GRADES 3 AND 6 SCIENCE TEACHERS' KNOWLEDGE AND SCIENTIFIC UNDERSTANDING OF THE PARTICULATE NATURE OF MATTER

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APPROVAL SHEET

In partial fulfillment of the requirements for the degree **MASTER OF ARTS IN TEACHING CHEMISTRY**, this dissertation entitled **"GRADES 3 AND 6 SCIENCE TEACHERS' KNOWLEDGE AND SCIENTIFIC UNDERSTANDING OF THE PARTICULATE NATURE OF MATTER"**has been prepared and submitted by **JOAN QUITALIG**, is hereby recommended for oral examination.

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DEDICATION

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ABSTRACT

This study investigated grade 3 and grade 6 science teachers' knowledge and scientific understanding of the particulate matter of public elementary schools in the City Division of Catbalogan, Samar. In this regard, the study employed descriptive research design which involved 36 grade 3 and 36 grade 6 teachers. Data were collected using a two-tier diagnostic test. For the findings, the result of t-test for independent samples revealed a computed t-value of 0.999 with a p-value of 0.320. It was very clear that the p-value was greater than the 0.05 significance level indicating no significant difference in level of knowledge of the particulate nature of matter between grade 3 and grade 6 teacher-respondents. The hypothesis "there is no significant difference in level of knowledge of the particulate nature of matter between grade 3 and grade 6 teacher-respondents" was accepted. For the conclusion, the majority of the teacher-respondents had below average knowledge of the particulate nature of matter. Age and knowledge of the particulate nature of matter were not significantly related. The level of knowledge was not significantly related to sex; grade level taught; years of teaching; educational background; and number of trainigs attended. There was no significant difference in level of knowledge of the particulate nature of matter between grade 3 and grade 6 teacher-respondents. All teacher-respondents had unscientific understanding of the particulate nature of matter. Results showed that teachers have below average knowledge and exhibited no scientific understanding of the particulate nature of matter and possess several unscientific understanding.

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Chapter 1

THE PROBLEM AND ITS BACKGROUND

Introduction

It is a common knowledge among educators that the Philippines implemented a new curriculum last school year 2012-2013. This is a shift from the Basic Education Curriculum to the new K to 12 Curriculum. The new curriculum has been made legal by Republic Act 1033 or the Enhanced Basic Education 2013.

Science is one of the core subjects in the K to 12 curriculum and just like in the old curriculum, it is compulsory for all students in the elementary and junior high school. In the old secondary curriculum, the different disciplines of science was offered separately according to year level – general science in first year, biology in second year, chemistry in third year and physics in fourth year. In the K to 12 curriculum, all the different disciplines of science are incorporated simultaneously in every grade level in a spiral progression starting from grade 3 up to grade 10 (K to 12 Curriculum Guide Science, 2013).

The spiral progression emphasizes no break in the continuum of the science contents from elementary to junior high school. Because of this structuring of the contents, it is expected that some chemistry topics will already be taught in the elementary grade. Indeed, review of elementary science textbooks and curriculum guides revealed the following – states of matter in grade 3, properties of matter in grade 4, changes of matter in grade 5, and mixtures in grade 6.

The unifying theory of the above science contents is the particulate nature of matter (Adbo and Taber, 2009). The particulate nature of matter is fundamental to almost every topic in chemistry such as kinetic theory of matter, atoms, molecules, gases, phase change, properties of matter, conservation of matter, and chemical reaction to name a few (Ayas, Ozmen, and Calik, 2010; Cardellini, 2012). The particulate nature of matter is a complex system of concepts and failure to grasp the scientific understanding of these concepts would affect learning of other chemistry topics and this is the reason why the particulate nature of matter is so important.

Literature and studies conducted around the world revealed that students find it hard learning the scientific understanding of the particulate nature of matter from the late 70s up to the present (Novick and Nussbaum, 1978; Aydeniz, Bilican and Kirbulut, 2017). To improve students' scientific understanding of the particulate nature of matter, several interventions have been conducted using different teaching approaches or pedagogies which were found out effective (Williamson and Abraham, 1995; Sanger, 2000; Onwu and Randall, 2006; Yezierski and Birk, 2006; Lekhavat and Jones, 2009; Özmen, 2011; Beerenwinkel, Parchmann, and Grasel, 2011; Morell and Wilson, 2016; Kellya and Hansenb, 2017).

