytical, and Biochemistry. The pretest and post-test scores were analyzed using the Wilcoxon Signed Rank Test.Findings showed that most Chemistry teachers have pursued their higher educational degrees in Science, with Instructor as academic ranks, LET passers, young in the teaching profession, and attended few numbers of seminars in the local, regional, national, and international levels. Pretest scores showed that the science teachers were below the passing rating along the four ares in Chemistry. Posttest revealed an increased level on both knowledge and laboratory skills. Thus, the training was found to have contributed in improving the content knowledge of Chemistry Teachers.

Introduction:-

Backgroud of the Study

The Philippines' urgent call is to develop a culture of science to keep up with the rapid advances in science and technology around the world. But to successfully meet this challenge, educational institutions all over the country become more innovative and creative in developing new science courses that are highly relevant and have practical applications in today's globalized society. Therefore, science educators should participate in various trainings, seminars, and workshops in exploring the many possibilities by which science instruction can be improved for they are tasked to bring science education to a cutting edge.

Notably, chemistry is considered as one of the cornerstones of science, technology, and industry. It forms the foundation of the life sciences and the core of every technology that people enjoy today. The chemical sciences provide enabling infrastructures that deliver food, fuel, medicine, and materials that are part of everyday life. Moreover, the contribution of chemists and chemical engineers is central to the technological progress of many areas including the chemical, pharmaceutical, electronics, agriculture, automobile, and aerospace industries. These contributions have created new jobs and have boosted the country's economic growth.

Guinocor, et al. (2020) cited the participation of the Philippines in TIMSS which confirmed this deplorable condition based on the report posted in 2013 that the performance of Filipino students in national and international surveys on mathematics and science competencies lag behind its neighboring countries like Singapore, South Korea, Hongkong, Chinese Taipei and Japan (Care et al., 2015). The Filipino students excel in knowledge acquisition but fare considerably low in lessons requiring higher order thinking skills (Dinglasan & Patena, 2013; Ganal & Guiab, 2014).

In 2019, the Philippines again participated in the TIMSS but did not place among the top-ranking countries that performed in the TIMSS 2019 as shown in the data of TIMSS & PIRLS International Study Center (2021) of Lynch School of Education, Boston College and International Association of Educational Achievement. In fact, the top performing countries in East Asia are Singapore, China Taipee, Korea, Japan, and Hongkong. In terms of science, the top-ranking performing countries are Singapore, China Taipee, Korea, and Japan performed well and were joined by the Russian Federation in Finland.

Accordingly, the Philippines through the joint effort of the Department of Science and Technology (DOST) and the University of the Philippines National Institute for Science and Mathematics Education Development (UP NISMED), developed the Framework for Science Teacher Education (FSTE) - a rubric that aims to measure science teachers' competencies for professional development. Lesson study, being a competency-based approach to teaching, is now gaining much attention for science education development to enhance teaching competencies. In this study, the program for chemistry teachers was designed to include all the necessary components that comprise the lifelong professional development of science teachers as well as components that are unique to the development of leadership among chemistry teachers. Curriculum developers can use the findings of studies as bases for framing the science education curriculum specifically in chemistry (Lucenario, et al., 2016). After all, the focus in chemistry education is improving teachers' understanding of the current trends in teaching and learning (Hofstein& Lunetta, 2004).

Meanwhile, The Manila Times (2014) stated that teaching preparation of public school teachers in science is also a factor in learning. There are only small fraction of teachers in high school that qualified and capable to teach Physics, Chemistry, Biology, and Mathematics. Accordingly, programs for the continuing professional development such as training programs and conferences are still needed although these numbers have increased for public schools due to scholarship efforts of the Department of Science and Technology–Sending Education Institution (DOST-SEI).

The transition period of the K-12 curriculum affects the students, teachers, and administrators of secondary and tertiary level. The update and reform of curriculum face many problems in the lecture and laboratory classes in science, particularly Chemistry. These problems encounter in school settings include the lack of qualified teachers to teach the subject, teacher-centered classrooms, insufficient instructional materials in lecture and laboratory manuals, outsized number of classes, inadequate professional growth for teachers, and teachers go to a foreign country for greener pasture (Rugian, 2018).

The issues and concerns on the challenges and opportunities in the implementation of the K-12 Science, Technology, Engineering, and Mathematics (STEM) Curriculum constitute on addressing the teachers training needs, the ability to adjust with the current set-up, capacity building, and teaching styles. These are the primary concerns in dealing with the teaching-related changes in the curricula. In addition, some students enroll in the STEM strand even if their skills do not match with the requirement of the strand. With this, one of the concerns now is to formulate a mechanism for screening students enrolling in the different tracks (The National Academy of Science and Technology, Philippines, through the Mathematical and Physical Sciences Division (MPSD, 2016).

