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Peer-Led Team Learning Approach: Effects on Students' Conceptual Understanding and Attitude towards Chemistry

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Philippine Normal University
National Center for Teacher Education

APPROVAL SHEET

In partial fulfillment of the requirements for the degree of Master in Science Education with Specialization in Chemistry, a seminar paper entitled **"PEER-LED TEAM LEARNING APPROACH: EFFECTS ON STUDENTS' CONCEPTUAL UNDERSTANDING AND ATTITUDE TOWARDS CHEMISTRY,"** prepared and submitted by **GINALYN P. BRAMAJE**

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PEER-LED TEAM LEARNING APPROACH: EFFECTS ON STUDENTS' CONCEPTUAL UNDERSTANDING AND ATTITUDE TOWARDS CHEMISTRY

A Special Project
Presented to the College of Graduate Studies
and Teacher Education Research

In Partial Fufillment of the Requirements for the Degree
Master in Science Education
with Specialization in Chemistry

GINALYN PACULAN BRAMAJE
October 2013

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ABSTRACT

Title: **Peer-Led Team Learning Approach: Effects on Students' Conceptual Understanding and Attitude towards Chemistry**

Researcher: **Ginalyn P. Bramaje**

Degree: **Master in Science Education**

Specialization: **Chemistry**

Key Concepts: **Peer-Led Team Learning, Conceptual Understanding, Attitude towards Chemistry**

The study was conducted to assess the effectiveness of Peer-Led Team Learning (PLTL) approach against the traditional teaching approach (TTA) in enhancing students' conceptual understanding and attitude towards Chemistry. Specifically, it sought to find out if: (1) students exposed to PLTL have higher conceptual understanding than those students exposed to the traditional teaching approach (TTA); and (2) students exposed to PLTL have higher positive attitude towards Chemistry than those students exposed to TTA.

Peer-Led Team Learning (PLTL) approach is a student-centered instruction in which it provides meaningful mentoring and leadership roles for students who bring a renewed sense of enthusiasm and insight. In this approach there is a PLTL workshop made by the researcher which used by the peer leaders in facilitating the discussions.

The study used the quasi-experimental pretest-posttest control group design. The sample of the study consisted of two (2) intact heterogeneous sections of Third Year High School students in a public school in Pasig City who are enrolled during the School Year 2013-2014. Forty three (43) students are in the PLTL class while forty five (45) students are in the TTA class.

Instruments used in the study were: (1) Chemistry Concepts Inventory (CCI) to evaluate students' conceptual understanding and (2) Chemistry Attitude and Experiences Questionnaire (CAEQ) to assess students' attitude towards Chemistry. The instruments were all content validated by panel of experts and were pilot tested.

The following are the findings and conclusions in the study:

1. The mean posttest score in the Chemistry Concepts Inventory was significantly higher for students exposed to PLTL than for students exposed to TTA.

2. The mean posttest rating in the Chemistry Attitude and Experiences Questionnaire was significantly higher for students exposed to COPT than for students exposed to TTA.

The Peer-Led Team Learning approach in chemistry was effective in enhancing students' conceptual understanding and attitude towards chemistry.

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

For future researchers in chemistry education and science education, investigate the effectiveness of the PLTL not only in terms of students' conceptual understanding and attitude towards chemistry but also to students' achievement, problem solving skills, decision making skills and self-efficacy. In addition, vary some aspects of the implementation of Peer- led Team Learning workshop such as:

1. Investigate the effects of PLTL in elementary setting to test whether this will produce also a significant effect on conceptual understanding and attitude towards science or not.
2. Investigate the effects of PLTL workshop in Grade 9 to test whether this will also produce a significant effect on conceptual understanding and attitude towards science or not.
3. Investigate the effects of having peer leaders in every classroom discussion in any science subject areas to test whether this will produce significant effect on conceptual understanding and attitude towards science.
4. Investigate the effects of using workshop sheets and activities as an alternative assessment in the classroom discussion in science.

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Summary of Revision of S Project
Peer-led Team Learning Approach: Effects on Students' Conceptual Understanding and Attitude towards Chemistry

Page No.	Revisions/ Corrections	Action Taken	Page No.
vi	Asking of conclusion; Addition of Recommendations	Conclusion is already included; Recommendation is added in the abstract	vi
1	Warner (1999), not in bibliography	Added in the bibliography	56
4	Discussion of conceptual framework diagram and relationship of concepts based on experts views	Added in the conceptual framework	4
5	Garcia (2004), not in bibliography	Added in bibliography	50
5	**Studies,** mentioned	As is as **studies** because experts views are added	6
13	Wiggins and Mc Tighe(1998), not in bibliography	Added in bibliography	56
14	Jaakkol (2012)	Added in bibliography	15
15	Shepardson & Britsch,1997, not in bibliography	Added in bibliography	55
17	Koballa (1988) and Laforgia (1988),not in bib.	Added in bibliography	52
17	Petty (1995), not in bibliography	Added in bibliography	54
18	Gardner, 1975; Crawley (1985), not in bib.	Added in bibliography	50
18	Synthesis; relate the study mentioned to your study	Added synthesis and relationship to the present study;	20
18	conceptual discussion must transferred to conceptual framework	transferred to conceptual framework	5
19	Discussion of research design	Already discussed	19
20	Ethical considerations in doing the experiment	Already written in "the sample"	**20**
32	Alexopoulou and Driver (1998) not in bib.	Added in bibliography	49
32	Nicol & Boyle (2010), not in bib.	Added in bibliography	54
32	Capstick and Fleming (2002)	Added in bibliography	49
40 41	Maria, Santos and Mortimer (2003) Sesen and Tarhan (2004)	Added in bibliography Added in bibliography	53 55

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Chapter 1

THE PROBLEM AND ITS SETTING

Background of the Study

The goal of science education is to help students develop a deep understanding of abstract concepts. But results of the National Achievement Test (NAT) in secondary science contradict this goal. In 2007, NAT was reported to have a 51.8% passing and in 2008 it was 57.8%. This is very far from the government's target criterion level of 75% (Lapus, 2009). Moreover, in 2003, the Philippines ranked 41st and 42nd in Mathematics and Science out of 45 participating countries in the Trends in International Mathematics and Science Study (TIMSS). According to Martin, Mullis, Gonzales, Gregory and Smith (2004), Filipino learners are weak in terms of mastery level in mathematics and science when they finished high school. In the field of Chemistry alone, Filipino learners have 30% average correct answers in TIMSS. This is very low and far from the international average of 45% correct answers.

One of the many factors attributed to achievement in Science is class size. Achievement is better when class size is small. However, in the case of public schools, crowded class size has always been a problem because of classroom and teacher deficiency. In the study of Burshall (1979), it has been pointed out that smaller classes must inevitably result to an improvement in the quality of life in the classroom. Thereby, it is expected to be followed with consequent beneficial effects on children’s social, emotional and intellectual development. In addition, Blatchford and Mortimer (1994) cited that smaller class sizes in schools will lead to educational benefits for pupils. On the contrary, large class size, overcrowding of classrooms and large numbers of transient students, leads to underachievement and poor resources for learning (Warner, 1999). Moreover, large classes make it difficult for teachers to know their students and to offer any individualize attention. Apparently this, situation negatively affects the student-teacher relationship. Thus, there is good evidence that reducing class size enhances academic achievement (Pritchard, 1999).

Another problem that might be attributed to underachievement and rote learning is the lack of conducive environment that promotes the development of conceptual understanding. Conceptual understanding refers to what learners know and understand about a concept, which are the generalizations learners can develop about the nature or properties of that concept. According to Kang and Howren (2004) conceptual understanding requires students to arrange facts and ideas into a significant concept of science. These facts and concepts form webs to help students make connections between the concepts of science and their experiences. In addition, conceptual understanding enables students to connect instinctive ideas with scientific ones which result to significant connections rather than just memorization of facts. Similarly, Gallagher (2007) cited that students who understand a subject conceptually do not depend on memorization approach rather they concentrated on formulating while learning. They continually ask questions based on their state of understanding. They also transform and reconstruct their knowledge structures. Although science educators have drawn attention to strengthen conceptual understanding of scientific concepts and processes, lots of teachers still fail to implement instructional strategies that guarantee assistance to learners. Hence, many students leave science classrooms with misconceptions even after instructions. (Boo, 1998; Taber & Watts, 2000; Nicoll, 2001; Geban & Pabucco, 2006; Duit, Treagust, & Widodo, 2008; Ozmen, 2008).

Chemistry students are not exempted to this trend. Studies done by Asoko, Driver Leach and Scott (1994); Leach and Scott (2000); Lyons (2006); and the National Research Council (1996) have shown that numerous key chemistry concepts and processes establish misconceptions on student learning. This is because teachers predominantly use knowledge-based instruction rather than conceptual based learning. In addition, it is shown that solving complex algorithmic and conceptual problems are often ambiguous in a field of chemistry where learners are always called upon to apply scientific principles. In other words, students need to navigate and coordinate between these interrelated variables in solving chemistry problems which require the use of complex reasoning (Bodner & Herron, 2002).

For students to favourably deal with the complexity of key chemical concepts and processes, the teachers need to use student-centered instructional approaches in teaching of chemistry (Leach & Scott, 2000). A study done by

Asoko, Driver, Leach, and Scott, (1994) has shown that higher level of cognitive processes are achieved when conducive learning environment. As such higher levels of thinking skills are produced from interactions between students which challenge ones understanding of the topics. In their argument, students develop a significant and durable understanding of basic science when they engage in a conducive learning environment.

Among the effective instructional strategies that promote student-centered learning in a large class size is Peer-led Team Learning Approach (Perdavis, 2001). According to the study of Tenney and Houck Peer-Led Team Learning on Introductory Biology and Introductory Chemistry results to improvement in students' conceptual understanding, retention of concepts, and study skills. Aside from the findings, they discovered that peer leaders also developed their involvement as mentors. As they formed the bridge of improved communication between faculty and students, there is also an enhancement in their problem solving skills, comprehension of basic concepts in biology and chemistry, and self-confidence in facilitating work groups. Hence, they became respected colleagues of the faculty. In addition, the study of Horwitz and Rodger (2009) showed that Peer-Led Team Learning was effective in improving retention of concepts and students performance in the computer science course. Aside from that findings they found out that students perception of the program were uniformly positive in eight universities.

The study therefore proposes an intervention called Peer-led Team Learning (PLTL) approach which aims to address the problem on class size and rote learning. It also hopes to develop students' conceptual understanding and positive attitude towards Chemistry among high school students.

Conceptual Framework

Based on the views of experts, PLTL have many benefits to the learning processes of students. The PLTL workshop model was developed to address faculty concerns about student learning and high attrition rates (Gosser & Roth, 1998; Sarquis *et al.,* 2001). The PLTL model addresses the needs of students by providing them with opportunities for intellectual and personal development as well as a restructuring of their content knowledge. This approach preserves the lecture and introduces a new structure—a weekly 2-hour workshop where six to eight students interact to solve problems under the guidance of a trained peer leader, a student who has done well in the course previously. In addition, Tenney and Houck (2003) cited that Peer-Led Team Learning has been used in Introductory Biology and Introductory Chemistry at the University of Portland since Fall of 1999, which proved to be effective in developing conceptual understanding, retention of students, and improvement in study skills.

On the other hand, Crawley (1985) suggested that attitude toward science might be viewed as *"a learned, positive, or negative feeling about science that serves as a convenient summary of a wide variety of beliefs about science"*. He also stated that *"attitude is important because it permits the prediction of science related behaviour"* (p.222).

Based on the literatures cited, Figure 1 shows the conceptual framework of the study that represents how the peer-led team learning and the traditional teaching approaches will affect the students' conceptual understanding and attitude towards chemistry.

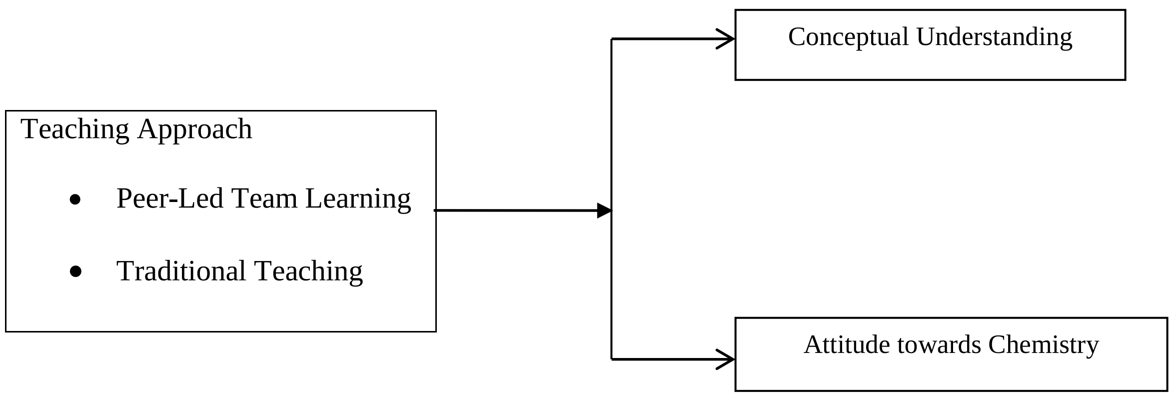

Figure 1. Conceptual Framework of the Study

The purpose of the study is to compare students exposed to PLTL and students exposed to traditional teaching approach in terms of their effect on students' conceptual understanding and the attitude towards chemistry. Garcia (2004) cited that concepts and conceptual understandings are described *as "the most productive means of accessing and framing knowledge in the curriculum"* (p.28). That is why he suggested that to develop new conceptual understandings, students need to build connections with other concepts that they already know. In the study of Alsadaawi (2008), performance-based assessment significantly developed sixth grade students' achievement and attitude towards science. The positive results about their studies mentioned above prompted the researcher to use the PLTL as an approach and relate it to students' conceptual understanding and attitude towards chemistry.

Statement of the Problems

The primary focus of the study is to investigate the effectiveness of Peer-led Team Learning Approach on selected topics in chemistry on students' conceptual understanding and attitude towards chemistry.

Specifically, this study answered the following research questions:

1. Did students expose to Peer-led Team Learning (PLTL) approach have higher conceptual understanding than those students who were exposed to the traditional teaching approach (TTA)?
2. Did students expose to PLTL have higher positive attitude towards Chemistry than those students who were exposed to TTA?

Significance of the Study

This study on Peer-led Team Learning (PLTL) and its effects on students' conceptual understanding and attitude towards chemistry will contribute to the field of chemistry education. The research will be beneficial to the following:

Students

This approach may help high school students in increasing their level of performance in chemistry specifically their conceptual understanding. This could also help them to develop positive attitude towards chemistry.

Chemistry Teachers

The outcome of the study will awaken Chemistry Teachers in making teaching and -learning process easy and effective. It may serve also as a guideline in making their own PLTL workshops.