However, pedagogy alone will not warrant excellent chemistry teaching to be effective in teaching abstract concepts in chemistry. A teacher must also possess sufficient subject matter or content knowledge (Nezvalová, 2011; Loughran, Berry, and Mulhall, 2012; Khwaja, 2014; Smith and Plumley, 2016). In the dimension of knowledge of students' understanding of science or knowledge of learners, teachers must possess sound understanding of science concepts which students find difficult to learn.

In other words, if teachers have content mastery then they will know the misconceptions which students have in a specific topic, as a result teachers could plan effective instruction by analyzing and interpreting students' ideas. Otherwise, when teachers have insufficient content knowledge they cannot identify students' misconceptions and they cannot make instantaneous adjustments or changes of their teaching pedagogies to accommodate learning styles of students (Bektaş, 2015).

In the local scene, the City Division of Catbalogan, Samar obtained the following grade 6 National Achievement Test (NAT) for two consecutive school years which revealed low performance in science. For school year 2015-2016, the Mean Percentage Score (MPS) was 66.11% and in school year 2016-2018 it was 52.95% which are below the 75% minimum proficiency level or passing mark. There is adage in the academe that a teacher cannot give what the teacher does not have. When the teacher lacks content knowledge in a specific topic in science then the teacher cannot transmit the full scientific understanding of the topic to students.

Statement of the Problem

This study examined grade 3 and grade 6 science teachers' knowledge and scientific understanding of the particulate nature of matter of public elementary school in the City Division of Catbalogan, Samar during the school year 2017-2018.

Specifically, the study sought answers to the following questions:

1. What is the profile of the teacher-respondents in terms of the following variates:

1.1 age and sex;

1.2 grade level taught;

1.3 number of years of teaching experience;

1.4 educational background; and

1.5 number of in-service training attended?

2. What is the level of level of knowledge of the teacher-respondents of the particulate nature of matter?

3. Is there a significant relationship between teacher-respondents' level of knowledge of the particulate nature of matter?

4. Is there a significant difference in teacher-respondents' level of knowledge of the particulate nature matter according to:

4.1 grade level taught; and

4.2 sex?

5. What is the level of scientific understanding of the teacher-respondents of the particulate nature of matter?

6. What are the specific unscientific understanding held by the teacher-respondents?

Hypotheses

Based on the specific questions posted in this study, the following hypotheses were tested.

1. There is no significant relationship between teacher-respondents' level of knowledge of the particulate nature of matter.

2. There is no significant difference in teacher-respondents' level of knowledge of the particulate nature matter according to:

2.1 grade level taught; and

2.2 sex.

Theoretical Framework

This study is supported by the theory called Pedagogical Content Knowledge (PCK) (Kind, 2009). In its original context, PCK represents that particular amalgam of content and pedagogy that is uniquely the prowess of teachers and distinguishes a teacher from a subject matter specialist. PCK results from the blending of content knowledge with pedagogical methods. Through that combination of knowledge and pedagogy, teachers gain a perspective that enhances their abilities to present specific topics in a specific subject area.

The notion of pedagogical content knowledge was first introduced by Shulman (1986) as a form of knowledge that connects a teacher's cognitive understanding of subject matter content and the relationships between such understanding and the instruction teachers provide for students. Bucat (2005) emphasized that there is a vast difference between knowing about a topic (content knowledge) and knowledge about the teaching and learning of that topic (pedagogical content knowledge).

Content knowledge of a particular discipline of science is essential not only for teaching itself but also for the evaluation of text books, computer software and other instructional materials. According to Cojill (2008), teachers with strong content knowledge may teach in a more interesting and dynamic way while those with little content knowledge may shy away from the more difficult aspects of the subject, or approach their teaching in a didactic manner. In the same vein, a Bachelor of Elementary Education (BEED) graduate who possess pedagogy cannot give justice in teaching chemistry because he or lacks mastery of the content knowledge but a chemist or a chemical engineer with professional education training would be better chemistry teacher.

Chemistry, like biology, physics and geology, is a subject of science which has its own concepts, technical terms, and topics, and the teaching and the learning of chemistry is thus unique. It is a must that science teachers possess subject-specific that would enable them to transform a particular chemistry content knowledge like the particulate nature of matter into forms that are understandable for a diverse group of students. This is only possible when teachers have mastery of the content.