Interestingly, instructional approaches to chemistry also contribute to the negative perception of the students of the subject. Reyes et al. (2014) argued that giving facts, figures, theories, laws, and other ideas verbatim without representations of the image or application in the real-life situation is not enough in teaching, especially chemistry subject. To them, teachers should integrate new teaching pedagogies through different hands-on activities connecting to the experiences of the learners. Accordingly, many high school and university students experience difficulties with fundamental ideas in chemistry. Despite the importance of the foundation of chemistry, most students emerge from introductory courses with a very limited understanding of the subject.

Notably, the most important agent of change on how chemistry is perceived and experienced by students is the teacher. A qualified teacher is crucial in any educational system that is why it is important to ensure every teacher is academically and professionally qualified. Teachers' qualifications have a serious implication on students' academic achievement. It is paramount always to consider it as part of teacher qualifications (Kola and Sunday, 2015). With these, teachers need an entirely new package of educational content, a new set of skills, and new methodologies for delivery. An important step forward in addressing this problem must begin with teacher preparation and professional development. Professional development contains a huge amount of knowledge and experience. These experiences can be divided into formal experiences (such as attending workshops, professional meetings, monitoring, etc.) and informal experiences such as (reading professional publications, watching television documentaries related to academic discipline, etc.) (Ajithkumar, 2016).

In addition, Espinoza et al. (2013) revealed that chemistry students find chemistry too abstract and mathematical. To them, most students perceived chemistry as a difficult subject despite being the most industrially relevant science that features every aspect of human endeavor and natural phenomena. These perceptions may be attributed by the abstract conceptions of chemistry which they think unrelated by many students to the world they live in. Brickhouse and Carter (1989) also pointed that many students get lost in the concepts in chemistry if they missed interpreting the correct idea (Lucenario, et. al, 2016).

According to the framework for Philippines Science Teacher Education, an effective science teacher practices safe and proper laboratory techniques for the preparation, storage, dispensing, supervision, and disposal of all science materials used in teaching and learning. The job of a science teacher is a tough one. Not only do they have to teach scientific knowledge, develop the skills of science and foster scientific attitudes, they also have to convey messages about the nature of science and the work of scientists. Also, the education of teachers is a continuous, ongoing process and that technical rationality can be overcome by the participation of these professionals in groups that conduct research and reflection and in learning communities, along with professors and undergraduate, masters, and doctoral students. This would allow them to revise their theories and practices and make it possible to transform the curriculums in their respective educational settings (Da Silva Sa & Dos Santos, 2017).

Similarly, Ravhuhal and Mutshaeni (2015) highlighted that teachers should be provided with enough time to attend workshops for their professional development. In fact, their study revealed that majority of the participants argued that in-service training supports the development of the education system; that in-service training programs have a purpose; that in-service training increases teachers' professional knowledge and skills.

Finally, the vital role of teachers in science education specifically in chemistry remains intact. That is why schools are urged to organize ongoing professional development programs that meet the teachers' specific needs (Magwilang, 2017). Also, studies from both developing and developed countries have shown that when well-designed in-service teacher training can increase teacher's content knowledge, improve their methods of instruction, and ultimately improve student learning outcomes (World Bank Group, 2016). Moreover, there is a change of profile of State Universities and Colleges because of retirement and there is no training for Chemistry teachers in the Region.

Objectives of the Study:-

This study aimed to determine the effect of the developed training program package to the SUC Chemistry teachers in Region I.

Specifically, the study answered the following questions:

1. What is the profile of Chemistry teachers as to:
   - 1.1. highest educational attainment;
   - 1.2. field of specialization;
   - 1.3. academic rank;
   - 1.4. eligibility;

1.5. years in teaching Chemistry; and
1.6. Chemistry seminars/attended?

2. What is the level of performance of the Chemistry teachers in the pre-test and post-test along with the following areas:
   2.1. Inorganic;
   2.2. Organic;
   2.3. Analytical
   2.4. Biochemistry; and
   2.5. Laboratory Skills?

3. What training program package for Chemistry can be developed to improve the level of performance of Chemistry teachers?
4.Are there significant differences between the level of performance of the Chemistry teachers before and after the training program?

Review of related literature:-

Teaching science requires both mastery of content and competence in process skills. While science teachers are not expected to know everything, they are responsible for effectively imparting fundamental concepts and principles to their students. More importantly, teaching science goes beyond transmitting facts; it involves equipping learners with the ability to learn independently and engage actively in the learning process. As Eslabra (2014) emphasizes, students should not merely be passive recipients of information but should instead acquire inquiry skills that foster independent and lifelong learning. To achieve this, professional development plays a crucial role. Resurreccion and Adanza (2015) note that participation in seminars and training enables science teachers to enhance their knowledge, adapt innovative teaching strategies, and stay abreast of developments in science education.