School Administrators

The results of the study will help school administrators to realize the significance of PLTL. This study will further encourage them to support science teachers in making their own PLTL workshops and to integrate it in other science subjects other than chemistry.

Curriculum Planners

The findings of this study will help curriculum planners realize that the inclusion of PLTL approach in Chemistry curriculum will be a good way to promote conceptual understanding and positive attitude towards chemistry.

Future Researchers

The findings of the study may be used by the researchers in chemistry education and science education as a whole to further develop PLTL or to either change some aspects of the PLTL.

Scope and Delimitation of the Study

The study was conducted during the first grading period of a High School Chemistry class for the school year 2013-2014. It lasted for a month. Specifically, August 2013. Two heterogeneous sections of Third Year High School classes in a public school in Pasig City were utilized in the study. One class was composed of 43 students who were exposed to Peer-led Team Learning Approach; then, another class of 45 students were exposed to Traditional Teaching Approach. The researcher taught both classes with the topics: Classifying Matter; Types of Pure Substance and Mixture; and Preparation, Separation, and Purifying Mixtures.

Definition of Terms

Peer-Led Team Learning Approach refers to a student-centered instruction. This teaching strategy provides meaningful mentoring and leadership roles for students who bring a renewed sense of enthusiasm and insight.

Traditional Teaching Approach refers to a teacher-centered instruction. The teacher is the doer of most tasks in the classroom while students just follow what is instructed by the teacher.

Conceptual Understanding refers to what learners know and understand about a concept that is; the generalizations learners can develop about the nature or properties of that concept. This is measured by the Chemical Concepts Inventory (CCI)

Attitude towards Chemistry refers to positive or negative set of beliefs about chemistry and chemistry courses. This is measured by the Chemistry Attitude and Experiences Questionnaire (CAEQ)

Chapter 2

REVIEW OF RELATED LITERATURE

This chapter presents related literatures and studies which will be the basic foundations of this research. It focuses mainly on peer-led team learning approach in Chemistry and other Sciences, conceptual understanding and attitude towards chemistry. It is also shows the conceptual framework, the research hypotheses, and the definitions of terms used in the study

Peer-led Team Learning

Conventional ways of teaching or discussion sections provide little interactive engagement. Generally, a teacher finishes examples on the board for the students. In this approach, students are largely passive wherein they are allowed to ask questions to the teacher, but extended interaction is limited. A study done by Bozzone, Buka, Chukuigwe, Dreyfuss, Gosser and Varma-Nelson (2001), Peer-Led Team Learning (PLTL) is an alternative approach. In PLTL workshop, there is a peer leader who guides the group, and the discussion approach is replaced by two-hour workshops in which groups are consisting of six to eight students. These groups work together to complete assigned material with the peer leader acting as the learning facilitator. In addition, students who hardly cope with the concepts are free to ask patterns or techniques on how to clearly understand difficult concepts. The PLTL approach provides a learning situation where students can formulate both conceptual understanding and improve their reasoning abilities. Similarly, the PLTL model has become a nationally recognized and replicated model of Science, Technology, Engineering and Mathematics (STEM) education which was developed for General Chemistry at the City College of New York in the early 1990's. It has been identified, and has tested valuable in distributing and evaluating PLTL. Through PLTL model there is an initial positive results of an increase of 15% in the number of A, B, or C grades in a General Chemistry course that were originally reported in *Peer-led Team Learning: A Guidebook* by Gosser (2001).

Another study done by Tenney and Houck (1999) in University of Portland showed that Peer-Led Team Learning Introductory Biology and Chemistry had been proven to improve conceptual understanding of biology and chemistry, raise students' success in first-semester courses, and retain students in their desired field of study.

According to Gafney (2000), there are six criteria as keys in assessing the critical components of Peer-Led Team Learning:

(1) Peer-Led Team Learning must be integral to the course and coordinated with all of the elements of the course;

(2) During the workshop instructor is always involved;

(3) Undergraduate workshop leaders must be trained in facilitating group work;

(4) Workshop materials must be challenging and interactive, meeting the needs of both the slow and fast learners by incorporating diverse methodologies to meet diverse learning styles; and

(5) Institutional support must be present.

Study done by Weimer, (1987) showed that large classes can be divided into small groups for discussion activities, writing assignments can be read and critiqued by students instead of the instructor which was the ideals of PLTL. In addition, study done by Lewis and Lewis (2005) cited that General chemistry courses at the University of South Florida have historically been taught in lecture format to accommodate the large class size, typically about 200 students. To create a more student-centered learning experience, a reform method was employed based on the Peer-Led Team Learning (PLTL) developed by the National Science Foundation systemic change initiative. In this method, students work in groups of 10, with each group assigned to one peer leader. The peer leader is an undergraduate student who has successfully completed the general chemistry course. Guided inquiry methodology as described by Farrell, Moog, and Spencer (1999) to be the basis for reformation. Fortunately, the PLTL scenario facilitates the implementation of the guided inquiry methods, which can be used in smaller groups within the already small groups of a typical PLTL workshop. This combination results in what we term peer led guided inquiry (PLGI). This pedagogy is purely student-centered which allows small group with a peer leader acting as a facilitator for those interactions.

Therefore, PLTL is a good assessment strategy in the teaching and learning process.

Conceptual Understanding

In chemistry, most concepts can be understood at the macroscopic, sub-microscopic, and symbolic levels (Johnstone, 1993). These three levels were positioned at the vertices of a triangle and stress that *"every learner studying chemistry for whatsoever purpose needs to perform within the triangle"* (Johnstone, 1993, p.703). Similarly Bowen and Bunce (1997) used the three forms of representations: macroscopic, submicrospic (particulate), and symbolic to stress conceptual understanding in problem solving as the ability to symbolize and translate chemical problems.

Furthermore, Kozma and Russell (1997) emphasize that the development of representational competencies is important for students since *"these skills can help students extend an understanding built on the surface features of a single representational form to one that is connected to other representational forms and includes underlying principles and concepts"* (p. 964). In addition, human influence is another significant visible feature of understanding chemistry (Mahaffy, 2004). He said that understanding chemistry relies on the various influences of the society and living environment that form the teaching and learning of chemistry.

Johnstone (1993) cited that this 'three-fold representations' have extended to tetrahedral chemistry ascilate 2006 which influences the need for new dimensions of learning chemistry. The tetrahedron model as shown in figure 1 unites conceptual knowledge of chemistry with its applications. Thus, conceptual understanding of chemistry involves conceptual knowledge, the ability to translate between and among different representations (representational competencies), and their use and application to explore new situations, and understand human influences and environmental events.

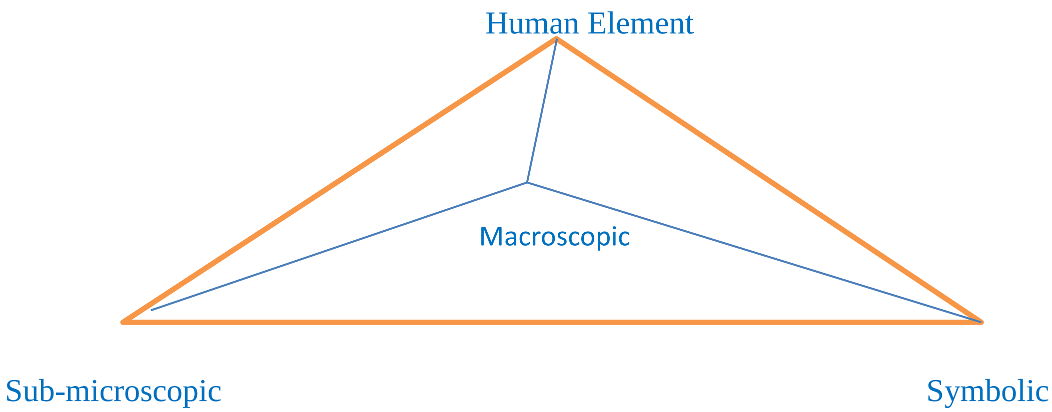

Figure 2. Tetrahedral chemistry education (Mahaffy, 2004, p. 231)

The American Association for the Advancement of Science or (AAAS) (1989) mentioned that developing deeper understandings of major concepts within a scientific discipline is an ultimate goal of science which is an explicit shift in the goals of science teaching from students simply constructing a knowledge based on scientific facts. This emphasis on conceptual understanding in science education reform has led the advancement of standards and spread throughout all major science education reforms policy document.

One of the strategies to facilitate conceptual understanding is conceptual change text (Al Khawaldeh & Al Olaimat, 2010; and Kenan & Ozmen, 2012). These texts are designed to make readers aware of the inadequacy of their intuitive ideas and help students understand and apply the target scientific concept through the use of explanations and examples (Hynd, McWhorter & Phares, 1994).

Wiggins and McTighe (1998) relate the term *knowing* with facts, memorization, and superficial knowledge, while the term *understanding* implies a more complex, multidimensional integration of information into a learner's own conceptual framework. They expand the definition of understanding into six facets of understanding and its complexity as compared with knowledge. These are to explain, interpret, and apply that knowledge, as well as have perspective on the information, possess self-knowledge of their own understanding, and empathize with the understandings held by others.

Gabel (1999) cited different strategies which can promote Conceptual Understanding namely:

(1) Learning Cycle Approach;

(2) Science, Technology and Society;

(3) Real-Life Situations;

(4) Discrepant Events;

(5) Analogies;

(6) Collaborative Learning;

(7) Wait-Time;

(8) Concept Mapping;

(9) Inquiry; and

(10) Mathematical Problem Solving.

Science process skills (Pınarbası, 2002), gender differences (Sungur and Tekkaya, 2003), and attitude towards science (George, 2000) are the alternative variables that affect students' understanding of science concepts according to many science education research studies. Similarly, Preece and Brotherton (1997) cited that science process skill is a strong predictor in understanding the concepts related to science.

Different studies on how to increase students' conceptual understanding have already been done. Below are chosen studies involving different strategies in developing conceptual understanding.

The study done by Jaakkola (2005) proves that the use of simulation along with laboratory activities in teaching Physics promotes students' conceptual understanding of electricity. The students can gain better understanding if they have an opportunity to use the simulation and the real circuits in parallel than if they have only the real circuits or only a computer simulation available, even if the use of the simulation is supported with the explicit instruction.

Formative assessment strategies are effective in enhancing the quality of student learning (Black, Harrison, Lee, Marshall & Wiliam, 2002; Nicol & Macfarlane-Dick, 2006; and Furtak, 2009). Educators who maintain that formative assessment strategies are effective in improving quality of student learning because teachers can identify students' misconceptions, and eventually make these misconceptions visible to the learner, and devise instructional strategies based on the feedback he/she receives from the students to address their learning needs (Black, Harrison, Lee, Marshall & Wiliam, 2002; and Furtak, 2009). It is believed that formative assessment strategies are effective learning tools because they engage students in the process of learning; the learner is able to monitor his/her own state of understanding, recognize his/her weaknesses and strengths, and with the aid of the teacher and the peers become aware of learning strategies that can help him/her to develop conceptual understanding of key scientific concepts and processes (Chin, Brown & Bruce, 2002; Clark & Rust, 2006; and Furtak, 2009).

Using Science notebooks can improve writing skills and conceptual understanding (Butler & Nesbit, 2008). In their study, the students who wrote in their science notebooks discovered what they think and come to a better understanding of what they know and questions which remain in their mind. According to Shepardson and Britsch (1997) *"Written reflection is essential to promote children's explorations of their own thinking and learning processes".* When students' writing is joined by an active science program there is a significant increase in students' conceptual understanding, (Shepardson & Britsch, 1997).

Another approach is the Guided Inquiry-Based, Hands-On Activities in improving conceptual understanding of chemistry topics. Most laboratory experiments are structured as recipe style and are used to adapt students with different laboratory technique as well as familiarize them to laboratory equipment. The problem for the recipe style is that students didn't understand the science concepts behind the experiments. The purpose of guided, inquiry-based, hands-on activities is to force the students to think critically and logically as much as possible during the activity. Through her study she found out that the students widen their critical thinking skills and conceptual understanding through working with the activities (Hillebrand, 2003).

Student Generated-Diagram is another approach which develops conceptual understanding (Gobert & Clement, 1999).This approach to Science education examines both the processes and products of science learning. This opposes the conventional use of diagrams as merely pictures of science concepts; instead, this is a diagram as significant tool for reasoning and model construction. The work of Lowe (1991), suggests that student-generated diagramming should be evaluated as a necessary part of the science curriculum.

Barbera and Wieman (2009) suggested Dynamic Learning Tutorial as another approach in developing conceptual understanding. Their study on thermodynamics and kinetics at a large research university has developed a learning tutorial that addresses common conceptual difficulties about thermodynamics that occurred during an undergraduate physical chemistry course. Their tutorial is interactive, in which it uses a hands-on physical model designed to engage students and allow them to experience various aspects of the concepts being addressed. Students used the tutorial just after completion of a standard semester's coverage of the First Law material. After the tutorial, they measure a normalized gain of 0.70 for students' understanding of internal energy changes associated with changes in heat and/or work. In addition, the percentage of students' possessing a robust understanding of thermal energy exchange (heat) is shown to increase from 69%, after course instruction, to 100% on measures after tutorial use.

Another approach is the use of computer-based technologies to couple software resources with physical analogies in teaching strategies (Weerawardhana & Ferry, 2006). They found out in their study that using this approach led to a motivational learning environment and have contributed to meaningful learning (conceptual understanding). In addition, data collection from students over an extended time period would be required to verify the extent of the development of their conceptual understanding. The process benefited by pre-service teachers in a way of allowing them to customise the media to suit their approach to teaching as well as to take into account the learning needs of their students.

Classroom-based assessment strategies influenced the development of conceptual understanding and motivational beliefs among elementary learners in Science (King, 2006). Classroom-based assessment strategy helped teachers make instructional decisions on a daily basis. They diagnosed students' strengths and weaknesses related to classroom instruction, and provide specific feedback to support students' language and content learning. Based on her study children enjoyed learning about Science. Their opportunities for interactive exploration and intellectual stimulation which resulted from new and unexpected discoveries in science were based on the positive feedback developed.

In view of the literatures mentioned, developing students' conceptual understanding is thus, one of the most important goals of science education.

Attitude towards Chemistry and other Sciences

According to university teachers, the most significant student characteristic associated with successful studies are traits such as attitude, motivation, and genuine interest. Thus, in the study of Koballa (1988) and Laforgia (1988) cited that science educators have agreed that the development of a positive attitude toward science should be an important goal of the school curriculum.

Eagly and Chaiken (1993) and Petty (1995) defined attitude as the tendency to think, feel, or act positively or negatively toward objects in our environment. Similarly, social psychologists defined that attitude have three components: the cognitive, the affective, and the behavioral. The cognitive component is a set of beliefs about the attributes of the attitudes' object and its assessment is performed using paper-and-pencil tests (questionnaires). The affective component includes feelings about object and its assessment is performed using psychological indices (heart rate). Finally, the behavioral component pertains to the way people act toward the object and its assessment is performed with directly observed behaviors (Eagly & Chaiken, 1993).