In order to achieve the dream of the Philippine government of producing scientifically literate citizens through the implementation of a spiral K to 12 science curriculum, grade 3 and grade 6 science teachers must possess not only mastery of content on the particulate nature of matter but also knowledge of teaching and learning of chemistry; knowledge of chemistry curriculum; knowledge of student conceptions and learning difficulties in chemistry; knowledge of instructional strategies; and knowledge of assessment. All these components should be simultaneously developed and integrated for an effective science or chemistry teachers.

The study is anchored on the Theory of Constructivism. The theory sets the foundation for many instructional methods in science. According to Gunstone (2011), knowledge is not passively received but is actively built by students, which can differ from person to person. The student is the "constructer" of knowledge and not an empty container to be filled with facts is what differentiates constructivism from other educational theories. It is for this reason that teachers when they were students will have different understanding of any concept or idea like the particulate nature of matter. What they have learned are what they will be teaching.

According to this theory, knowledge cannot be transmitted from the teacher to the learner intact but is actively built up or mentally constructed by the learner. From this perspective, learning in classroom settings is seen to require well designed practical activities that challenge the learners; prior conceptions encouraging learners to recognize their personal theories. Practical activities include performing experiments where learners apply the different integrated science process skills.

Constructivism views each learner as a unique individual with unique needs and backgrounds. The learner is also seen as complex and multidimensional. Constructivism not only acknowledges the uniqueness and complexity of the learner, but actually encourages, utilizes and rewards it as an integral part of the learning process. It encourages the learner to arrive at his or her version of the truth, influenced by his or her background.

Furthermore, it is argued that the responsibility of learning should reside increasingly with the learner. Constructivism thus emphasizes the importance of the learner being actively involved in the learning process, unlike other educational viewpoints where the responsibility rested with the teacher to teach and the learner played a passive, receptive role. For learners to construct the accepted understanding of the particulate nature of matter, they should be exposed to varied learning situations that depend on their way of learning.

Von Glasersfield (2001) emphasized that learners construct their own understanding and that they do not simplify and reflect what they read. Learners look for meaning and will try to find regularity and order in the event of the world even in the absence of full or complete information but when such information is not found out, unscientific understanding will be constructed in their minds about the particulate nature of matter.

Conceptual Framework

Figure 1 shows the conceptual framework of the study illustrating, among other things, the variables involved in the study and their relationships.

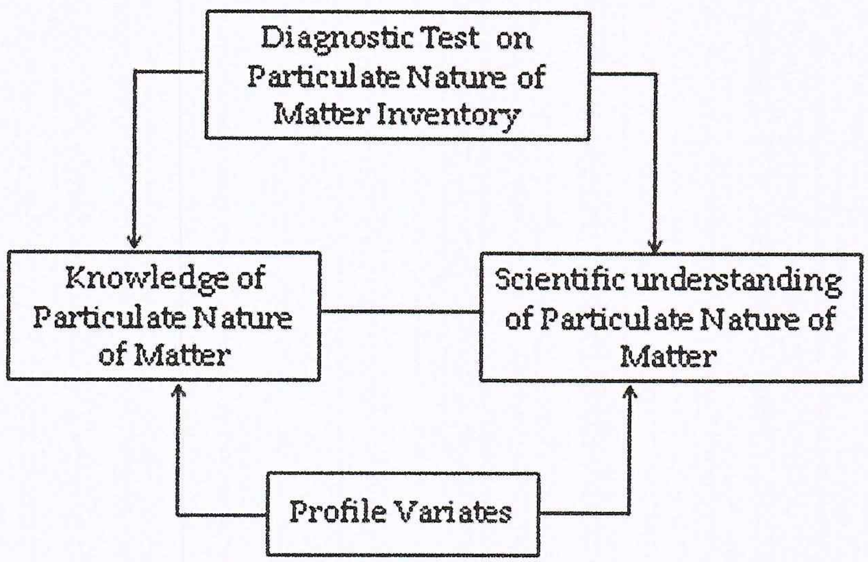

Figure 1. Conceptual Framework of the Study

Teachers' knowledge of the particulate nature of matter will depend to some to their profile variates like age, sex, number of years of teaching experience, educational background and number of in-service training attended. In the same manner, teachers' scientific understanding of the particulate nature of matter will also depend on their knowledge of the topic and profile variates.

Knowledge and scientific understanding can only be exposed or known by conducting a diagnostic test.

Scope and Delimitation

This research involved one hundred twelve (12) grade 3 and grade 6 science teachers of the DepEd City Division of Catbalogan, Samar.