Keane (2016) highlights that professional development influences student achievement through a three-step process: it first strengthens teacher knowledge and skills, which subsequently improves classroom instruction, and ultimately leads to enhanced student learning outcomes. However, the effectiveness of this chain depends on the consistent application of new knowledge and skills in actual teaching practice. Similarly, Kamisah, Zanaton, and Lilia (2007, as cited in Copriady, 2014) point out that positive attitudes toward science emerge through continuous monitoring of experiments and practical activities, underscoring the importance of teacher competence in implementing and assessing laboratory work.

Kolb's (1984) experiential learning theory further reinforces the significance of learning through experience, reflection, and application. The model, consisting of concrete experience, reflective observation, abstract conceptualization, and active experimentation, is particularly relevant in science education where laboratory activities and fieldwork provide meaningful learning experiences. Teachers also acknowledge that workshops and experiential training can inspire students to develop greater interest in biology and chemistry. Nonetheless, challenges such as limited laboratory facilities, inadequate equipment, large class sizes, and time constraints hinder the full integration of laboratory activities in science instruction (Cossaa&Uamusseb, 2014).

Innovative teaching approaches such as Process Oriented Guided Inquiry Learning (POGIL) have been shown to enhance student performance compared to traditional methods. Villagonzalo (2014) found that POGIL significantly improved students' academic outcomes, as it engages them in higher-order thinking skills and collaborative problem-solving. This finding aligns with Dunkin's (2009) assertion that students exposed to higher-order learning tasks perform better in comprehension and problem-solving tests. Traditional methods, in contrast, often emphasize rote memorization rather than conceptual understanding (Triangle Coalition for Science and Technology Education, 1993). Similarly, Barthlow (2011) notes that POGIL provides opportunities for deeper exploration of complex concepts, allowing students to refine their mental models in alignment with scientific perspectives.

Furthermore, in-service training has been shown to improve teachers' perceptions of laboratory work in science instruction. Cossaa and Uamusseb (2014) observed that after participating in training workshops, teachers recognized the value of laboratory activities in making science content more meaningful, even in the absence of complete infrastructure. They reported that engaging in experiments during the workshops enhanced their awareness of how laboratory work contributes to student learning and motivation.

Taken together, the literature suggests that teacher competence, continuous professional development, experiential learning approaches, and the effective integration of laboratory activities are all essential factors in improving science teaching and student achievement.

Materials and Methods:-

Research Design:

This study used a one group pretest-posttest quasi experimental research design. According to Cresswell and Cresswell (2018), one-shot pre-experiment is a form of experimental research in which individuals are not randomly assigned to groups. Because the participants were not grouped accordingly, only one group received the pretest, treatment and post-test. In this study, the 19 Chemistry teachers in the SUCs of Region 1 were the participants of the training program. This same group was pretested before attendance to the training; after which, a post-test was administered to them to assess whether or not the training program contributed to their Chimstry knowledge and laboratory skills.

Locale of the Study

The sources of data were taken from three groups of people. The first group was the participants in the training program who were from the College of Teacher Education in the five State Universities and Colleges (SUC) in Region I. There were 19 teacher-participants who were from the five universities/colleges; namely, Pangasinan State University (PSU), 1; Don Mariano Marcos Memorial State University (DMMMSU), 4; North Luzon Philippines College (NLPSC), 3; Ilocos Sur Polytechnic State College (ISPSC), 8; and University of the Philippines (UNP), 3.

The second group was the Chemistry teachers from CAR and Region 1from whom the pilot-test was administered. These Chemistry teacher are from the College of Teacher Education in Abra State Institute of Science and Technology (ASIST), St. Paul College (SPC)-Abra, Divine Word College (DWC)-Vigan, Union Christian College (UCC)- San Fernando City, St. Mary's College (SMC)-IlocosSur and Science Education graduate students of DMMMSU-SLUC.

The third group was the validators who were from Mid La Union Campus and Open University System of DMMMSU, Union Christian College, and Ilocos Sur Polytechnic State College, Tagudin Campus.

Data Gathering Procedures

The data gathering process was carried out in three main stages: planning and organizing, implementation, and training proper.

Planning and Organizing.

Prior to the conduct of the training program, the researcher presented the results of the pre-test (pilot testing) to the Oral Research Evaluation Committee (OREC) for validation in June 2019. The results of the pre-test, which highlighted the areas of difficulty in Chemistry, served as the basis for designing the training program package. This package included lectures on fundamental Chemistry concepts, discussions on innovative teaching strategies, and laboratory activities aimed at improving teachers' laboratory skills and their proper use of laboratory apparatuses. The study was reviewed and approved by the Mariano Marcos State University University Research Ethics Board, which issued an ethical clearance certificate (Appendix F). In addition, a Memorandum of Agreement (Appendix E) was signed between Ilocos Sur Polytechnic State College (Sta. Maria, Ilocos Sur) and Don Mariano Marcos Memorial State University to formalize the collaboration. The training program was scheduled and conducted at Ilocos Sur Polytechnic State College, Sta. Maria, Ilocos Sur on July 25–27, 2019.

Implementation Stage.