Attitudes towards chemistry signify to a positive or a negative set of beliefs about chemistry and chemistry courses. It is the students' disposition towards like or dislikes chemistry. In addition, attitudes towards science, is defined as "*a learned predisposition to evaluate in certain ways objects, people, actions, situations, or propositions involved in learning science"* (Gardner, 1975, p. 123).

According to Yara (2009) students beliefs and attitudes have the possibility to motivate or discourage learning. Several basis could contribute to students' learning toward science specifically, chemistry. In the study done by Wilson (1983); Soyibo (1985); Berg (2005); and Adesoji (2008) showed that students' interest towards learning science tend to decrease in the following order: Biology, Chemistry, Physics and Mathematics.

There are identified factors related to students' attitude towards Science specifically Chemistry as given by Halladyna and Shanghnessy (1982) and Adesoji (2008). These factors are teaching methods, teacher attitude, influence of parents, gender, age, cognitive styles of students, career interest, social view of science and scientific world, social implication of science and achievement.

In view of the literatures mentioned, it is therefore an important goal of Science education to build positive attitude towards learning Science in general and Chemistry in particular.

Synthesis

Literature analysis supports the importance of student-centered approaches in developing conceptual understanding. Conceptual understanding refers to what learners know and understand about a concept that is; the generalizations learners can develop about the nature or properties of that concept. One of the student-centered approaches is the Peer-Led Team Learning (PLTL). This teaching strategy provides meaningful mentoring and leadership roles for students who bring a renewed sense of enthusiasm and insight. In addition, according to university teachers attitude, motivation, and genuine interest are the most significant student characteristics associated with successful studies.

In view of the studies mentioned, developing students' conceptual understanding and attitude towards chemistry are the most important goals of science education.

Chapter 3

METHODOLOGY

This chapter discusses the research design used in the study, the description of the sample, the instruments and the procedures used for data collection and analysis.

Research Design

The two-group pre-test-post-test quasi-experimental research design was used in this study to test the effectiveness of Peer-Led Team Learning Approach in developing conceptual understanding and the students' attitude towards chemistry compared to the traditional teaching approach (TTA). The figure below shows the research design.

O_1	O_2	X_1	O_1	O_2
O_1	O_2	X_2	O_1	O_2

Figure 3. Research design

where:

X_1- Peer-Led Team Learning Approach (PLTL)

X_2 - Traditional Teaching Approach (TTA)

O_1 – Chemical Concepts Inventory Test, which was administered before and after the intervention

O_2 - Chemistry Attitudes and Experiences Questionnaire, which was administered before and after the intervention

The Sample

The sample of the study were composed of two intact heterogeneous sections of eighty eight (88) third year high school students of a public high school in Pasig City. The study was conducted during the first grading period for the whole month of August, School Year 2013-2014. The assignment of the teaching approach to the class was based on the result of tossing a coin. The third year section Carbon was assigned as the PLTL class, while section Calcium was assigned as the TTA class.

Thirty eight (38) students from section carbon and forty (40) students from section calcium took the pretest, while forty three (43) students from section carbon and forty two (42) students from section calcium took the posttest. A sum of seventy eight (78) students took the pretest while eighty five (85) took the posttest.

Before conducting the study, the researcher sought permission to the superintendent of the division, the principal of the school and the parents of the two sections who underwent the intervention. Students are also aware that they are under study.

After conducting the study, the section calcium that underwent the traditional teaching approach also experienced the Peer-Led Team Learning approach to make sure that this section was not deprived of the said intervention.

The Instruments

There were two instruments used in the study—the Chemical Concepts Inventory (CCI) and the Chemistry Attitudes and Experiences Questionnaire (CAEQ).

Chemical Concepts Inventory (CCI)

The Chemical Concepts Inventory (CCI) was developed by Doug Mulford for his master's thesis, entitled *An Inventory for Measuring College Students' Level of Misconceptions in First Semester Chemistry* in 1996. The CCI was published in Journal *of Chemical Education On-Line: Library of Conceptual Questions* on 2001.

The Chemical Concepts Inventory (CCI) is a multiple choice instrument that can be used to indicate the level of chemistry misconceptions held by students. The inventory is a multiple choice instrument composed of one- and two-tiered non-mathematical conceptual questions (22 questions total). The questions are based on commonly-observed student misconceptions about topics generally covered in a general chemistry course. The reliability coefficient Cronbach Alpha of this instrument is 0.704.

The CCI was pilot tested to two sections of fourth year high school students in a public secondary school during the first grading period of School

Year 2013-2014 to test the validity of the instrument in the high school setting. These students were currently taking chemistry as their science subject. A total of seventy seven (77) students took part in the pilot testing. After the pilot testing, an item analysis was done to determine the difficulty and discrimination indices of the CCI. The scores were then subjected to a statistical treatment to determine the reliability coefficient Cronbach Alpha of the instrument. The reliability coefficient was calculated to be 0.7508 (Appendix H). This reliability coefficient is acceptable because according to Fraenkel and Wallen (2011) the acceptable values of alpha ranges from 0.70 to 1.00.

Chemistry Attitudes and Experience Questionnaire (CAEQ)

In 2001, Richard Coll, Jacinta Dalgety and David Salter developed the original version of the Chemistry Attitudes and Experiences Questionnaire (CAEQ). This instrument was part of their research entitled *"The Development of the Chemistry Attitudes and Experiences Questionnaire (CAEQ)"* which was published in two journals namely Chemistry Education Research and Practice in Europe 2002 and Journal of Research in Science Teaching in 2003.

There were three parts of the original CAEQ version. Students' attitude-toward-chemistry scale (semantic differential) which includes a sum of 21 questions is the first part. This was composed of five subscales namely: attitude towards chemists, skills of chemists, attitude toward chemistry in society, leisure interest in chemistry, and career interest in chemistry. Students' self-efficacy scale

(Likert) which consists of 17 questions containing one scale with students not appearing to have various efficacious beliefs for the different tasks in chemistry is the second part. Students learning experiences scale (Likert) which consists of 31 questions is the third part. This was composed of four subscales namely: demonstrator learning experiences, laboratory class learning experiences, lecture learning experiences and tutorial learning experiences. The attitude towards chemistry part of the CAEQ was utilized in the study. This was also included in the study of Espinosa (2013) on "Career-Oriented Performance Tasks in Chemistry: Effects on Students' Critical Thinking Skills" which has a cronbach alpha of 0.8577.

The shortened version of the CAEQ was pilot tested to two sections of third year high school students in a public high school in Pasig City during the first grading period of School Year 2013-2014. These students are currently taking chemistry as their science subject. During the pilot testing, the topics being covered are measurements and matter. A sum of eighty nine (89) students took part in the pilot testing.

The data gathered from the pilot testing were utilized to determine the reliability of the shortened version of CAEQ. Cronbach Alpha was calculated to be 0.8755 (Appendix I).

Teaching Approaches

Peer-Led Team Learning Approach

The PLTL class used the usual routine in teaching and learning process which includes motivation, lesson proper, generalization, and assessment with the presence of the peer leader which serves as the facilitator in every group instead of the teacher who handled the class all throughout the period.

The students were already aware about the PLTL intervention before the class started to avoid questions and confusion in their part. There was a peer leader assigned in every group. The member was assigned in each group through counting number. (i.e., all who are number one are group members of group 1).

Peer Leader Selection and Training

A qualified peer leader must successfully completed the course (general chemistry for third year high school) and who is knowledgeable enough to facilitate the interaction of ideas with a great performance in his previous class in chemistry. He also must have a long patience in entertaining questions with his teammates without telling the correct answers.

After finding the peer leaders, they were trained. A resource for leader training is *Peer-Led Team Learning: A Handbook for Team Leaders* by Roth, Goldstein, and Marcus (2001) was utilized in the study. In their manual, the following areas should be tackled in the training: content knowledge, pedagogical knowledge, pedagogical content knowledge, and leadership roles. In the content knowledge, leader must be confident with his own understanding of the concepts. Second, in pedagogical knowledge, it is necessary for the leader to motivate interaction within the members of the group and group dynamics. Next, is the pedagogical content knowledge, it explains specific teaching strategies and methods that affect students understanding in a particular content area. Since, leaders didn't have their experiences in teaching yet; the teacher-researcher took charge in giving insight of a good strategy that they may use. The training of the leaders occurred all throughout the study. It begun with two days leader training before the implementation of the strategy, followed by one hour weekly meetings as the study progresses.

The teacher-researcher made the PLTL Workshops for the students and workshop guides for the peer leaders which were designed for group work. In addition, the actual materials were focused to enhance students' attention to specific concepts that have proven difficult to previous students. Although some of the questions were designed to provide students opportunity to practice using their newly acquired concepts, most of the questions focus on developing strong conceptual understanding in chemistry. The selected topics were the ones covered in the first grading period. These were Classifying Matter, Types of Matter-Pure Substances and Mixtures and Preparing, Separating, and Purifying Mixture. For each topic there were different activities prepared.

The PLTL Workshops consist of different activities which were used by the peer leaders for their group and the workshop guide which served as the guide for each peer leader in facilitating their own group. The PLTL Workshop drafts were given to three Chemistry and Chemistry Education experts. The panel of experts were Chemistry and Chemistry Education professors from Philippine Normal University (PNU), Manila. (See Appendix A for sample PLTL Workshop)

Table 1 summarizes the activities in each PLTL workshop.

Table 1

Summary of different activities in each PLTL workshop

Workshop Topic	**Activity**	**Concepts**	**Strategy**	**Skills**
Classifying matter	Pairing of mixture and identify either hetero-generous/homo geneous	Similarities and differences of homogeneous or heterogeneous	Activity based	Formulating concepts; manipulating materials.
	Picture identification of properties and changes in matter	Physical and chemical properties Pure	Predict-Observe-Explain	Analyzing pictures; distinguishing
	Comparison of Pure substance And Mixture Through actual materials	Substance and mixture	Discussion and debate, experimen-tation	difference reasoning, comparing

Types of Pure Substance And Mixture	Different-iating each type of mixtures through picture illustration and actual materials	Solution suspension, and colloid	Brain-storming Hands-on-Acti-vities	Recognizing differences; comparing and contrasting materials
	Comparing from metal/ nonmetal through actual materials	Metal and Nonmetal	Inspection of of materials	
	Classifying Compounds Through Chemical symbol analysis	Acids, Bases, salts	Interactive discussion	Categorizing materials and classifying; inferring
Preparing, Separating, and Purifying Mixtures	Preparing herbal medicines Preparing set-ups in ways of separating Mixtures	Preparation of mixtures Distillation, Filtration, Mechanical Separation, Decantation, and etc.	Hands-on activity Experimen-, tation Discussion round-robin format Schematic diagram	Manipulating materials; Creating set ups; Operating instruments; interpreting illustrations;
Purification Of Mixture	Purifying rock salts	Purification	Experimen-tation	Organizing procedures

The PLTL Workshop was divided into a three-week session. Each week has a certain activity. The first activity under the topic classifying matter was the pairing of mixture and identifying the system either homogeneous or heterogeneous. The students used the activity-based approach to observe the differences between the two systems. The second activity was the picture identification of the properties and changes in matter. Students used the predict-observe-explain to deeply understand the physical and chemical properties of matter. Additional concepts like changes in matter were given to further understand the lesson. The third activity was comparison between pure substance and mixture. The students used the discussion and debate within the group. Actual materials were provided which served as the springboard to arouse their interest for the comparison between the two. The fourth and last activity was the continuation about the properties of pure substance and mixture, wherein the students need to compare the boiling point and melting point. Performance and outputs in each activity were graded according to the rubrics prepared.

The second week workshop was about the types of pure substances and mixtures. The first activity in this part was the picture illustration of different mixtures. Actual materials for the types of mixtures were also provided for better understanding. Brainstorming and hands-on activities were the techniques used to classify the materials as solution, suspension, and colloid. The second activity was the counting of the number of atom and identifying the characteristics of elements and compounds. Students used the picture analysis and experimentation to deeply understand each concept. The third activity was comparing metals and non-metals using actual materials. The students compared their characteristics through different samples. They worked cooperatively to get the correct identification. The fourth and fifth activities were the classification of compounds through symbol analysis. But beforehand, the students did the experiment for the identification of acids and bases and organic and inorganic. Interactive discussion was the strategy used. Performance and outputs were graded according to the given rubrics ahead of time.

The third week workshop was about the preparation, separation and purification of mixtures. The first activity in this workshop was the preparation of medicinal plants which are very useful for easing pain. In this part, students must be aware with the help and usefulness of preparing medical plants which is an example of mixtures. The students work cooperatively within their group and used experimentation as the strategy. The second activity was observing the setups for the ways of separating mixtures. The students used the round robin strategy for the identification of the labelled parts. Aside from the picture illustration shown in the workshop students prepare different actual set-ups for the methods of separating mixtures. In this activity the students developed further understanding of the different methods. The third and fourth activities were the continuation of the second activity wherein the students fill in the correct information which is appropriate in each box. The students used brainstorming to polish the words and find the best answer in each box. Aside from that activity students also prepared actual materials which help them to easily identify the proper materials and method in each step. In every activity there was a scribe assigned to take down notes of necessary ideas. The last activity was about the purification of rock salt. In this part, students experienced purifying mixture. Performance and output of every group were graded according to the prepared rubrics.

Traditional Teaching Approach

The TTA was exposed the usual routine in teaching namely, motivation, review, lesson proper, generalization and assessment. The spring board was usually puzzle and group activity; review part was recalling the lesson discussed the other day lesson proper part was usually the passive way of teaching-lecture; the generalization part is always reciting the summary of the lesson; and the assessment stage utilizes the pen and paper test.

Data Collection Procedure

Two intact groups were utilized in the study. The first group used the Peer-Led Team Learning (PLTL) while the second group used the Traditional Teaching Approach (TTA). The researcher handled both classes so that the same lessons, quizzes and assignments were carried out; hence they differ only in terms of teaching strategy. The researcher also invited teacher- observers twice to observe in the PLTL class and TTA class to ensure that there is no teacher bias. A total of four (4) observations were done by the observer. The observations were conducted while the two groups were discussing the same topic.

Before the treatment, the two groups under study took the pretest in Chemical Concepts Inventory (CCI) to determine their conceptual ability and the Chemistry Attitudes and Experiences Questionnaire (CAEQ) to determine their attitude towards chemistry. One group was exposed to Peer- Led Team Learning (PLTL) while the another group was exposed to Traditional Teaching Approach (TTA). Posttest in Chemical Concepts Inventory and Chemistry Attitudes and Experiences Questionnaire were also administered simultaneously to both groups under study to eliminate possible threats to validity such as place and time.

Data Analysis Procedure

All computations and analyses of data were done with the use of the SPSS. The level of confidence in all the statistical treatments was set at 0.05.