The study focused only in determining the level of knowledge and scientific understanding of the particulate nature of matter. Since the topic on the particulate nature of matter is a complex system related concepts, the coverage was limited to the characteristics of atoms and molecules, states of matter, structure of matter and phase changes. The main instrument used was a two-tier multiple choice diagnostic test.

The study was conducted during school year 2011-2012.

Significance of the Study

The results of this study would be beneficial to the following stakeholders.

School Administrators. The findings of this study would serve as baseline information regarding their teachers' subject matter knowledge competence and thereby encourage their teachers to continually improve their competency by attending seminars and training or pursue graduate schooling.

Teachers. The result of this study would inform them that being a science teacher does not only require the basics of teaching methods but also mastery of the content of the specific science they are teaching. As such, they will be motivated to continually add to their subject knowledge to keep up-to-date with changes in their subject area.

Students. The findings of this study would bring out more information that would help students to try their best in learning science.

Parents. From this study, parents may come to know about their children's ability or inability to succeed in science. They would somehow give or pay attention in guiding their children and thus, gather from them the strongest support, morally, socially and financially.

Future Researchers. The findings of this study would give information to the future researchers who are interested in investigating deeply into this area on subject matter competence in science.

Definition of Terms

The following terms are defined conceptually and/or operationally for easy reference and understanding of the study.

Level of knowledge. This refers to a point on a scale (status) that describes the quality of learning a person has (Bucat, 2005). The same definition is used in the present study as determined by the Particulate Nature of Matter Inventory.

Particulate nature of matter. It is basically the same as the kinetic molecule theory of matter which means matter is made up of tiny particles (atoms, molecules or ions) and there are empty space between the particles

(Zumdahl and Zumdahl, 2014). The same definition is used in this study but is limited to the concepts being measured by the research instrument.

Scientific understanding. As used in this study, it refers to the knowledge of a specific topic or concept one (teacher-respondents) has including the ability of that knowledge to describe, explain and predict a phenomenon that is accepted by the scientific community (Adbo and Taber, 2009). In this study, the same definition is used as measured by the research instrument.

Spiral curriculum. It refers to big ideas, important tasks and ever deepening inquiry must recur in ever increasing complexity through engaging problems and applications; - form follows function; if the goal (function of curriculum) is increased understanding , then amore spiral-like logic (form) may be necessary (The K to 12 basic Education Program, 2012).

Unscientific understanding. Also known as misconception; it refers to a knowledge that is incorrect because it is based on faulty thinking which cannot describe, explain and predict a phenomenon and such knowledge is not accepted by the scientific community (Makaye, Ndunguru, and Mkoma, 2013). The same definition is used in this study as measured by the research instrument.

Chapter 2

REVIEW OF RELATED LITERATURE AND STUDIES

This chapter deals with the review of conceptual and research literature from books, periodicals, research, journal and master's theses which helped the researchers in conceptualizing the present study.

Related Literature

The Philippines implemented a new curriculum last school year 2012-2013 popularly known as the K to 12 curriculum which means kindergarten plus 12 years basic education (grades 1 to 12) for a total of 13 years of schooling. There are several reasons of the shift from a 10-year basic education to 13-year basic education which will not be expounded because they are beyond the scope of present study.

Aside from the three years of additional schooling – one year kindergarten and two years senior high, an innovation introduced in the K to 12 curriculum. Another innovation is the structuring of some subjects in each grade level. Science and Mathematics are still included in the core subjects of the K to 12 curriculum just like in the old curriculum, but this time they will be taught by spiral progression.

Science is important to everyone. School science education should support the development of scientific literacy in all students as well as motivate them to pursue careers in science, technology, and engineering. Science is useful because of its links to technology and industry, which, from a national perspective, are areas of high priority for development.

Science provides ways of making sense of the world systematically. It develops students' scientific inquiry skills, values and attitudes, such as objectivity, curiosity, and honesty and habits of mind including critical thinking. All these are useful to the individual student for his or her own personal development, future career, and life in general. These skills, values, attitudes, and dispositions are likewise useful to the community that an individual student belongs to, and are further useful to the country that he or she lives in.

The learning of science is also important for the nation's cultural development and preservation of its cultural identity. Science is most useful to a nation when it is utilized to solve its own problems and challenges, keeping a nation's cultural uniqueness and peculiarities intact. Thus in many countries, science teaching and learning are linked with culture.

Some Filipino students have gained recognition for their high level of accomplishments in the International Science and Engineering Fair, Robotics Competition, and Physics Olympiad, to name a few. There are also reports of students in far-flung rural schools scoring much higher than the international mean in the case of the Third/Trends in International Mathematics and Science Study (TIMSS) or have gone beyond the 75% mastery level in the case of the National Achievement Test (NAT).