The researcher sought permission from the Commission on Higher Education (CHED) Region I to conduct the training-workshop. Following approval, the program was disseminated to the Presidents of various State Universities and Colleges (SUCs) through electronic mail, with follow-ups made by the researcher to ensure proper communication and coordination.

Training Proper.
The training program lasted for three consecutive days in July 2019. A pre-test was administered to the participants prior to the lecture sessions. Resource speakers from DMMMSU-SLUC and St. Louis University (School of Teacher Education and Liberal Arts, Baguio City) facilitated lectures and laboratory sessions on identified areas of difficulty in Chemistry. The first lecturer focused on solids, liquids, gases, and stoichiometry, which included problem-solving activities and experiments such as the appearance test. The second lecturer discussed kinetics, separations, carboxylic acids, and esters, with corresponding laboratory activities on reaction rates and properties of carboxylic acids and esters. The third lecturer handled topics on amines, amides, proteins, and carbohydrates, and facilitated experiments on the detection of proteins and carbohydrates. All compiled lectures and experiments were distributed to participants during the training and electronically mailed as copies of the training package.

Post-Training Assessment.
At the end of the program, a post-test was administered to measure knowledge gain and performance improvement. Additionally, participants were tasked to conduct demonstration teaching in their respective universities, which were video recorded. With permission from the SUC Presidents, the researcher collected the recorded demonstration classes, which were later evaluated by the Oral Research Examination Committee (OREC) using the DMMMSU-SLUC demonstration rating form (Appendix T). Out of 19 participants, 13 voluntarily submitted their video-recorded demonstrations for evaluation.

Population and Sampling
The Chemistry Proficiency test was presented to the panel members of the Oral Examination Committee (OREC) for their evaluation. Their suggestions and comments were integrated for the final draft before they were validated by a pool of experts in the field of Chemistry from Mid La Union Campus and Open University System of Don Mariano Marcos Memorial State University (DMMMSU), Union Christian College, (UCC), and Ilocos Sur Polytechnic State College, (ISPSC), Tagudin Campus.

Statistical Treatment of Data
The study employed both descriptive and inferential statistical tools. Content validity of the instrument was determined using **a** five-point validity scale**,** while difficulty indexand discrimination power were computed to evaluate test items. Data on participants' professional profiles were analyzed using weighted means, frequency counts, and percentages. The participants' performance was measured throughmedian scores, with proficiency levels interpreted based on norms and standards prescribed by CHED, DepEd, and the ISPSC grading system. Pre-test and post-test scores were converted into percentage equivalents using a prescribed formula with corresponding descriptive ratings. The results of the demonstration teaching were evaluated using the DMMMSU Demonstration Rating Scalewith descriptive equivalents**.** Finally, to test thesignificant differencebetween pre-test and post-test scores, the Wilcoxon Signed Rank Testwas applied.

Results and Discussion:-

Profile of the Chemistry Teachers of SUC's in Region I
Table 1 shows that 47 percent of the Chemistry teachers have a master's degree with doctoral units, 37 percent have a master's degree, 11 percent have a doctoral degree, and 5 percent have bachelor's degrees. It can be inferred that teachers have the motivation and desire to pursue higher education for professional growth. It also implies that teachers have to keep abreast with the new trends and developments in Chemistry teaching through continuous professional advancement. Findings imply that science teachers have endeavored to improve their competencies by updating themselves on new trends in science teaching (Sonza, 2016).
Field of Specialization

In terms of the field of specialization, 32 percent among the participants specialized in Biological Science, 26 percent in General Science, 21 percent in Biology, 11 percent in Physical Science, and 5 percent both in Chemistry and Physics. These findings show that a great percentage of the participants are inclined to Biological Science and Physical Science, Biology and Chemistry. This also means that the teachers are vertically articulated in the field of Science. The teachers desire professional growth and are determined to enhance their proficiency. Furthermore, it cannot be denied that graduating in education helps teachers to grow professionally effective and worthy members of the teaching profession (Rugian, 2018). It must be noted that there are teachers who specialized in Biology or Physics, yet they teach in other fields. This could be attributed to the lack of Chemistry teachers in the field.

Among the 19 teacher respondents, Table 1 shows that 69 percent are Instructors, 21 percent are Assistant Professors and five percent are Associate Professors and another five percent are Contractual Instructors. This implies that majority of the teacher- participants are in the lower academic rank but are enrolled in the graduate programs for professional advancement. This finding also implies that these Chemistry teachers are newly hired in the university or college such that they are still in the lowest rank. However, they are promising Chemistry teachers as evidenced by their educational qualifications.

Eligibility

This also suggests that the College of Teacher Education adhere the CMO 52, series 2007 which states that a faculty members teaching the professional education courses in a teacher education program must be a holder of a valid certificate of registration and professional Licensure Examination for Teachers (LET). Also, Section 11 of RA 8981 (PRC 8891 (PRC Modernization Act of 2020) stated under Persons to Teach Examination on all Professions that all subjects for Licensure Examinations shall be taught by persons who are holders of valid certificate of registration and valid professional licenses of the profession and who comply with other requirements of the Commisssionon Higher Education (CHED) and of a master's degree in education from any of the allied fields. However, two of the Chemistry teachers are not licensed professional teachers. The College of Teacher Education must consider this requirement to be a compliant to CHED order.