Descriptive statistics such as mean, frequency, standard deviation and percentages were utilized in the item analysis for the data gathered during the pilot testing as well as the actual implementation.

Item analysis was used in determining the indices of difficulty and discrimination of the Chemical Concepts Inventory from the pilot testing data.

Cronbach alpha was computed from the data obtained in the pilot testing to establish the reliability of the Chemistry Conceptual Inventory and the shortened Chemistry Attitudes and Experiences Questionnaire.

Independent t-test was utilized to determine if there is a significant difference in the mean pretest and posttest scores in the Chemical Concepts Inventory for both PLTL and TTA classes.

Mann Whitney-*U* test was utilized to determine if there is a significant difference in the mean pretest and posttest ratings in the Chemistry Attitude and

Experiences Questionnaire. The Mann-Whitney *U* test provides an alternative to the parametric test when applied to the kinds of ordinal data typically generated by semantic differential and Likert-type scales (Adams, 1976).

Polarity profile was used to identify group differences in the mean pretest and posttest ratings in the Chemistry Attitude and Experiences Questionnaire.

Analysis of Covariance (ANCOVA) was also used to test whether the difference in the mean pretest and posttest ratings in the Chemistry Attitude and Experiences Questionnaire is statistically significant.

Chapter 4

PRESENTATION AND ANALYSIS OF DATA

This section presents the findings, analysis and interpretation of the data gathered from conducting the research.

The research was designed to identify significant change in students' conceptual understanding and attitude towards Chemistry using Peer- Led Team Learning among third year high school students.

Peer- Led Team Learning and Students' Conceptual Understanding

The pretest scores on the Chemical Concepts Inventory (CCI) were subjected to two-tailed independent samples t-test to establish the initial comparability of the Peer- Led Team Learning (PLTL) and Traditional Teaching Approach (TTA) approaches in terms of conceptual understanding. Then the posttest scores were analyzed for group differences using a one-tailed independent samples t-test.

Initial Comparability on Students' Conceptual Understanding

A two-tailed independent-samples t-test was conducted to compare the pretest scores of PLTL and TTA classes on the Chemical Concepts Inventory (CCI) as shown in Table 2. The results showed that there is no significant difference in the conceptual understanding pretest scores of the PLTL ($M=4.50$, $SD= 1.80$) and the TTA classes ($M=4.88$, $SD= 2.29$); $t(76) =-0.802$, $p = 0.425$. These results suggest that the PLTL and the TTA students' conceptual understanding were comparable prior to intervention.

Table 2

Independent Samples t-test on Conceptual Understanding Pretest

Group	N	Mean	SD	*t*	*df*	*p*
PLTL	38	4.50	1.80	-0.802	76	0.425
TTA	40	4.88	2.29			

Effects of Peer-Led Team Learning on Students' Conceptual Understanding

A one-tailed independent samples t-test was conducted to compare the posttest scores of PLTL and TTA students on the Chemical Concepts Inventory (CCI).

Table 3

Independent Samples t-test on Conceptual Understanding Posttest

Group	N	Mean	SD	*t*	*df*	*p*
PLTL	43	6.93	1.96	2.090	83	0.020
TTA	42		6.05	1.94		

Table 3 shows that there is a significant difference in the posttest mean scores in the CCI of PLTL *(M=6.93, SD= 1.96)* and TTA *(M=6.05, SD=1.94), t (83)=2.090, p =0.020.* This result suggests that the conceptual understanding of students who were taught using PLTL was enhanced compared to those who were exposed to TTA approach.

The three-week exposure of the students to intervention showed significant difference between the conceptual understanding of PLTL and TTA classes. This suggests that the Peer- Led Team Learning approach increased the conceptual understanding of PLTL students compared to the TTA students.

One possibility which increased the conceptual understanding of students is that they are always involved in hands-on activities. Most of their sessions were engaged in actual hands-on activities in which they learn more rather than lecture-type of discussion because of their involvement and actual experience in the activities. In the study done by Hillebrand (2003) showed that guided inquiry-based, hands-on activities help in improving conceptual understanding of chemistry concepts. Through her study she found out that the students widen their critical thinking skills and conceptual understanding through working with the activities.

Another factor associated to the significant difference could be the grouping of students. Small group was utilized in the study in which students interact with each other without hesitation. Everyone was free to express their own idea in a certain topic in every discussion. Alexopoulou and Driver (1998) cited in their study that Greek secondary school students progressed significantly more in their physics reasoning and conceptual understanding after participating in small group than pairs. In the study of Nicol and Boyle (2010) cited that peer instruction has a great improvements in conceptual reasoning and understanding compared to class-wide discussion in large classes.

Likewise, the presence of the peer leader who facilitated motivated, and encouraged the students to participate, think and do activities could also be another factor which helped the students to improve and develop their conceptual understanding in chemistry. The peer leader was not the one who gives the answers for the group but instead he facilitates the members to give direction in finding the correct answer for all the workshop activities. In the study done by Capstick and Fleming (2002) it gave emphasis on the acquisition by first years of a deeper understanding of course subject matter and the development of critical thinking skills with the presence of peer leader who facilitates in group discussion.

Workshop activities could also be another factor which contributes in better conceptual understanding of the students. These workshop activities were developed by the researcher prior to the intervention setting which was used for students learning.

Peer-Led Team Learning and Students' Attitude towards Chemistry

The pretest ratings on the Chemistry Attitude and Experiences Questionnaire (CAEQ) were analyzed using polarity profile to establish the initial comparability of the PLTL and TTA classes in terms of attitude towards Chemistry. Then the posttest ratings were analyzed for group differences using polarity profile also. In addition, Mann-Whitney U test was used in the CAEQ to test their difference in pretest and posttest scores.

Initial Comparability on Students' Attitudes in Chemistry

A polarity profile was constructed to compare the pretest ratings of PLTL and TTA classes on the Chemistry Attitude and Experiences Questionnaire (CAEQ) as shown in Figure 4. At most bipolar adjectives, the PLTL and TTA classes had different perceptions about each domain on attitude in Chemistry. Furthermore, there was large variation in one visible point in the graph on how students view chemistry jobs: varied/repetitive. This shows that students have lack of knowledge/idea about the chemistry jobs.

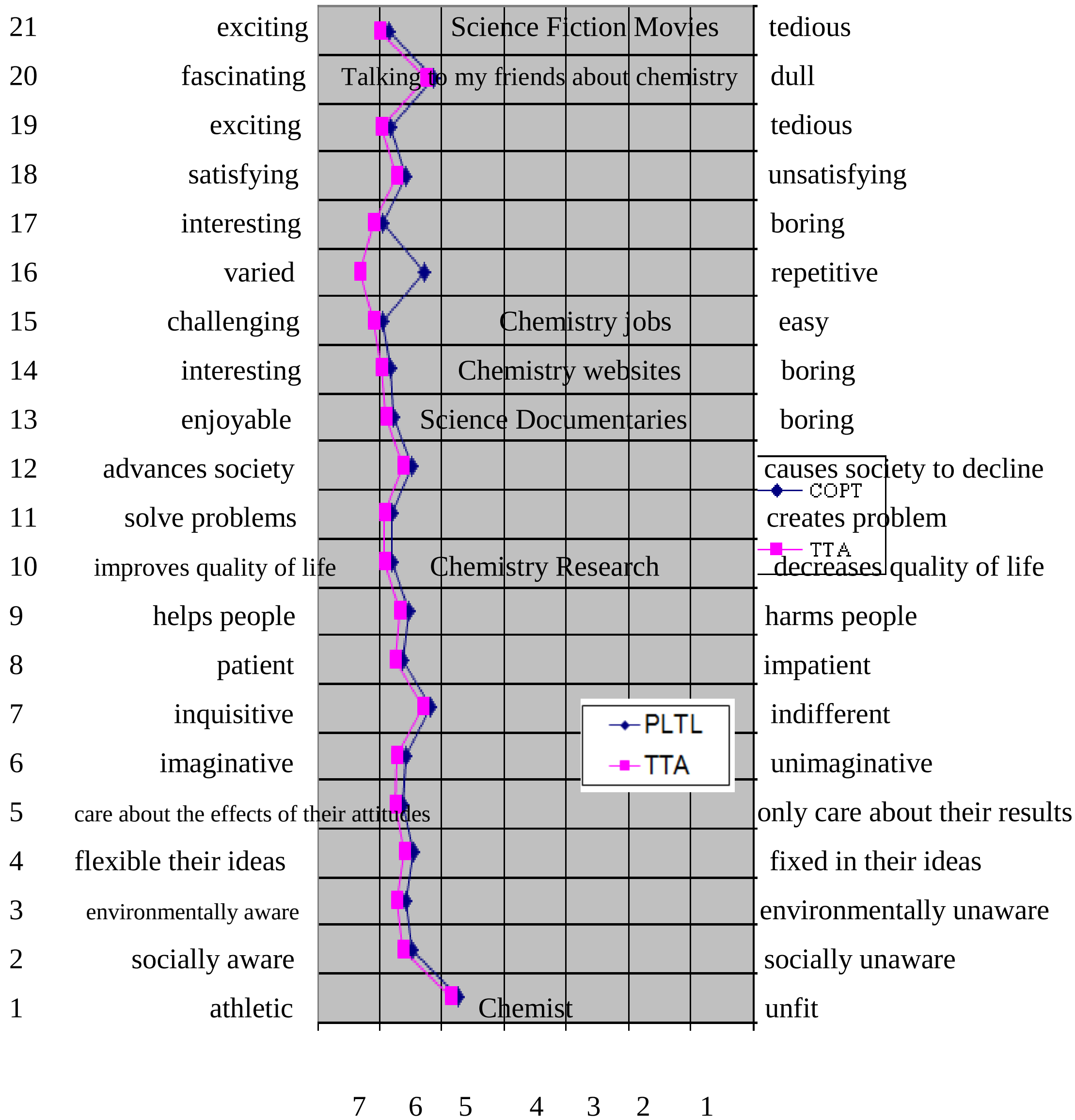

Figure 4 . Polarity Profile on Chemistry Attitude and Experiences Questionnaire Pretest

A two-tailed Mann-Whitney *U* test for two independent samples was also conducted to compare the pretest ratings of PLTL and TTA classes on the Chemistry Attitudes and Experiences Questionnaire (CAEQ) as shown in Table 4. The results showed that there is already a significant difference in the CAEQ pretest ratings of the PLTL class with *mean rank of 33.03* and the TTA class with *mean rank of 53.20; U =*

474.50, p = 0.0001. These results suggested that the PLTL and the TTA students' attitude towards Chemistry were not comparable prior to the intervention.

Table 4

Independent Samples Mann-Whitney U Test on Attitude in Chemistry Pretest

	N	Mean Rank	Sum of Ranks	*U*	*p*
PLTL	43	33.03	1420.50	474.50	0.0001
TTA	42	53.20	2234.50		
Total	85				

Effects of Peer- Led Team Learning on Students' Attitude towards Chemistry

A polarity profile was constructed to compare the posttest ratings of PLTL and TTA students on the Chemistry Attitude and Experiences Questionnaire (CAEQ) as shown in Figure 5. The polarity profile shows differences with that of the pretest and posttest results. But posttest shows more consistency or uniformity between groups. At most bipolar adjectives, the PLTL and TTA classes have different perceptions or view about each domain on attitude towards Chemistry. These are visible points in the graph such how students view chemists: athletic/unfit and socially aware/socially unaware; how students view chemistry research: helps people/ harms people and improves quality of life/ decreases quality of life; how students view Chemistry websites: interesting/boring; and how students view chemistry jobs: varied/repetitive.

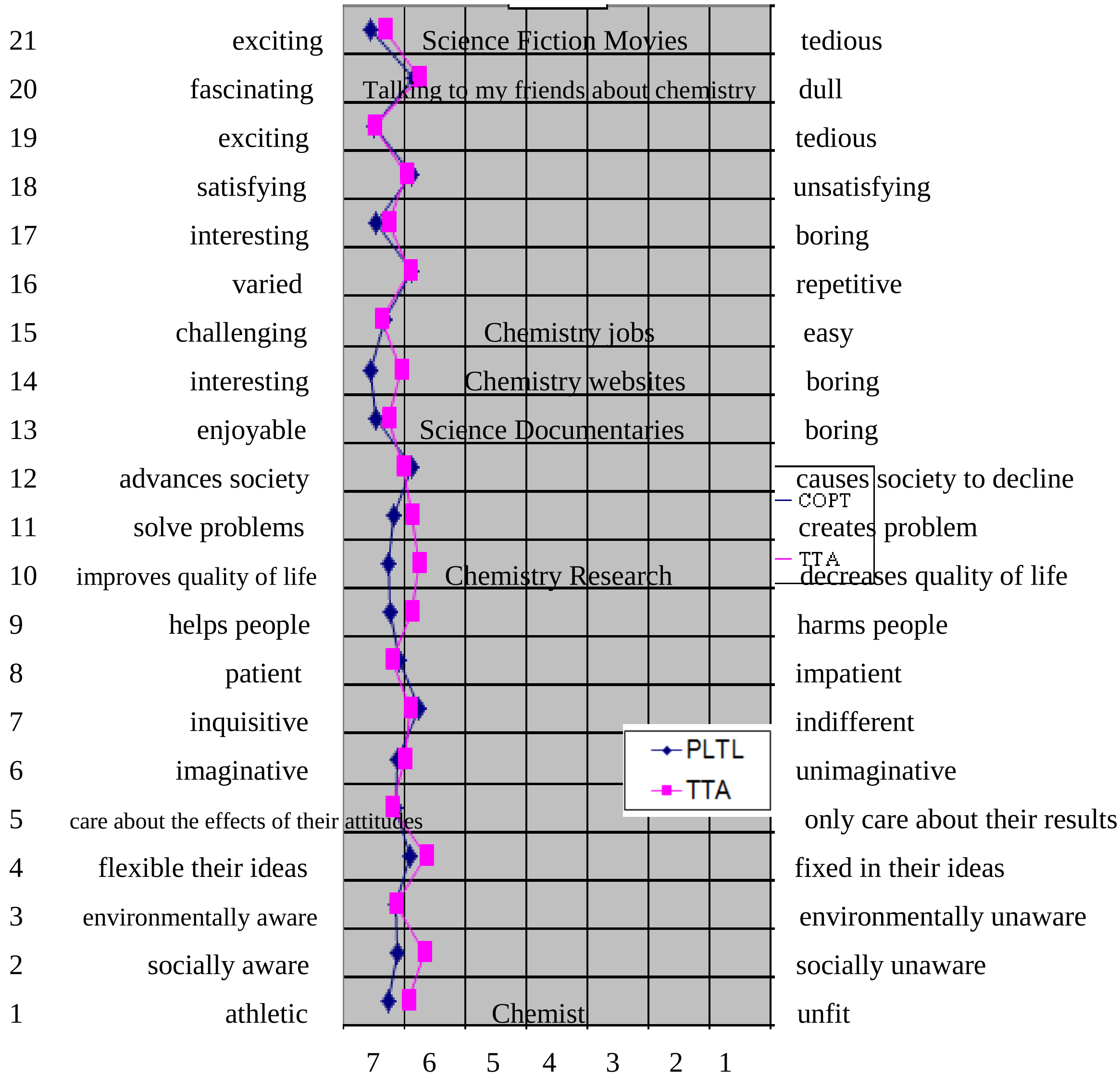

Figure 5. Polarity Profile on Chemistry Attitude and Experiences Questionnaire Posttest

Comparing the pretest and posttest polarity profiles of PLTL and TTA classes, it is noticeable that some points increased and, some points decreased, whereas, others remain the same. Table 5 summarizes these observations.