However, the accomplishments of a few students are overshadowed by the consistently poor performance of Filipino students in international assessment studies and national assessment studies. Studies reveal that Filipino students have low retention of concepts, have limited reasoning and analytical skills, and poor communication skills (they cannot express ideas or explanations of events and phenomena in their own words) (UP NISMED, 2004). In addition, a large percentage of Grade 6 and fourth year students in selected schools cannot apply concepts to real-life problem solving situations nor design an investigation to solve a problem (UP NISMED, 2005).

One reason attributed to the above scenario was the linear progression of teaching and learning science. In the old curriculum, the different science disciplines are offered separately by year level in high school – general science in first year, biology in second year, chemistry in third year, and physics in fourth year. In the linear progression, students will not understand the concept if teachers plan to teach it using only the teacher's level of understanding.

This is the mean reason why the spiral progression of teaching and learning science and mathematics. The curriculum is organized in spiral manner so that the student continually builds upon what they have already learned. The idea in spiral progression approach is to expose the learners into a wide variety of concepts/topics and disciplines, until they mastered it by studying it over and over again but with deepening of complexity. The topics and concepts of the four science disciplines (General Science, Biology, Chemistry, and Physics) are taught all at the same time which starts from grade 3 up to grade 10.

In the elementary science of the K to 12 curriculum, the following are the chemistry related topics: states of matter in Grade 3, properties of matter in grade G, changes of matter in Grade 5, and mixtures in Grade 6 (K to 12 Curriculum Guide Science, 2013). All these topics are better taught and understood with the particulate nature of matter.

The particulate nature of matter is fundamental to almost every topic in chemistry. Failure to grasp the scientific understanding of this concept would affect learning of other chemistry topics such as atoms, molecules, behaviour of gases, phase changes, properties of matter, conservation of matter, and chemical reaction to name a few and this is the reason why the particulate nature of matter is so important (Ayas, Ozmen, and Calik, 2010).

The particulate nature of the matter is rated by several authors as significant for students' long-term success in the pursuit of chemistry. An appropriate understanding of the particulate nature of matter is essential to the learning of chemistry (Adbo and Taber, 2009).

How does a phase change occur? How is it explained using the particulate nature of Matter? Usually, a solid is made up of orderly arrange particles called atoms or molecules and in a liquid the particles are less ordered. So, the change from solid to liquid like melting of ice is simply the rearrangement of the particles from an ordered arrangement to a less ordered arrangement (The National Strategies – Secondary, 2008)

The pictures from the studies conducted employing different research designs showed a widespread failure of students to grasp the particulate nature of matter. Findings indicate that students in various grades and nationalities do not understand the particulate-level processes necessary to explain observed phenomena (Gabel, Samuel, and Dunn, 1987; Tsai, 1999; Park, Light, Swarat, and Denise, 2009; Chiu and Wu, 2013; Adadan, 2014).

The same findings were obtained among pre-service teachers. Dindar, Bektas, and Celik (2010) in their study found that pre-service chemistry teachers had some misconceptions or difficulties in explaining some chemistry concepts. They also had partial understanding of aforementioned chemistry concepts. The most challenging topic for the pre-service chemistry teachers was one of the basic topics in chemistry which was the particulate nature of matter.

When learners have difficulties in such fundamental topics, it is much more difficult for them to understand and illustrate the other subsequent topics meaningfully. The next topics which were more challenging for the pre-service chemistry teachers were chemical equilibrium and acids and bases topics. During the inquiry it was observed that the pre-service chemistry teachers had no difficulties in recognizing and defining the concepts, but they commonly have difficulties in the way to express the background knowledge and explaining the concepts. Even the participants related some topics such as gases, evaporation and boiling point, and solubility into their daily life, they had misconceptions or no ideas about the aforementioned topics.

Tuysuz, Ekiz, Bektas, Uzuntiryakic, Tarkina and Kutucua (2011) conducted a study to investigate how pre-service chemistry teachers use macroscopic, symbolic, and microscopic levels and how they integrate teaching strategies at these three levels while instructing phase changes and dissolution. Results revealed that pre-service chemistry teachers faced difficulties in using and explaining both symbolic and microscopic levels for phase changes and dissolution whilst they could make explanations at the macroscopic level.