Years of Experience in Teaching Chemistry

Table 1 alsoshows that 48 percent had an experience of one to four years in teaching Chemistry; 37 percent had five to nine years, and five percent had 20 and above years of experience. This data implies that the Chemistry teachers in the State Universities and Colleges in Region I have varied years of teaching experiences. A great percentage of the respondents are beginners in teaching and some are teaching for long years. The finding affirms the academic rank of Chemistry teachers. Since almost half of them spent less than five years in the service, they are still in the lowest academic rank.

Table 1. Professional Profile of Respondents

Variables	*f* (N= 19)	%
a. Highest Educational Attainment		
Bachelor's degree with Masteral units	1	5
Master's degree	7	37
Master's degree with Doctoral units	9	47
Doctoral degree (Ph. D/Ed. D.)	2	11
b. Field Specialization		
General Science	5	26
Physical Science	2	11
Biological Science	6	32
Biology	4	21
Chemistry	1	5
Physics	1	5
c. Academic Rank/Teaching Position		
Contractual	1	5
Instructor	13	69
Asst. Professor	4	21
Asso. Professor	1	5
d. Eligiblity		
LET	9	47
LET & PD 907	3	16
PBET	2	11
BLEPT	2	11
BLEPT & CSC Honor	1	5
CS	1	5

Variables	f (N= 19)	%
RN	1	5
e. Years of Experience		
less than a year	1	5
1-4 years	9	48
5-9 years	7	37
10-14 years	1	5
15-19 years	0	0
20 years and above	1	5
f. Trainings/Conferences/Seminars Attended in Chemistry		
a. Local		
none	12	63
1	3	16
3	0	0
4	0	0
5 or more	4	21
b. Division		
none	14	73
1	2	11
2	0	0
3	1	5
4	0	0
5 or more	2	11
c. Regional		
none	13	68
1	2	11
2	2	11
3	0	0
4	0	0
5 or more	2	11
c. National		
none	15	79
1	2	11
2	1	5
3	0	0
4	0	0
5 or more	1	5
c. International		
none	15	79
1	4	21
2	0	0
3	0	0
4	0	0
5 or more	0	0

Table 1 shows that very limited seminars, workshops, and training related to Chemistry had been attended by the teachers. It can be noted that 79 percent of teachers had no chance to go both to the international and national level, 68 percent did not attend the regional level; 73 percent did not attend any in the division level, and 63 percent have attended at the local level. These imply that the great majority of the teacher-respondents have not been attending seminars, workshops, and training related to Chemistry. These findings support the earlier finding that Chemsitry teachers are young and new in the academe, thus attendance in seminars related to Chemistry is needed.

Notwithstanding, seminars of teachers are necessary to understand better natural sciences which include Chemistry. Science Teachers should be given more time, seminars, and various trainings because it is hard to implement, and teachers need to change/improve their way of teaching and learning (Resurreccion and Adanza, 2015). The schools are urged to organize ongoing professional development programs that meet the teachers' specific needs (Magwilang, 2017).

This finding also implies that majority of Chemistry teachers in SUC-1 are young, neophyte, and still in their way to become more competent, more skillful and more confident in delivering their lessons and in performing laboratory experiments in Chemistry. Cosares (2006) said that the science performance of the students was significantly related to the length of teaching experience of the teachers and the more experienced the teachers are, the more effective they are to teach (Obaldo, 2011). Obillo (2014) and Messen (2019) affirmed that teachers with long years of teaching are more experienced and more confident to teach in different classroom situations.
Chemistry Seminar/Training Attended

Performance of Teachers along the Four Areas of Chemistry
Table 2 shows that the Chemistry teacher-participants failed in the pretest in all the four areas in Chemistry: Inorganic Chemistry (63%), Organic Chemistry (63%), Analytical Chemistry (63%), and Biochemistry (65%). This implies that teachers have very limited knowledge in understanding the basic concepts in the four areas in Chemistry before the training program. This also implies the need for Chemistry teachers to enhance their knowledge along with the four areas in Chemistry.