Table 5

Summary of scores of CAEQ Item Numbers which increased, decreased or remained the same in the Pretest and Posttest Polarity Profile.

Group	Increased		Decreased		Remained the Same	
PLTL Only	1, 2, 3, 5, 6, 7, 9, 13, 14, 15, 16, 19, 20, 21	14	none	0	4, 10, 18	3
TTA Only	none	0	2, 4, 9, 10, 18	5	5, 6, 7, 13, 14, 15, 16, 19, 20, 21	10
Both PLTL and TTA	none	0	none	0	8, 11, 12, 17	4

Based on the table, it shows that the result of the PLTL and TTA groups differ from each other. This implies that the PLTL class' attitude towards science positively changed as compared to the TTA class.

It is noticeable that there was an increase in the rating for items 1, 2, 3, 5, 6, 7, 9, 13, 14, 15, 16, 19, 20, 21 after the intervention. These items show how students view chemist: athletic/unfit; socially aware/socially unaware; environmentally aware/environmentally unaware; care about the effects of their attitudes/ only care about their results; imaginative/ unimaginative;

inquisitive/indifferent. At the same time, these items which students view chemistry research: helps people/ harms people; science documentaries: enjoyable/boring; chemistry websites: interesting/ boring; chemistry jobs: challenging/ easy; varied/repetitive; exciting/ tedious; talking to my friends about chemistry: fascinating/ dull; and last is science fiction movies: exciting/ tedious. This shows that students exposed to PLTL changed their perception in favor of the positive impact of chemistry and related topics. The PLTL exposed students in different areas such as exposure to different strategies of teaching, encounter new colleagues, exchanging ideas and opinions with the group, building self-confidence, developed different skills and broaden their knowledge about the facts in chemistry. These can be the reasons for the increase in the positive perception in all aspects of the chemistry attitudes and experience questionnaire.

A one-tailed Mann-Whitney U test for two independent samples was also conducted to compare the posttest ratings of PLTL and TTA classes on the Chemistry Attitudes and Experiences Questionnaire (CAEQ) as shown in Table 6. The results show that there was a significant difference in the CAEQ posttest ratings of the PLTL class with mean rank of *49.93* and the TTA class with mean rank of *36.76*; $U = 641.0$, $p = 0.0140$. These results suggest that the PLTL positively increased attitude towards chemistry as compared to the TTA class.

Table 6

Independent Samples Mann-Whitney U Test on Attitude towards Chemistry Posttest

	N	Mean Rank	Sum of Ranks	*U*	*p*
PLTL	43	49.93	2197	641.0	0.0140
TTA	42	36.76	1544		
Total	85				

It was hypothesized that students from the PLTL group would show a significantly higher mean rating on CAEQ than those students in the TTA group. The pretest rating in Chemistry Attitudes and Experience Questionnaire of PLTL and TTA group was presented in Table 4 to observe the initial comparability of PLTL and TTA groups. Table 4 shows that a *p= 0.0001* suggests that the CAEQ pretest mean rating of the PLTL group is significantly higher than that of the TTA group, thus it can be said that the two groups had different attitude towards chemistry before the implementation of the treatment.

Table 6 shows the posttest rating in chemistry attitude and experience questionnaire of the PLTL and TTA group. The mean rating in chemistry attitude and experience questionnaire of the PLTL group is *49.93* and the TTA is 36.76 while the sums of rank were *2197*and *1544* in favour of the PLTL group. It shows that the PLTL group had a numerically higher posttest mean rating in the CAEQ compared to the TTA group whereas the pretest mean rating was numerically higher for the traditional teaching approach group (TTA).

Table 7

Mean Rank and Standard Deviation of CAEQ Posttest Ratings

Group	N	Mean Rank	SD
PLTL	43	133.488	11.879
TTA	42	127.357	11.131

To see if the mean posttest rating was indeed significantly higher, Analysis of Covariance (ANCOVA) was done using the CAEQ pretest mean score as a covariate. The results of the ANCOVA are shown in Table 8. As shown in the table, the main effect of treatment after removing the effects of the covariate is significant, $F(1, 82)= 6.270, p=0.014$. That is, p $(0.014) < .05$. The observed F ratio indicates that there is a significant difference on the CAEQ posttest between PLTL and TTA group. This means that the attitude of the students under PLTL group was significantly enhanced.

Table 8

Analysis of Covariance (ANCOVA) on Attitude towards Chemistry Posttest

Source	Sum of Squares	*df*	Mean square	*F*	*Sig.*
Corrected Model	861.141(a)	2	430.571	3.226	.045
Intercept	12027.736	1	12027.736	90.120	.000
PRE	62.422	1	62.422	.468	.496
GROUP1 (PLTL)	**836.780**	**1**	**836.780**	**6.270**	**.014**
Error	10943.965		82	133.463	
Total	1458463.000		85		
Corrected Total	11805.106		84		

In the implementation of PLTL, the workshop was done in the classroom every meeting. After the class activity each group was expected to submit the group output and it is required that one or two members explain the results gathered by the group. Based on the consultation done by the researcher to the chosen peer leaders, everyone was willing to give their opinions and ideas which helped the group finish their work on time with great enthusiasm. This could be one of the evidences which show the positive attitude of the students toward the intervention. Sharan (1980) cited that through the medium of interaction and communication process within small groups cooperating on academic tasks, which these team learning methods strive to influence pupil’s cognitive learning, their attitudes towards learning and school and their relations with members of other group in ethnically heterogeneous classrooms.

In addition, students were also motivated to participate with the group because of the harmonious relationship formed between the peer leader and the members. In the study of Maria, Santos and Mortimer (2003), showed that positive emotions shapes the relationship between the facilitator and the students which increase the positive behaviour towards chemistry. Harmonious relationship was accompanied by active participation of the students. A study done by Pardhan (2004) found out that active engagement enhanced interest in Physics among students. Similarly, Paris, Yambor and Packard (1998) showed that active participation in hands –on activities in Biology positively enhanced interest in the subject.

Moreover, the faculty members who observed both the PLTL and TTA classes noticed a great difference in the conduct of the study. The first observer said that the students in PLTL are strictly student-centered wherein the members are actively involved in group discussion while in the TTA class is purely teacher-centered.

Also, according to the observers, students performed their tasks and participated actively in group discussions. They also observed that the positive attitude towards learning were evident based on their performance. On a study done by Sesen and Tarhan (2010) about teaching acids and bases based on constructivist approach, they revealed that active participation among students positively enhanced achievement and attitude towards Chemistry. Similarly, Pardhan (2004) found out in his study that active engagement enhanced interest in physics among students.

Chapter 5

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This section presents a brief summary of the study, the conclusions drawn from the analyses of data, and some recommendations for the use of education stakeholders and researchers.

Summary

The study determined the effectiveness of Peer- Led Team Learning in enhancing students' conceptual understanding and positive attitude toward chemistry. The PLTL exposed students to PLTL workshop activities which developed their conceptual understanding in selected topics in chemistry.

It employed a pretest-posttest quasi-experimental research design that involved 88 third year high school students from two intact heterogeneous classes in a public secondary school in Pasig City.

The classes were randomly assigned to two teaching approach groups namely peer- led team learning approach (PLTL) and traditional teaching approach (TTA). Students were exposed to the intervention during the whole month of August, school year 2013-2014.

Two (2) research instruments were used in the study, namely, the Chemical Concepts Inventory (CCI) and the Chemistry Attitudes and Experiences Questionnaire (CAEQ). The CAEQ was a shortened version. They were validated by a panel of experts and were pilot tested to establish their reliability. All instruments were administered prior to the intervention.

The PLTL used the same routine in teaching and learning process: motivation, lesson proper, generalization and assessment with the presence of the peer leader which served as the facilitator in each group instead of the teacher who handled the class all throughout the period. The students were oriented ahead of time regarding the flow of the lesson for the entire intervention period. Especially on assigning them student peer leaders instead of the teacher. The motivation stage made use of interactive questions, which stimulate their minds in addition to demonstrations, puzzles and predict-observe-explain or POE activities. In the lesson proper, peer leaders took charge in this part. They facilitated the groups using the validated PLTL workshop guide made by the researcher. They made use of cooperative learning, hands-on activities and experimentation, brainstorming, round robin strategy, inquiry, discovery learning and discussion within the group to increase student's participation. The generalization stage made use of group presentations and reporting of what they learned in their discussion. The assessment stage made use of the group output aside from the usual quizzes and long tests. In addition, it is important that activity questions were presented after the group activity to clarify the answers to every question.

The TTA was exposed to the usual routine in teaching namely, motivation, review, lesson proper, generalization and assessment. The spring board was usually puzzle and group activity; review part is recalling the lesson already discussed; lesson proper part is usually the passive way of teaching-lecture; the generalization part is always reciting the summary of the lesson; and the assessment stage utilizes the pen and paper test.

The three-week intervention was extended to almost four weeks due to flooding in the area brought about by the monsoon rains and typhoon Maring. At this time students were disrupted with the flow of intervention. The instruments that were administered as pretests were also used as posttests.

An independent sample t-test was used to compare the mean scores of the two classes in the pretest and postest of the Chemical Concepts Inventory (CCI). On the other hand, mean ratings of the two classes in the Chemistry Attitudes and Experiences Questionnaire (CAEQ) were subjected to polarity profile, Mann-Whitney *U*-test, and Analysis of Covariance (ANCOVA). All statistical treatments, computations, and analyses of data were done with level of confidence of 0.05.

Analyses of data showed the following results:

1. The mean posttest score in the Chemical Concepts Inventory was significantly higher for students exposed to PLTL than for students exposed to TTA.
2. The mean posttest in Chemistry Attitudes and Experiences Questionnaire was significantly higher for students exposed to PLTL than for students exposed to TTA.

Conclusion

From the results enumerated, the following conclusions were drawn from the study:

1. The Peer-Led Team Learning approach in chemistry was effective in enhancing students' conceptual understanding.
2. The Peer-Led Team Learning approach in chemistry was effective in enhancing students' attitude towards chemistry.

Recommendations

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

For future researchers in chemistry education and science education, investigate the effectiveness of the PLTL not only in terms of students' conceptual understanding and attitude towards chemistry but also to students' achievement, problem solving skills, decision making skills and self-efficacy. In addition, vary some aspects of the implementation of Peer- led Team Learning workshop such as:

1. Investigate the effects of PLTL in elementary setting to test whether this will produce also a significant effect on conceptual understanding and attitude towards science or not.

2. Investigate the effects of PLTL workshop in Grade 9 to test whether this will also produce a significant effect on conceptual understanding and attitude towards science or not.
3. Investigate the effects of having peer leaders in every classroom discussion in any science subject areas to test whether this will produce significant effect on conceptual understanding and attitude towards science.
4. Investigate the effects of using workshop sheets and activities as an alternative assessment in the classroom discussion in science.

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APPENDICES

Appendix A

WORKSHOP

Week 1

Classifying Matter: Pure Substance and Mixture

Day 1

1. Everything you see is matter. It is important to know the similarities and differences of each.
   Make a mixture out of each pair and identify if the system either homogeneous or heterogeneous.
   a. Sugar and water
   b. Mongo beans and corn grains
   c. Cooking oil and water
   d. Aluminium foil and iron nail
   e. Sugar and cooking oil

   What observations will make you decide that a system is heterogeneous? Homogeneous?

Day 2

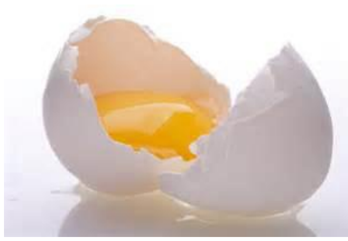
2.1. Classify the following as either physical or chemical property.

a. The salt is white.
b. The temperature this morning is 22^0 C.
c. Fumes are produced when bleached is mixed with vinegar.
d. The milk curdles in vinegar.
e. Candle melts when heated.

These items show properties of matter while undergoing changes. Explain your reasoning.

Day 3

2.2. Identify each illustration as physical or chemical change.



Frying egg cracking egg slicing bread

Lighting a match

roasting chicken

rusty nails

Ice melting

glass breaking

boiling water

Baking a cake

mowing a lawn

fireworks

Differentiate physical change from chemical change based on thegiven illustrations.

Day 4

3.1. Make a definition of pure and mixture in separate poster paper. Give examples which you consider pure on one side and mixed substance on the other side. Make a connection between pure substance and mixture.

Show the actual materials and categorize them according to their characteristics.

1 small tub of Playdough
1 Piece of granite
Water and food coloring mixture

Oil, water, soap immersion
¼ cup of Sand
Iron filings, sugar, and wood
¼ cup chalk powder (calcium carbonate and salt)
Small sample of Shaving cream in plastic bowl

Day 5

3.2. Consider the data for boiling point determination of distilled water and salt water. Fill up the table base on the observation.

Procedure:

a. Boil the distilled water until it reach its boiling point.
b. After 30 seconds measure the temperature and record to the table.
c. Repeat measuring the temperature after 60 seconds and 90 seconds. Afterwards record your observation.
d. Reapeat procedure with the salt water.

Chemical Sysem	Boiling Temperature (^{0} C)			
	start	30s	60s	90s
Distilled water	100			
Salt water	110			

1. Which is the pure substance?
2. Which is the mixture? Explain your reasoning based on your observation.

3.3. Materials C and D are tested for their melting points. The results are given below. Based on the melting point difference, identify whetherthe material is a mixture or a pure substance. Explain your reasoning.

Material	Melting Temperature (^{0} C)		Temperature Difference	Pure Substance or Mixture
	Initial	Final		
C	40	40		
D	65	72		

WORKSHOP GUIDE

Week 1

Classifying Matter: Pure Substance and Mixture

Question 1.Activity- based approach is a great technique to really observe the differences between homogeneous and heterogeneous system. In a group, two members work in every assigned materials.

The workshop leader randomly assigns students in mixing the assigned materials. He can act as scribe.After all the task is through,the students bring together to compare, summarize, and discuss the results through illustration on the table form format.

Take Home Points. The leader may suggest the appearance, kinds and number of phases used to distinguish homogeneous and heterogeneous mixtures.

Question 2.1. The best technique is the Observe-Predict-Explain. The students will identify the specific property which best describes the statement and classify them accordingly.