The same observation was obtained by Valanides (2000) in an earlier study. One-to-one interviews were administered to a sample of thirty female, primary student teachers of different backgrounds in science. A distillation apparatus accompanied by a diagram was presented to each student and its use for distilling liquids was fully discussed. Students were then asked to describe the macroscopic and microscopic changes which would occur when different water solutions were to be distilled.

The results revealed from the interviews support the idea that primary student teachers have limited understanding of the particulate nature of matter and the relation of observable macroscopic changes (i.e., change of phase) with changes in the configuration and energy of molecules, that is, the result of the way molecules move in relation to one another and how they are held together. They face difficulties in understanding the essential changes during chemical transformations of matter, which involve the breaking apart and recombination of molecules, and are unable to differentiate chemical from physical transformations where the structure of molecules is unaffected. They also attribute changes in substances to changes in molecules themselves corroborating with the conclusions of other research studies, where subjects suggested that particles can become hot or cold or even melt.

Very recently, Adadan (2017) explored the change in the nature and quality of pre-service chemistry teachers' explanations about the phenomenon of dissolving from pre-interview to post-interview in the context of multi-representational (MR) instruction. A total of 29 pre-service chemistry teachers participated in the study, including 17 female and 12 male. Qualitative data were collected through interviews, involving multiple modes of evidence (verbal and visual). Data from pre and post-interviews were analyzed using the constant comparative method. The participants' explanations were analyzed in terms of their nature and quality, utilizing the two different frameworks from previous literature. Findings showed that the nature of majority of participants' explanations changed from descriptive to cause and effect type of explanations. In addition, the quality of participants' explanations changed from naive to more scientific ones from pre to post-interview, frequently indicating a strong or moderate progress towards a scientific explanation. In other words, these findings referred to the development of high-quality sophisticated explanations among the pre-service chemistry teachers as they involved in multi-representational instruction on dissolving.

According to Riaz (2004), the particulate theory of matter is fundamental in science. Scientists use it to explain the behaviour of matter and the complex configuration of the materials that make up objects. The arrangement and behaviour of the particles in materials are abstract concepts because of their invisibility at the macro level. The abstract nature of matter is thus beyond the understanding of primary and secondary students, as well as many teachers.

To teach this concept, teachers must provide clear explanations and representations of the particulate model at the macro level. Where the macro representation of particles is not sufficient to give students a visual image of the micro perspective of particles, teachers must demonstrate the hybrid model of the macro perspective and the micro perspective. Research also shows that the particulate theory of matter is an abstract concept.

Educators, policymakers, school administrators, and even teachers are faced with a common dilemma: what makes a teacher more effective in educating children. Research indicates that teacher preparation and knowledge of teaching and learning, subject matter knowledge, experience, and qualifications measured by the teacher licensure are contributing factors in making teachers more effective (Darling-Hammond, 2006).

However, there are two keys that deserve to bear more weight than the others mentioned above, namely (1) teacher knowledge of subject matter or content knowledge and (2) knowledge and skill in how to teach that subject or pedagogical knowledge. The combination of two keys is called pedagogical content knowledge or PCK (Ayvazo, 2007).

Chang (2014) examined the influence of a teacher professional development workshop on a teacher's pedagogical content knowledge (PCK) of throwing unit in Physical Education class and determined the effects of teachers' instruction of a four day throwing unit on student throwing performance prior to and following the professional development workshop. A randomized control-group pretest-posttest with a retention test design was utilized to examine the change of the teacher's PCK and students learning in the teacher's intact classes.

The following variables were measured: (a) task representation; (b) task demonstration; (c) feedback; and (d) task modification alignment for teachers, and throwing performance (body component levels for the step, trunk, humerus, and forearm, and the ball velocity) for students. Analysis of the collected data showed that teachers' PCK can be changed as a function of teachers' knowledge bases. Furthermore, the improved teachers' PCK can influence the increase of students' throwing performance. The findings of the study suggest that teacher education programs should provide content courses to improve the teacher's knowledge bases and many opportunities to improve PCK that influence student learning.

In mathematics education, Sibuyi (2012) investigated the pedagogical content knowledge held by two mathematics teachers as they taught quadratic functions in grade 11 classes. The criterion for selecting the two teachers was that they had consistently produced good results (overall pass rate of 80% or more) in the National Senior Certificate in mathematics examinations for three years or more and thus, they were classed as effective.