Table 2. Performance of the Respondents in the Pre-test and Post-test Median Scores along the four Areas of Chemistry

Areas	Pre-test Median Score	%	DR Score	Post-test Median	%	DR
Inorganic	5	63	F	11	78	S/F
Organic	5	63	F	9	73	CP
Analytical	5	63	F	9	73	CP
Biochemistry	6	65	F	10	75	S/F

**Legend:* *97-100 Excellent/Superior (ES)* *DR Descriptive Rating*
94-96 Superior (S)
85-93 Very Good (VG)
79-84 Good/Average (G/A)
75-78 Satisfactory/Fair (S/F)
72-74 Conditional Pass (CP)
Below 74 Failed (F)

The participants performed satisfactorily with median scores of the post-test performance of the participants of 11 (78 %) and 10 (75%), respectively. The data on the performance of teachers in Organic Chemistry and Analytical Chemistry are both at the conditional pass level with a median score of 9 (73%). The data show an increase in the performance of the Chemistry teachers in the four areas of Chemisty after their attendance to the training. This may be attributed to the strategies, lectures and activities that were conducted during the training. It also implies that the intervention strategy is contributory in the increased level of performance of the participants.

Results coincide with Lucenario, et. al.(2016) which found that teacher's teaching is shaped by the level of the acquired pedagogical content knowledge of the subject matter. It is therefore clear that the teachers' mastery of the subject matter and its good use in the process of teaching and learning will always indicate the depth of teachers' knowledge of the subject matter. Also, various teaching methods must be used to guarantee that everybody learns in the class or training-workshop (Fayombo, 2015).

Test of Difference Between Pretest and Post-test Performance in Chemistry:
A Signed Rank Test showed that the training program was able to elicit a statistically significant change in the performance of the respondents in Inorganic Chemistry ($Z = -3.627$, $p = 0.000$). Indeed a median difference of 6 between the pre-test and post-test is evident. Hence, the training program has contributed in enhancing the knowledge of the respondents along with Inorganic Chemistry.

Moreover, Organic Chemistry ($Z = -3.\ 254$, $p = 0.001$), Analytical Chemistry ($Z = -3.640$, $p = 0.000$) and Biochemistry ($Z = -3.289$, $p = 0.001$) are identified in the study presented a median score difference of 4. This difference is trivial and can be considered too small, however, with its p-value of < 0.05, the finding reveals that there is asignificant difference between pre-test and post-test results and that means there is evidence that post-test results are higher than the pre-test.

Table 3. Comparison between the Pre-test and Post-test Median Scores using Signed Rank Test

Areas	Median Difference	Z	p-value
Inorganic	6	-3.627*	0.000
Organic	4	-3. 254*	0.001
Analytical	4	-3.640*	0.000
Biochemistry	4	-3.289*	0.001

**Significant at α = 0.05*

The lectures helped them to recollect and associate to mind their past learning on Inorganic Chemistry, Organic Chemistry, Analytical Chemistry, and Biochemistry, which eventually steered them to generate a better performance during the post-test.

Findings support the study of Jauhiainen (2013), Obillo (2014), and Rugian (2018) that skills or proficiencies of teachers increased after the conduct of the training workshop. Results are also comparable to the findings of Aquino (2017) that the content of the training program and the topics are beneficial to the teacher participants. This means that the participants paid much attention during the training workshop; this is a positive result. Moreover, it is also consistent with the idea of Anastacio (2012) and Meresen (2019) that the training program is a behavior-changing activity focused on knowledge building, behavior changing, developing skills new skills, improving opportunities to use newly acquired skills, and receiving constructive feedback.

Conclusion:-

Based on the findings of the study, several conclusions were drawn. Most Chemistry teachers in the State Universities and Colleges (SUCs) of Region I pursued advanced degrees related to Chemistry; however, many still held lower academic ranks, had relatively fewer years of teaching experience, and had limited participation in seminars at the regional, national, and international levels. Prior to the training program, the teachers demonstrated a poor level of performance in Chemistry, but their performance improved to a higher level, categorized as fair, after the intervention. The training program package was effective in enhancing both the laboratory skills and teaching performance of the participants. Overall, the program contributed significantly to the improved performance of Chemistry teachers in the region.

Table of Specification

Learning Content/Task	No of Items	Cognitive Domains						Total Points
		Remembering	Understanding	Applying	Analysing	Evaluating	Creating	
A. Inorganic Chemistry								**30**
I. Introduction to Chemistry: Matter and Measurement	3		1,3	7,				
II. Atomic Structure and the Periodic Table	3				14, 16,	25,		
III. Chemical Bonding and Nomenclature	3		2,	8,	18			
IV. Stoichiometry: Calculations with Chemical Formulas and Equations	5				21, 22	26,	29, 30,	
V. Gases, Liquids and Solids	5		6	9, 10, 11,	23,	27,		
VI. Solutions and Colloids	6		4,5	12,	19, 20	28,		
VII. Acids and Bases	3		15	13, 20				
VIII. Chemical Kinetics and Equilibrium	2			17	24,			
B. Organic Chemistry								**30**
I. Organic Compounds	6			42	49, 50, 51,52	58,		
II. Alcohols, Phenols, Ethers and Thioalcohols	6		33, 34, 35, 36,	39. 40				
III. .Aldehydes and Ketones	6		31,	43, 44, 45,	57		60	