2.2. question is use to deepen their understanding on physical and chemical properties wherein these materials undergo change as well. Members of the group talk about the differerent illustration about the changes thathappened and collate their answers afterwards.

Question 3.1 The students make connections between pure substance and mixture to the words pure and mixed. Discussion and brainstorm within the group are applicable techniques to enhance students understanding between pure substance and mixture. Actual materials serve as springboard to arouse their interest for the comparison between the two. Questions 3.2, 3.3 are just a continuation of developing concepts. The leader may guide the students in getting the boiling point and melting point of the sample and analyze.

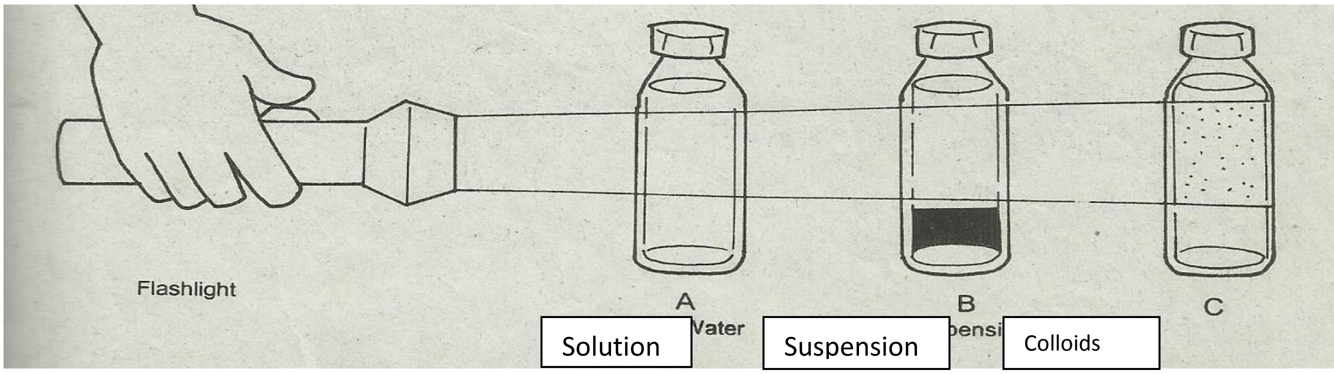
WORKSHOP

Week 2

Types: Mixtures ; Pure Substances

Day1

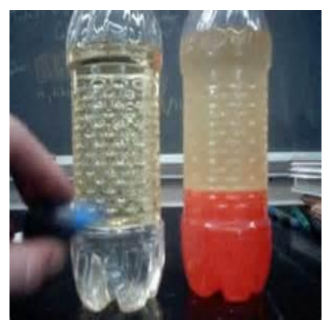
1.1. Study the illustration below. Describe and make statements about the types of mixtures.



1.2. Tell whether the mixture is a solution, suspension, or colloid. Explain your reasoning.

1.

2.



3.

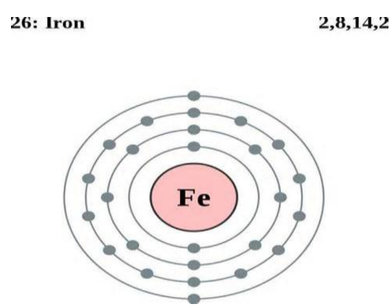
4.

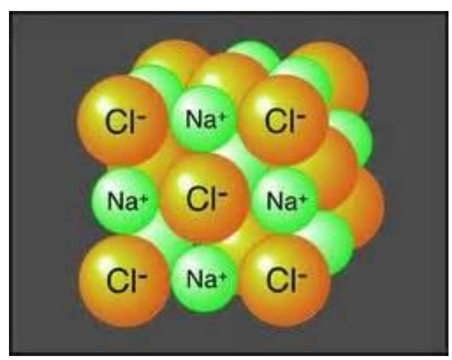
5. 

7. 

Day 2

2.1. The illustration shows an element and compound. Compare the number of atoms present in each.





2.2. Classify the element and compound base on the observation.

Chemical System	Properties before Heating			Properties After Heating		
	Color	Odor	Taste	Color	Odor	Taste
Iron fillings						
sugar						

Caution: Do not taste the iron fillings.

1. What properties after heating are different from those of the original or unheated ones?
   a. Iron fillings____
   b. Sugar____
2. Which of the given substances has the same property before and after heating?
3. Differentiate element and compound based on your observation.

Day 3

2.3. A molecule of water has three atoms: H_2O= two hydrogen atoms and one oxygen atom. Encircle the elements in the box needed to complete the following compounds and write theelement and number of atoms present in each element on the space provided.

1. Methane (gas)- CH_4= ___________________________________
2. Carbon dioxide- CO_2=___________________________________
3. Silicon dioxide- SiO_2=___________________________________
4. Sulphuric acid- H_2SO_4= ___________________________________
5. Calcium chloride- $CaCl_2$=________________________________
6. Calcium sulphate- $CaSO_4$=________________________________
7. Potassium chloride-KCl=__________________________________

O	**O**	**H**	**H**	**C**	**Cl**	**O**	**H**	**O**	**OCl**
O	**H**	**Ca**	**O**	**Cl**	**C**	**O**	**Si**	**S**	**Ca**
					O				
H	**O**	**Cl**	**O**	**S**	**K**	**H**	**O**	**Na**	

Notice two of the uncircled element symbols. When these two elements are combined, they will form a compound which is a well known seasoning. What is it?

3.Which of the given chemical systems are metals? Non-metals?Explain your reasoning.

a. copper wire

b. magnesium ribbon

c. aluminium foil

d. rubber band

e. candle

f. coin

g. plastic button

Day 4

4.1. Compare the three sets of compounds below. What is common in their formulas in each set of compound? Make a description of acids, bases, and salts based on your analysis.

Acids	Bases	Salts
HCl	$Al(OH)_3$	$NaCl$
H_2SO_4	$Mg(OH)_3$	$Ca_3(PO_4)_2$
HNO_3	$NaOH$	$NaHCO_3$

4.2. Classify the compounds as acids,bases or salts. What are the basis used in classifying the substances? Explain your reasoning.

1. NH_3
2. HNO_3
3. H_2SO_4
4. $NaCl$
5. H_2CO_3
6. $NaOH$
7. $Ca(OH)_2$
8. NaF
9. KCl
10. $Mg(OH)_2$

Day 5

5. Analyze the two sets of formulas shown below.

Set A (Inorganic)	Set B (Organic)
Calcium oxide, CaO	Methane, CH_4
Sodium nitrite, $NaNO_2$	Ethanol, C_2H_5OH
Magnesium sulphate, $MgSO_4$	Acetone, CH_3COCH_3

What common elements are present in Set B that are not found in Set A?Make your own description regarding organic and inorganic compounds.

6. Match the given elements and compounds in column B with their corresponding uses in column A. Write the letter of your choice in the answer sheet.

A	B
1. Used in industry as a purifier	a. calcium and phosphorus

2. Major components of cement	b. potassium nitrate
3. Important for the normal functioning	c. borax
of the thyroid gland	d. carbon
4.Used as a meat preservative	e. barium sulphate
5. Essential for the development of	f. xenon
bones and teeth	
6. Used in x-ray photographs.	g. calcium carbonate
7.Used by dentists to fill cavities	
In teeth.	h. silver and mercury
8.Used as antiseptic, detergent	i. fluoride
and water softening agent .	
9.Used in making coolants for refrigerators	j. iodine
and propellants for aerosol spray,	
added also to toothpaste and drinking water.	
10. The gas in the tube of a photographer's	
electronic flash and high powered-	
electric lamps.	

WORKSHOP GUIDE

Week 2

Types: Mixtures ; Pure Substances

Question (1.1, 1.2) shows the difference among the three types of mixtures. The group brainstorms about the characteristics of the mixtures. The leader can act as scribe while they are brainstorming. It is more effective to bring each group different materials to describe and classify base on their appearance.

Pure substances are classified into elements and compounds. It is important to show the difference by building a model of an element and a compound using modelling clay. Members of the group work cooperatively to identify the difference of elements and compounds in *Question 2.1.*

*Question (2.2, 2.3)*is a continuation of developing deep understanding about elements and compounds. The leader can group the members into four to do the activity.He can also assign each member to identify the elements present in a compound and let each one share the answer to the group for the discussion.

Question 3 extends the activity about elements to either metal or non-metal by identifying their properties. Actual materials help students deeply compare their differences.

Take Home Points: Examine each material through the observe property in order to get the correct identification.

Compounds are classified into acids, bases, and salts as well as organic and inorganic. Before they proceed with the analysis of the table, let each member taste the food (sampalok candy, salt, tea). Interactive discussion is a strategy which is best in Questions 4,5, and 6. The leader can act as scribe to take down important notes.

WORKSHOP

WEEK 3

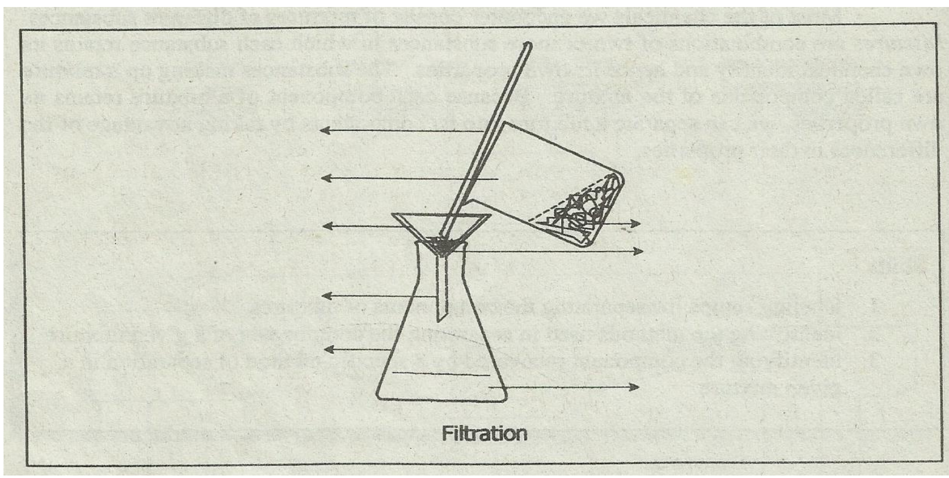
Preparing, Separating, and Purifying Mixture

Day 1

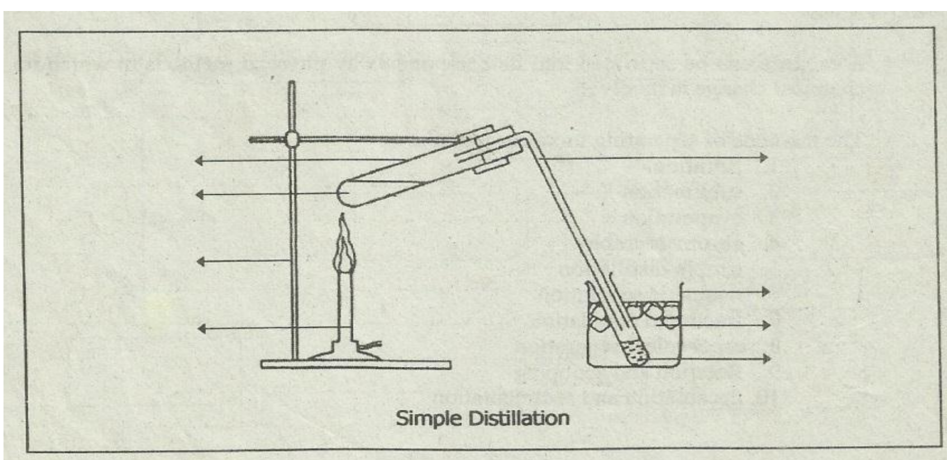
1. The Philippines is blessed with a variety of flora from which useful materials can be obtained. The active ingredients of these plants can be extracted from the fruits, leaves, barks and roots. When purified, they can be used in many medicinal preparations. Plan ways to prepare herbal medicines which help people to ease their pains like muscle pain, stomach pain, insect bites, etc.

Day 2

2 .1.Label the setups shown below.



Filtration



Simple Distillation

2.2. You were given a mixture composed of three substances with different properties. *Substance A* can escape from the solid directly to the gaseous phase. *Substance B* is soluble in water. Its solubility is 36.7 g/100 ml of cold water. *Substance C* is insoluble in water. How will you separate the component of mixture.

Arrange the steps to be undertaken in the given situation and identify the process involved. Use letters A to E to arrange and write the process on the blank after each step.

_____1. Add water to the mixture and stir it.________________________

_____2. Heat the solution to remove the water.________________________

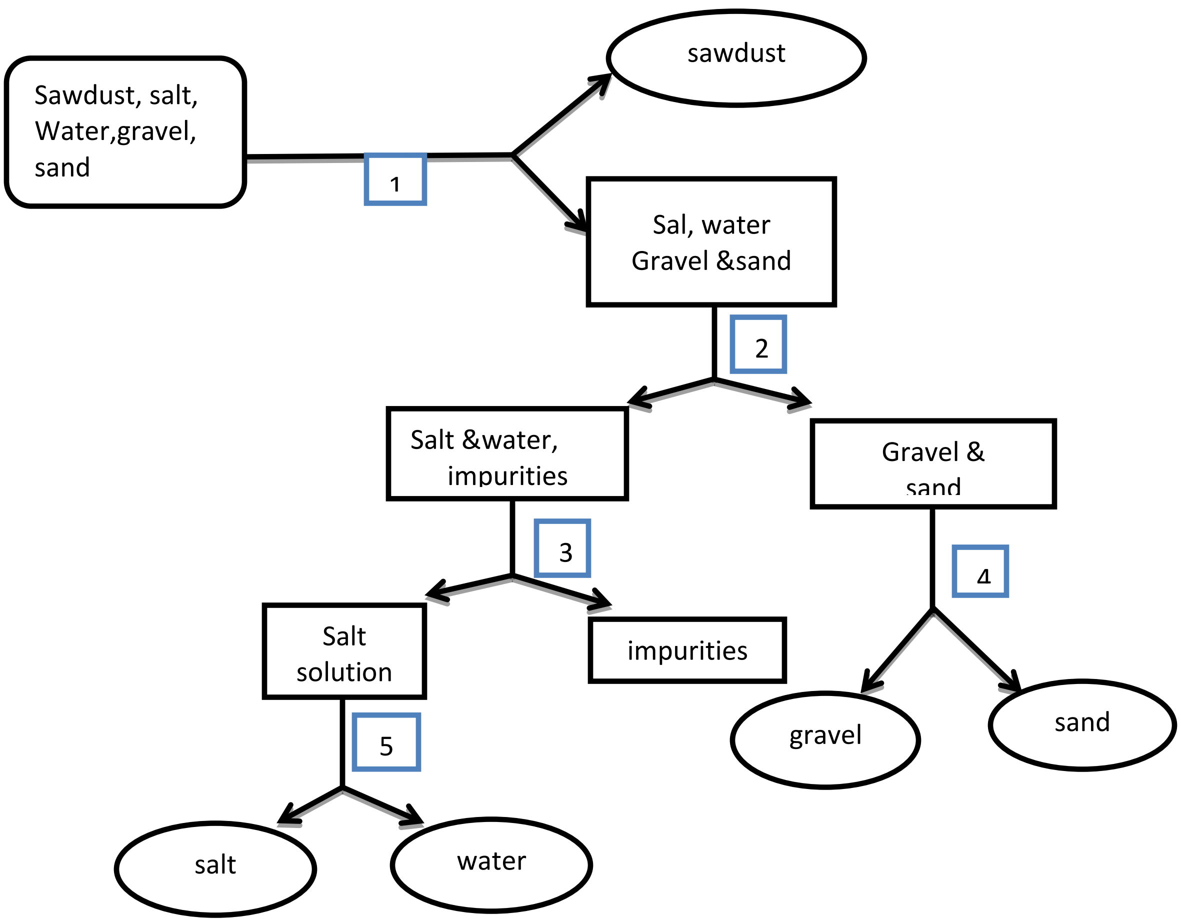
_____3. Set aside the insoluble substance and let it dry._______________