The two teachers prepared and taught lessons on quadratic functions in grade 11 while they were being observed. The study focused on teacher knowledge base as exemplified in the teachers' pedagogical content knowledge (PCK) - (1) knowledge of the subject matter; (2) knowledge of teaching strategies and (3) knowledge of learners' conceptions. A case study research method was used to collect qualitative data of the two teachers through lesson observations, lesson plan analysis and interviews.

Analysis of the results suggests that the two teachers have adequate subject matter knowledge but have limited knowledge on the aspects of teaching strategies and knowledge of learners' pre-conceptions and misconceptions on the topics of quadratic functions that they taught. The study recommends that teachers be exposed to workshops that deal specifically with the various topic specific teaching strategies and knowledge of learners' pre-conception and misconceptions on the topic of quadratic functions.

The teacher's own content knowledge and knowledge of resources play important roles in the students' understanding; in my context, these are the most crucial issues. Helping students understand the concept is possible only when the teacher clarifies his or her own conception of the particulate nature of matter and develops appropriate resources. The teacher must have sufficient content knowledge and pedagogical content knowledge at the secondary level to teach concepts comprehensively.

It is important to determine the conceptions of in-service teachers and how they interpret chemistry concepts since their scientific understandings of chemistry take a crucial role; therefore, if they are well educated in the subject of chemistry, then it will be helpful for their students. Understandings of subject matter knowledge become important when researching students' conceptual understandings because teachers' knowledge of organization, connections among ideas, ways of proof and inquiry, and knowledge growth within discipline are important factors needed to teach a subject.

Related Studies

The following studies reviewed by the researcher was found similar to the present study.

Cole (2017) conducted a study entitled "Spatial Reasoning and Understanding the Particulate Nature of Matter: A Middle School Perspective". This dissertation employed a mixed-methods approach to examine the relationship between spatial reasoning ability and understanding of chemistry content of middle school students and their science teachers and the ways both students and teachers talk about matter and chemicals. Indeed, the data showed a significant, positive correlation between scores on the Purdue Spatial

Visualization Test of Rotations and the Particulate Nature of Matter Assessment (ParNoMa) for both students and teacher. Moreover, students and teachers with higher spatial ability tended to provide more of appropriate explanation about the particulate nature of matter.

The study of Cole is considered similar by the research since both studies delved on the understanding of teachers about the particulate nature of matter. The study of Cole included the spatial reasoning of teachers which will not be treated in the present study. Another difference between the two studies is in terms of the instrument used in the study of Cole and the present study in determining teachers' knowledge of the particulate nature of matter.

Another similar study was conducted by Baluyut (2015) entitled "Unpacking Students' Atomistic Understanding of Stoichiometry". The study investigated how students coordinated symbolic and microscopic representations to demonstrate their knowledge of stoichiometric concepts. Interviews with students asked to draw diagrams for specific stoichiometric situations showed dual processing systems were in play. Many students were found to have used these processing systems in a heuristic-analytic sequence. Heuristics, such as the factor-label method and the least amount of misconception, were often used by students to select information for further processing in an attempt to reduce the cognitive load of the subsequent analytic stage of the solution process.

The study of Baluyut is deemed similar to the present study because it also pertains to the particulate of matter only that it was applied to check the understanding of students on stoichiometry. The differences of the two studies are in terms of research design and respondents. The study of Baluyut used qualitative design and involved students. The present study is purely descriptive- correlational and will involve elementary teachers.

Williams (2015) embarked on a study entitled "Students' Understanding of Structure-Property Relationships and the Role of Intermolecular Forces". Using a qualitative approach, the researcher interviewed seventeen students enrolled in either general or organic chemistry courses. She found that, while many students could correctly predict and rank melting and boiling points of various compounds, few successfully used the molecular level structure of each compound to predict and explain its properties.

The study of Williams is related to the present study since both studies used the particulate nature of matter as one of the main variable. However, Williams' study determined the understanding of students on structure-properties relationship by applying knowledge of the particulate nature of matter. On the other hand, the present study will explicitly determine the level of scientific understanding of teachers of the particulate nature of matter.

Phenglengdi (2015) did a study entitled "Evaluation of the Molecular Level Visualization Approach for Teaching and Learning Chemistry in Thailand". The research evaluated the use of a molecular level visualisation approach using VisChem animation in Thai secondary schools. The goal was to obtain insights about the usefulness of this approach, and examine possible improvements in how the approach might be applied in the future. The results showed that students had misconceptions at the molecular level, and VisChem animations could help students understand chemistry concepts at the molecular level across all three types of schools. While the animation treatment group had a better score on the topic of states of water, the non-animation treatment group had a better score on the topic of dissolving sodium chloride in water than the animation group.