APPENDICES

IV. Carboxylic Acids, Esters, and Related Compounds	6		37	46, 47, 48	54, 55,			
V. Amines and Amides	6	32	38, 41, 53		56	59,		
C. Analytical Chemistry								**30**
I. Tools of Analytical Chemistry	5	61, 62	63	82	81			
II. Chemical Equilibria	5		65	73	80	86	90	
III. Classical Method of Analysis	5		67	66, 75	84	89		
IV. Electrochemical & Spectrochemical Methods	5		68, 72	70	69, 71			
V. Kinetic and Separations	5		64		85,83	87, 88		
VI. Practical Aspects of Chemical Analysis	5			76	74, 77	79	78	
D. Biochemistry								**30**
I. Carbohydrates	7	91	103, 105	107,108	112,113			
II. Lipids	7		93,94,95, 96	101, 102		118		
III. Proteins	7		97,98,99,100	109, 110	114			
IV. Nucleic Acids	9	92	104,106	111	115,116, 117	119	120	
Overall Total	120							**120**

The Research Instrument
Don Mariano Marcos Memorial State University
South La Union Campus

COLLEGE OF GRADUATE STUDIES
Agoo, La Union

DIRECTIONS
You may use the following abbreviations and symbols, constants, equations, the periodic table and the genetic code for your reference.

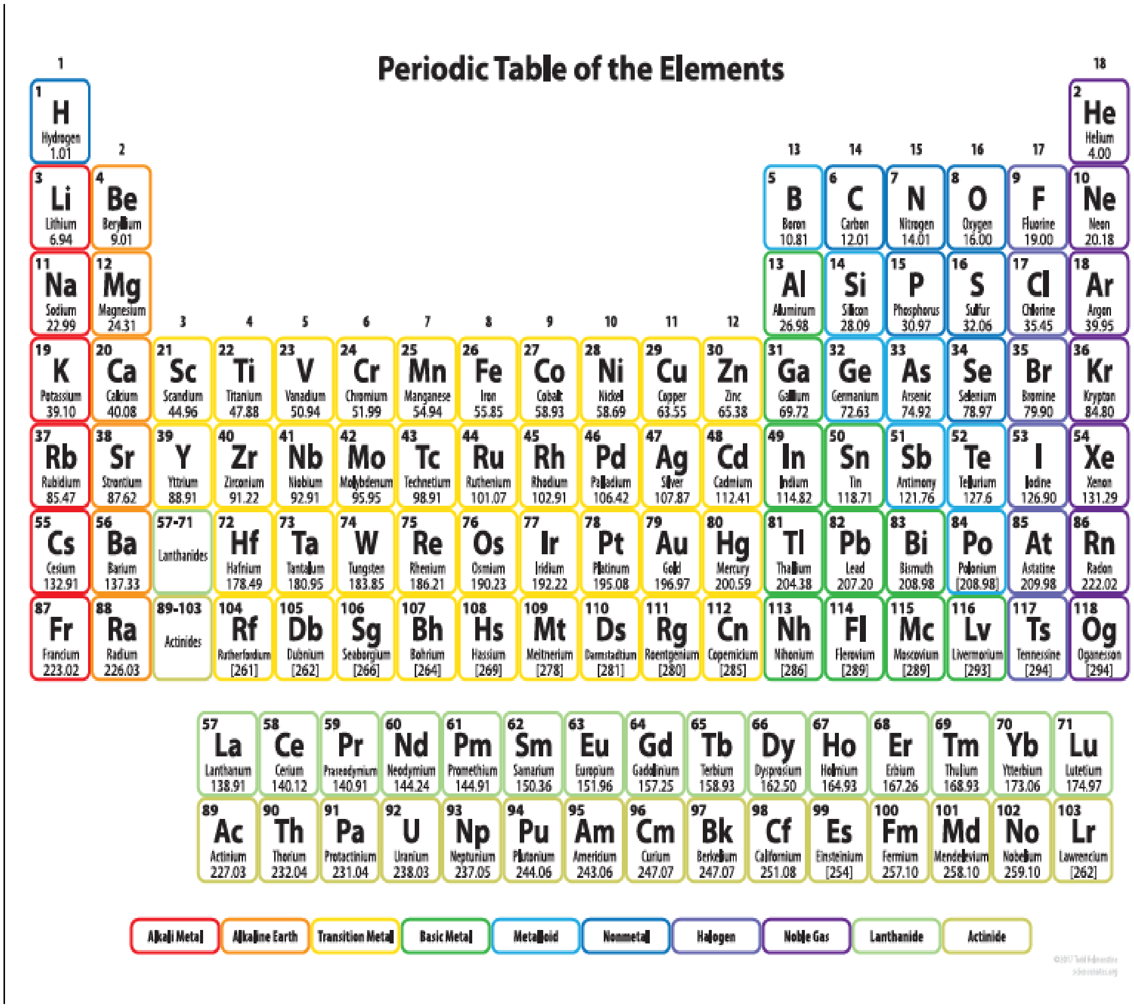
ABBREVIATIONS AND SYMBOLS					
amount of substance	n	Faraday constant	F	molar mass	M
ampere	A	free energy	G	mole	mol
atmosphere	atm	frequency	ν	Planck's constant	h
atomic mass unit	u	gas constant	R	pressure	P
Avogadro constant	N_A	gram	g	rate constant	k
Celsius temperature	°C	hour	h	reaction quotient	Q
centi– prefix	c	joule	J	second	s
coulomb	C	kelvin	K	speed of light	c
density	d	kilo– prefix	k	temperature, K	T
electromotive force	E	liter	L	time	t
energy of activation	E_a	measure of pressure	mm Hg	vapor pressure	VP
enthalpy	H	milli– prefix	m	volt	V
entropy	S	molal	m	volume	V
equilibrium constant	K	molar	M		