_____4. Transfer the solution to another container and wash the residue several times with water. ______________________

_____5. With an ice cube on an evaporating dish sitting on top of the beaker with the mixture, heat the beaker over a low flame._______________

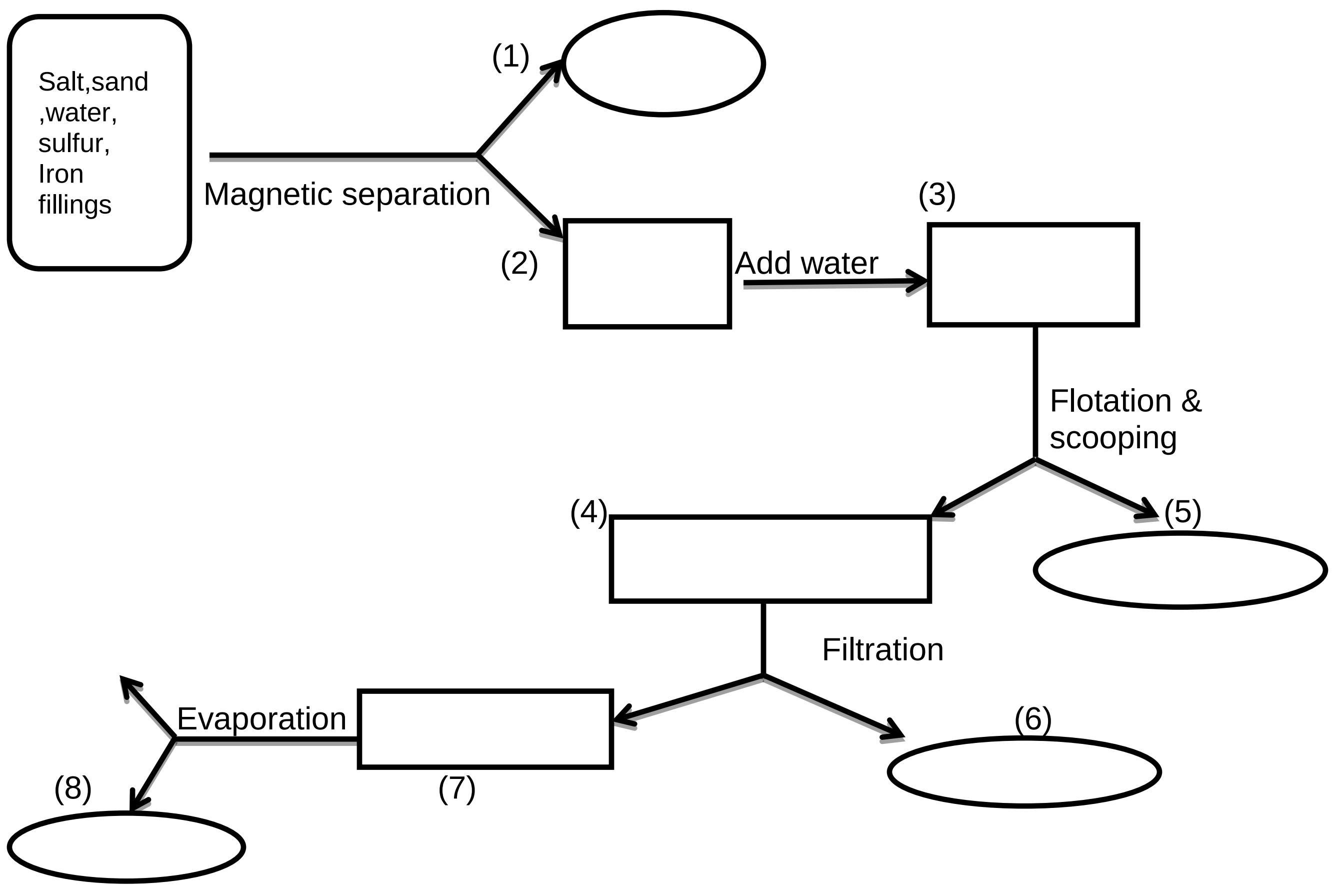
Day 3

2.3. Complete the schematic diagram on separating the given mixture by identifying the methods used



Day 4

2.4. Complete the schematic diagram on separating the given mixture by identifying the component recovered by using a particular method.



Day 5

3.Plan steps to be followed on purifying rock salts.

WORKSHOP GUIDE

WEEK 3

Preparing, Separating and Purifying Mixtures

Making useful mixtures like medicine, extracting important substances from naturally occurring mixtures and separating mixtures into their components as in processing coconut meat to obtain oil are important physical activities associated with chemistry.*Question 1*emphasizes the importance of preparing a mixture which helps eases pain. The group collates information in preparing mixtures through sharing what they know. The leader may assign one member to write all important details which can help them to formulate their plans in preparing useful mixtures which can ease pain. Afterward, the group tries to prepare a mixture.

Questions 2.1, 2.2are warm up activities which help every group in separating mixtures. Through the illustration the students think critically what the instruments and materials are.

*Questions 2.3, 2.4*focus on methods of separating mixtures and identifying the components recovered through particular methods. This can be discussed using a round-robin format for the workshop group. The workshop leader assigns a student to each task. The group then follows the steps to the solution. One member of the group can write the aswer on the shapes provided. After all, the group brainstorms their answers.

Question 3 emphasizes the purification of rock salt. Experimentation is the technique which can use in this part to determine the steps in purifying mixture.

Appendix D

Learning plan comparison between PLTL and TTA classes on the topic Matter

PLTL

Motivation:

Prior to the start of the lesson, the PLTL is already explained and the class had already grouped into sevento eight members. Each group has each own peer leader who facilitated the members. There is also a prepared PLTL Workshopfor the leaders which they used for the entire class sessions.

Activity: Homogeneous and Heterogeneous System of Matter

Show to the students a set of materials: 1) orange juice 2) halo-halo and sand and gravel. Let the students differentiate the two sets.

Lesson Proper

Activity: PLTL Workshop Activities

(1)The class is divided into six groups with seven to eight members.

(2)Each group has each own peer leader who leads the group.

(3)The task of each group is refer to the PLTL workshop prepared and evaluated ahead of time.

Day 1: "Homo or Hetero"
Day 2: "What's yourProperty"
Day 3: " Changes occur in Matter"
Day 4: "Is it Pure or Mixed?"
Day 5: "Melting and Boiling Point"

Concept Development: Homogeneous and Heterogeneous System

(1)Group describes homogeneous and heterogeneous through activity-based approach(actual materials are evident).

(2)Studensts compare, summarize, and discuss the results of their observation through illustration on the table form format.

(3)Each group explains their output through think aloud thechnique.

(4) Peer leader gives different mixtures and students identify the mixture through giving evidences based on the appearance, kinds and number of phases.

Concept Development: Physical and Cemical Property

(1)Groupidentifies the specific property which best describes the statement and classify them accordingly through Observe-Predict-Explain technique.

(2)Students differentiate the physical and chemical property through the actual materials shown.

(3)Group discusses their output infront so that everyone will become aware with their similarities and differences.

(4) Peer leader gives details in addition to the physical property either intensive or extensive by giving situations which students best describe the differences between the two.

(5) Students formulate description about the lesson.

Concept Developent: Physical and Chemical Change

TTA

Motivation

Activity: Homogeneous and Heterogeneous System of Matter

Show to the students a set of materials: 1) orange juice 2) halo-halo and sand and gravel. Let the students differentiate the two sets

Lesson Proper

Concept Development: Homogeneous and Heterogeneous System

(1)Students identify the difference between homogeneous and heterogeneous through the example shown a while ago.

(2) Teacher posted on the board the definition of of the two.

(3) Students realize that their answer is correct based on the evidence given by the teacher.

(4) Teacher posted on the board different mixtures and let the students answer it correctly. The teacher checks the work.

Concept Development: Physical and Chemical Property

(1)Teacher explains the difference between physical and chemical property by showing examples.

(2)Students realize the difference between physical and chemical property.

(3) Teacher again posted on the board the definition of intensive and extensive property of matter and ask the students to give examples based on the definition.

(4) Teacher gives boardwork exercises and let the students identify the appropriate property with each statement.

(5)The teacher checks their work.

Concept Development: Physical and Chemical Change

(1) Teacher explains the physical and chemical change by citing an instance or examples which show changes happened in matter.

(2)Students gives examples of physical and chemical change which they know.

(3) Teacher gives exercises and let the students identify either physical or chemical change.

(4)Teacher checks their work.

Concept Development: Pure Substance and Mixture

(1)Teacher asks students about ther ideas on pure substance and mixture.

(2)Teacher posted on the board the definition of the two.

(3)Students realize the meaning of the two.

(4)Teacher ask examples of pure substance and mixture and students give it according to their understanding.

Generalization/ Synthesis

Students enumerate the two systems;the properties and changes; and their differences.

Students describe the difference between pure substance and mixture.

Assessment

Boardmwork, seatwork, quiz

(1) Students give statements on changes in matter.
(2)Group identifies the change occur in each picture and let each one gives evidence which serves as proof.
(3) Peer leader shows an example and let the group identifies either physical or chemical change occur and evaluate the ir reason.
(4) The group describes the differences between physical or chemical change.

Concept Development: Difference between Pure Substance and Mixture

(1) Group makes a definition of pure and mixture in separate poster paper then give examples which they consider pure on one side and mixed substance on the other side and makes a connection between pure substance and mixture.
(2) Group prepares the actual materials and categorize them according to their characteristics.
(3) Members of the group compare, discuss and brainstorm the difference between pure substance and mixture
(4) To deepen their understanding about the pure substance and mixture the melting and boiling point of two samples are determined through showing in an experiment.
(5) Students realize the difference between the two through the melting and boiling point .

Generalization/Synthesis

(1) Every member of the group contributes an idea to sum up each lesson: homogeneous and heterogeneous; physical and chemical property and changes; and pure substance and mixture.
(2)Group presents their output

Assessment

Individual performance and group performance based on their peer leader,seatwork, quiz, output based on the PLTL workshop.

Appendix B

Conceptual Questions (CQs): Chemical Concepts Inventory

This inventory consists of 22 multiple choice questions. Carefully consider each question and indicate the one best answer for each. Several of the questions are paired. In these cases, the first question asks about a chemical or physical effect. The second question then asks for the reason for the observed effect.

1. Which of the following must be the same before and after a chemical reaction?

a. The sum of the masses of all substances involved.
b. The number of molecules of all substances involved.
c. The number of atoms of each type involved.
d. Both (a) and (c) must be the same.
e. (e) Each of the answers (a), (b), and (c) must be the same.

2. Assume a beaker of pure water has been boiling for 30 minutes. What is in the bubbles in the boiling water?

a. Air.
b. Oxygen gas and hydrogen gas.
c. Oxygen.
d. Water vapor.
e. Heat.

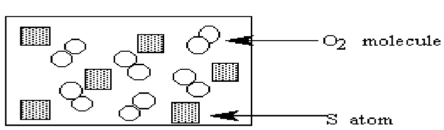
3. A glass of cold milk sometimes forms a coat of water on the outside of the glass (Often referred to as 'sweat'). How does most of the water get there?

a. Water evaporates from the milk and condenses on the outside of the glass.
b. The glass acts like a semi-permeable membrane and allows the water to pass, but not the milk.
c. Water vapor condenses from the air.
d. The coldness causes oxygen and hydrogen from the air combine on the glass forming water.

4. What is the mass of the solution when 1 pound of salt is dissolved in 20 pounds of water?

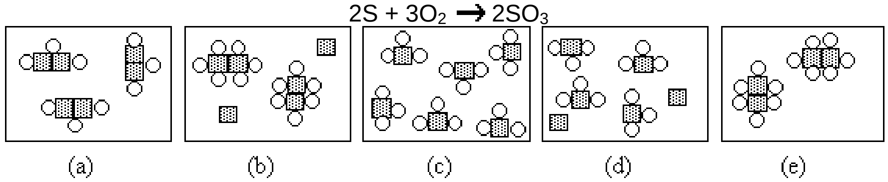
a. 19 Pounds.
b. 20 Pounds.
c. Between 20 and 21 pounds.
d. 21 pounds.
e. More than 21 pounds.

5. The diagram represents a mixture of S atoms and O_2 molecules in a closed container.

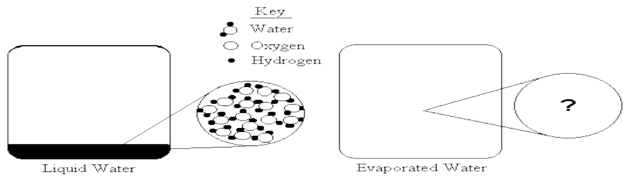


Which diagram shows the results after the mixture reacts as completely as possible according to the equation:

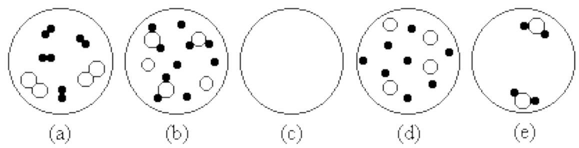
$$2S + 3O_2 \longrightarrow 2SO_3$$



6. The circle on the left shows a magnified view of a very small portion of liquid water in a closed container.



What would the magnified view show after the water evaporates?



7. True or False? When a match burns, some matter is destroyed.

a. True
b. False

8. What is the reason for your answer to question 7?

a. This chemical reaction destroys matter.
b. Matter is consumed by the flame.
c. The mass of ash is less than the match it came from.
d. The atoms are not destroyed, they are only rearranged.
e. The match weighs less after burning.

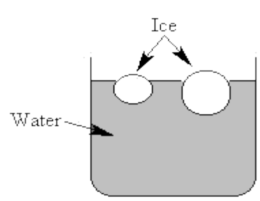
9. Heat is given off when hydrogen burns in air according to the equation

$$2H_2 + O_2 \rightarrow 2H_2O$$

Which of the following is responsible for the heat?

a. Breaking hydrogen bonds gives off energy.
b. Breaking oxygen bonds gives off energy.
c. Forming hydrogen-oxygen bonds gives off energy.
d. Both (a) and (b) are responsible.
e. (a), (b), and (c) are responsible.

10. Two ice cubes are floating in water:



After the ice melts, will the water level be:

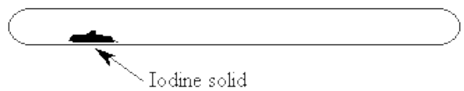
a. higher?
b. lower?

c. the same?

11. What is the reason for your answer to question 10?

a. The weight of water displaced is equal to the weight of the ice.
b. Water is more dense in its solid form (ice).
c. Water molecules displace more volume than ice molecules.
d. The water from the ice melting changes the water level.
e. When ice melts, its molecules expand.

12. A 1.0-gram sample of solid iodine is placed in a tube and the tube is sealed after all of the air is removed. The tube and the solid iodine together weigh 27.0 grams.



The tube is then heated until all of the iodine evaporates and the tube is filled with iodine gas. Will the weight after heating be:

a. less than 26.0 grams.
b. 26.0 grams.
c. 27.0 grams.
d. 28.0 grams.
e. more than 28.0 grams.

13. What is the reason for your answer to question 12?

a. A gas weighs less than a solid.
b. Mass is conserved.
c. Iodine gas is less dense than solid iodine.
d. Gasses rise.
e. Iodine gas is lighter than air.

14. What is the approximate number of carbon atoms it would take placed next to each other to make a line that would cross this dot: ▪

a. 4
b. 200
c. 30,000,000
d. 6.02×10^{23}

15. Figure 1 represents a 1.0 L solution of sugar dissolved in water. The dots in the magnification circle represent the sugar molecules. In order to simplify the diagram, the water molecules have not been shown.

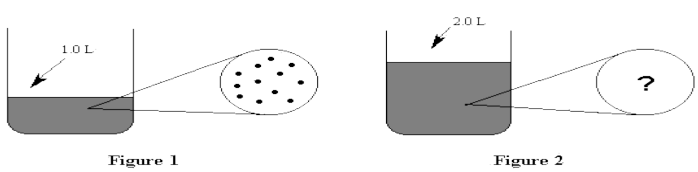


Figure 1

Which response represents the view after 1.0 L of water was added (Figure 2).

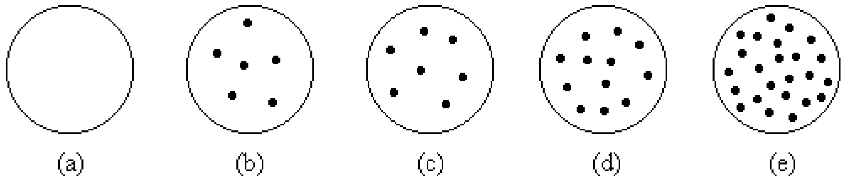


Figure 2

16. 100 mL of water at 25°C and 100 mL of alcohol at 25°C are both heated at the same rate under identical conditions. After 3 minutes the temperature of the alcohol is 50°C. Two minutes later the temperature of the water is 50°C. Which liquid received more heat as it warmed to 50°C?

a. The water.
b. The alcohol.
c. Both received the same amount of heat.
d. It is impossible to tell from the information given.

17. What is the reason for your answer to question 16?

a. Water has a higher boiling point then the alcohol.
b. Water takes longer to change its temperature than the alcohol.
c. Both increased their temperatures 25°C.
d. Alcohol has a lower density and vapor pressure.
e. Alcohol has a higher specific heat so it heats faster.

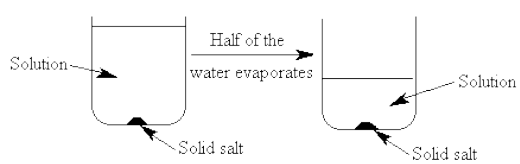
18. Iron combines with oxygen and water from the air to form rust. If an iron nail were allowed to rust completely, one should find that the rust weighs:

a. less than the nail it came from.
b. the same as the nail it came from.
c. more than the nail it came from.
d. It is impossible to predict.

19. What is the reason for your answer to question 18?

a. Rusting makes the nail lighter.
b. Rust contains iron and oxygen.
c. The nail flakes away.
d. The iron from the nail is destroyed.
e. The flaky rust weighs less than iron.

20. Salt is added to water and the mixture is stirred until no more salt dissolves. The salt that does not dissolve is allowed to settle out. What happens to the concentration of salt in solution if water evaporates until the volume of the solution is half the original volume? (Assume temperature remains constant.)



The concentration

a. increases.
b. decreases.
c. stays the same.

21. What is the reason for your answer to question 20?

a. There is the same amount of salt in less water.
b. More solid salt forms.
c. Salt does not evaporate and is left in solution.
d. There is less water.

22. Following is a list of properties of a sample of solid sulfur:

i. Brittle, crystalline solid.
ii. Melting point of 113^oC.
iii. Density of 2.1 g/cm3.
iv. Combines with oxygen to form sulfur dioxide

Which, if any, of these properties would be the same for one single atom of sulfur obtained from the sample?

a. i and ii only.
b. iii and iv only.
c. iv only.
d. All of these properties would be the same.
e. None of these properties would be the same.

Appendix C

CHEMISTRY ATTITUDES AND EXPERIENCES QUESTIONNAIRE

The questionnaire investigates the perceptions you have about Chemistry and related topics. For example: If you feel chemistry is mostly about the study of natural substances, and only a little bit about the study of synthetic substances then you would answer the following questions as shown:

Chemistry Natural Substances___ _√_ ___ ___Synthetic Substances

	Please Indicate what you think about the following
	Chemists
1	athletic ___ ___ ___ ___ ___ ___ ___ unfit
2	socially aware ___ ___ ___ ___ ___ ___ ___ socially unaware
3	environmentally aware ___ ___ ___ ___ ___ ___ ___ environmentally unaware
4	flexible in their ideas ___ ___ ___ ___ ___ ___ ___ fixed in their ideas
5	care about the effects of their attitudes ___ ___ ___ ___ ___ ___ ___ only care about their results
6	imaginative ___ ___ ___ ___ ___ ___ ___ unimaginative
7	inquisitive ___ ___ ___ ___ ___ ___ ___indifferent
8	patient ___ ___ ___ ___ ___ ___ ___ impatient
	Chemistry Research
9	helps people ___ ___ ___ ___ ___ ___ ___ harms people
10	improves quality of life ___ ___ ___ ___ ___ ___ ___ decrease quality of life
11	solves problems ___ ___ ___ ___ ___ ___ ___creates problems
12	advances society ___ ___ ___ ___ ___ ___ ___ causes society to decline
	Science Documentaries
13	enjoyable ___ ___ ___ ___ ___ ___ ___ boring
	Chemistry Websites
14	interesting ___ ___ ___ ___ boring
	Chemistry Jobs
15	challenging ___ ___ ___ ___ ___ ___ ___ easy
16	varied ___ ___ ___ ___ ___ ___ ___ repetitive
17	interesting ___ ___ ___ ___ ___ ___ ___ boring
18	satisfying ___ ___ ___ ___ ___ ___ ___ unsatisfying
19	exciting ___ ___ ___ ___ ___ ___ ___ tedious
	Talking to my friends about chemistry
20	fascinating ___ ___ ___ ___ ___ ___ ___ dull
	Science Fiction Movies
21	exciting ___ ___ ___ ___ tedious

Appendix E

CLASSROOM OBSERVATION CHECKLIST

Name of Researcher______________________ Date _________________________

Name of Observer _______________________ Subject Observed _______________

Term _________________________________ Topic Covered _________________

Class 1 _______________________________ Class 2 _______________________

Time Started ___________________________ Time Started ___________________

Time Ended ____________________________ Time Ended ____________________

Directions: Please judge the extent to which the researcher clearly meets each criterion listed below. Encircle the appropriate number that corresponding to your rating. Use the scale below in rating.

4 – Strongly Agree
3 – Agree
2 – Disagree
1 – Strongly Disagree

Criterion		Remarks
1. Makes explicit the difference between the two strategies	4 3 2 1	______________________
2. Follows the corresponding lesson plans for the two classes	4 3 2 1	______________________
3. Manifests no biases in terms of attitude and personality to any of the two classes	4 3 2 1	______________________
4. Promotes classroom environment conducive to learning (e.g., lightning, ventilation, seating arrangement)	4 3 2 1	______________________
5. Asks the same or		

parallel questions to
both classes 4 3 2 1 ______________________

6. Gives both classes same amount and quality of exercises/quizzes/ assignments 4 3 2 1 ______________________

7. Uses the same medium of instruction (English) to both classes 4 3 2 1 ______________________

Other observations:

____
Signature of Observer

Conforme:

____
Signature of Researcher

Adapted and modified from

Florendo, Liezl A. (2007). *Visualizing Problem Solving: Effects on Students Performance and Problem Solving Skills in Chemistry.* Unpublished Master's Thesis: University of the Philippines Diliman.

Appendix G

Reliability Test for Chemical Concepts Inventory(CCI)

R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

Item-total Statistics

if Item	Scale Mean if Item Deleted	Scale Variance Total Deleted	Corrected Item- Correlation	Alpha if Item Deleted
Q1	7.0130	15.1972	.1241	.7555
Q2	7.0649	13.7984	.5088	.7254
Q3	7.4026	14.6647	.5010	.7335
Q4	6.9740	15.4204	.0672	.7597
Q5	7.3247	14.5379	.4218	.7348
Q6	7.2468	14.3199	.4259	.7332
Q7	6.8701	14.9829	.1921	.7500
Q8	6.8701	14.4303	.3460	.7385
Q9	6.9740	14.7625	.2391	.7468
Q10	7.2208	13.7006	.6031	.7198
Q11	7.2338	13.7867	.5857	.7214
Q12	7.1948	14.7905	.2592	.7449
Q13	7.1688	14.5632	.3159	.7408
Q14	7.3377	14.3582	.5029	.7302
Q15	7.1688	15.2738	.1175	.7552
Q16	7.1429	15.3083	.1042	.7564
Q17	7.1948	14.2116	.4292	.7325
Q18	7.2468	14.8199	.2715	.7439
Q19	7.1039	14.6206	.2843	.7432
Q20	7.2078	14.8510	.2462	.7458
Q21	7.4026	15.0595	.3288	.7418
Q22	7.2727	15.8062	-.0148	.7621

Reliability Coefficients

N of Cases =   77.0   N of Items = 22

Alpha =   .7508

Appendix H

Reliability Test CAEQ

R E L I A B I L I T Y   A N A L Y S I S   -   S C A L E   (A L P H A)

Item-total Statistics

	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Alpha if Item Deleted
Q1	122.2697	133.1083	.3639	.8733
Q2	122.2135	132.4880	.5122	.8695
Q3	122.1798	129.1037	.5761	.8670
Q4	122.1573	131.9522	.3786	.8731
Q5	122.3820	129.0569	.4355	.8715
Q6	122.4157	129.0184	.3799	.8745
Q7	122.5843	127.4502	.4993	.8691
Q8	122.0449	129.2707	.5683	.8672
Q9	121.9438	132.4400	.5035	.8696
Q10	121.8989	132.3874	.4444	.8709
Q11	121.9888	132.2158	.5446	.8688
Q12	122.2247	133.5853	.4855	.8704
Q13	122.1685	129.2099	.5124	.8687
Q14	122.1685	123.7326	.6494	.8634
Q15	121.8539	134.7625	.4312	.8717
Q16	122.3371	126.9987	.5830	.8662
Q17	121.9213	129.9142	.5865	.8670
Q18	122.1236	133.4505	.3169	.8751
Q19	121.9326	129.5863	.6147	.8664
Q20	122.9213	125.6869	.3449	.8808
Q21	121.8876	129.2372	.5292	.8682

Reliability Coefficients

N of Cases = 89.0   N of Items = 21

Alpha = .8755

Appendix I

SPSS Output: Initial Comparability

Chemical Concepts Inventory Pretest

Group Statistics

	GROUP1	N	Mean	Std. Deviation	Std. Error Mean
VAR00001	1.00	38	4.5000	1.79714	.29154
	2.00	40	4.8750	2.28919	.36195

Independent Sample t-test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
VAR00001	Equal variances assumed	.496	.483	-.802	76	.425	-.3750	.46764	-1.30638	.55638
	Equal variances not assumed			-.807	73.438	.422	-.3750	.46476	-1.30117	.55117

Mann-Whitney Test Pretest CAEQ

Ranks

	GROUP1	N	Mean Rank	Sum of Ranks
VAR00001	1.00	43	33.03	1420.50
	2.00	42	53.20	2234.50
	Total	85		

Test Statistics(a)

	VAR00001
Mann-Whitney U	474.500
Wilcoxon W	1420.500
Z	-3.769
Asymp. Sig. (2-tailed)	.000

a Grouping Variable: GROUP1

Appendix J

SPSS Outputs: Test for Group Differences after the Intervention

Chemistry Concepts Inventory Posttest

Group Statistics

	GROUP1	N	Mean	Std. Deviation	Std. Error Mean
VAR00001	1.00	43	6.9302	1.95662	.29838
	2.00	42	6.0476	1.93747	.29896

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
VAR00001	Equal variances assumed	.485	.488	2.089	83	.040	.8826	.42243	.04241	1.72281
	Equal variances not assumed			2.090	82.984	.040	.8826	.42238	.04251	1.72272

Ranks POSTTEST CAEQ

	GROUP1	N	Mean Rank	Sum of Ranks
VAR00001	1.00	43	49.93	2197.00
	2.00	42	36.76	1544.00
	Total	85		

Test Statistics(a)

	VAR00001
Mann-Whitney U	641.000
Wilcoxon W	1544.000
Z	-2.447
Asymp. Sig. (2-tailed)	.014

a Grouping Variable: GROUP1

Appendix K

Analysis of Covariance (ANCOVA) on Attitude towards Chemistry Posttest

Between-Subjects Factors

		N
GROUP1	1.00	43
	2.00	42

Descriptive Statistics

Dependent Variable: POST

GROUP1	Mean	Std. Deviation	N
1.00	133.4884	11.87910	43
2.00	127.3571	11.13076	42
Total	130.4588	11.85483	85

Tests of Between-Subjects Effects

Dependent Variable: POST

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	861.141(a)	2	430.571	3.226	.045	.073
Intercept	12027.736	1	12027.736	90.120	.000	.524
PRE	62.422	1	62.422	.468	.496	.006
GROUP1	836.780	1	836.780	6.270	.014	.071
Error	10943.965	82	133.463			
Total	1458463.000	85				
Corrected Total	11805.106	84				

a R Squared = .073 (Adjusted R Squared = .050)