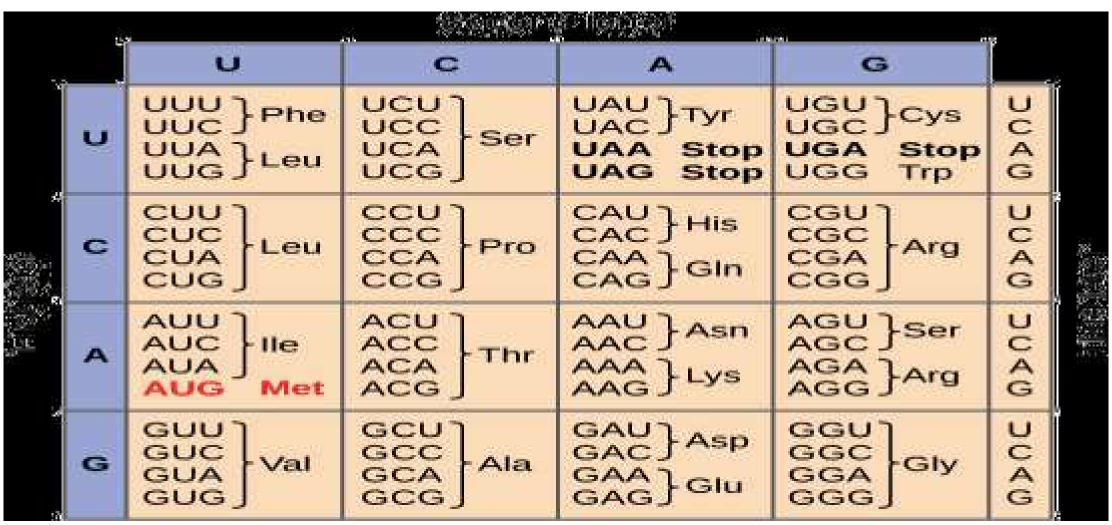
CONSTANTS
$R = 8.314\ \text{J mol}^{-1}\ \text{K}^{-1}$
$R = 0.08314\ \text{L bar mol}^{-1}\ \text{K}^{-1}$
$F = 96,500\ \text{C mol}^{-1}$
$F = 96,500\ \text{J V}^{-1}\ \text{mol}^{-1}$
$N_A = 6.022 \times 10^{23}\ \text{mol}^{-1}$
$h = 6.626 \times 10^{-34}\ \text{J s}$
$c = 2.998 \times 10^{8}\ \text{m s}^{-1}$
0 °C = 273.15 K
1 atm = 1.013 bar = 760 mm Hg
Specific heat capacity of H_2O = $4.184\ \text{J g}^{-1}\ \text{K}^{-1}$

EQUATIONS

$$E = E^\circ - \frac{RT}{nF}\ln Q \qquad \ln K = \left(\frac{-\Delta H^\circ}{R}\right)\left(\frac{1}{T}\right) + \text{constant} \qquad \ln\left(\frac{k_2}{k_1}\right) = \frac{E_a}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

Source: 2017 U.S. National Chemistry Olympiad National Exam Part I. p. 2.





	U	C	A	G	
U	UUU, UUC – Phe; UUA, UUG – Leu	UCU, UCC, UCA, UCG – Ser	UAU, UAC – Tyr; UAA Stop; UAG Stop	UGU, UGC – Cys; UGA Stop; UGG Trp	U C A G
C	CUU, CUC, CUA, CUG – Leu	CCU, CCC, CCA, CCG – Pro	CAU, CAC – His; CAA, CAG – Gln	CGU, CGC, CGA, CGG – Arg	U C A G
A	AUU, AUC, AUA – Ile; AUG Met	ACU, ACC, ACA, ACG – Thr	AAU, AAC – Asn; AAA, AAG – Lys	AGU, AGC – Ser; AGA, AGG – Arg	U C A G
G	GUU, GUC, GUA, GUG – Val	GCU, GCC, GCA, GCG – Ala	GAU, GAC – Asp; GAA, GAG – Glu	GGU, GGC, GGA, GGG – Gly	U C A G

Genetic Code

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