The above study indirectly related to the present study since the two studies because they delved on the particulate nature of matter. The above study was an evaluation of a computer animation to be used in teaching the particulate nature of matter while the present study will look into the understanding of elementary teachers about the particulate nature of things.

Hammar (2013) conducted a study entitled "Teaching the Gas Properties and Gas Laws: An Inquiry Unit with Alternative Assessment". In this study, a unit about gas properties and gas laws was modified to include inquiry-based teaching methods. The research questions focused on how these changes affected student results on a traditional end-of-the-unit test and on an alternative assessment. The results showed that an inquiry approach improved the student's ability to perform on a traditional end of the unit test in the areas of microscopic understanding (atomic level), symbolic understanding (mathematical level) and graphical understanding (relationships between pressure, volume and temperature).

The study of Hammer was on the effect of inquiry approach in teaching the particulate nature of matter. Because of this, the study of Hammer was considered to be similar to the present. The difference lies in the focus and design of the study. The previous study was after the effectiveness of teaching an inquiry approach in teaching the particulate nature of matter which employed experimental design while the present study is aimed at determining the understanding of teachers of the particulate nature of matter and will employ descriptive-correlational design.

In 2012, Bedward did a study entitled "Exploring Elementary Students' Use of Semiotic Tools and Self-Explanations When Learning about the Particulate Nature of Matter". Descriptive statistics revealed distinct patterns in student model-based discourse and sign use across the four modalities. Sixty-six per cent of students' demonstrated improvement on their pre-post test while 54 per cent demonstrated no improvement. Students incorporated a variety of sign types (iconic, indexical and symbolic) across all modalities and more often used symbolic signs to represent an iconic view of phenomena.

The study of Bedward is related to the present study since one of its goals is determining the understanding of students of the particulate nature. However, it differs from the present study because the study of Bedward used an intervention to determine its effectiveness in teaching the particulate of matter while in the present study will no employ any intervention. Rather, the knowledge base of teachers of the particulate nature of matter will be identified without any intervention.

"Using Student-Generated Animations about Water Boiling to Impact Student Understanding of the Particulate Nature of Matter" was undertaken by Albert (2012). The purpose of the study was to identify the understanding of students of the particulate nature of matter by requiring students to generate animated movement of particles to simulate the boiling of water. Findings indicated that the creation of animations affected students' understanding of motion and of the composition of atoms and molecules of the boiling water. The creation of digital animations enhanced conceptual learning.

The above study is similar to the present because it also employed the particulate nature of matter in explaining the boiling of water just like the present study where the focus is on teachers understanding of the particulate nature of matter. The limitation of the present study compared to the study of Albert is that understanding of teachers of the particulate nature of matter is through a paper-and-pencil test not through the creation of an animation of boiling water.

Merritt (2010) conducted a study entitled "Tracking Students' Understanding of the Particle Nature of Matter". The purpose of the study was to monitor students' understanding of the particle nature of matter as they participated in this contextualized and model-based chemistry unit using paper-and-pencil tests. The data collected revealed that students' pre-test performance was weakly correlated to their performance on successive assessments. Moreover, students' performance on the pre-test is moderately correlated with their performance on the post-test. The result indicates that the knowledge students at the start of the unit has a weak influence on how they perform on the rest of the unit, and may be a moderate indicator of how students will perform on the post-test.

The study of Merritt is related to the present study since the focus of the two studies was on determining the understanding of the particulate nature of matter. One of the main differences is in terms of the data collection. The study of Merritt administered several pencil-and-paper tests for the purpose of tracking the understanding of students as the unit on the particulate nature of matter progresses. On the other hand, the present study will administer the particulate nature of matter test only once. Of course, another difference between the two is terms of the respondents. The previous study involved students while the present study will involve elementary teachers.

The above literature and studies provided the researcher ideas about the variables of the study including guidance in conducting the study.

Chapter 3

METHODOLOGY

This chapter presents the research design that was employed in the study including the instrumentation, sampling procedure, data gathering procedure and statistical treatment of data.

Research Design

The study employed descriptive research design. The descriptive design was employed in describing the demographic profiles of the respondents and level of scientific understanding of the particulate nature of matter. The needed data were collected using a diagnostic test.

The study employed descriptive statistics to describe the profile of the teacher-respondents like frequency, percentage, mean, weighted mean. Correlational analysis was employed in order to determine if there was relationship between respondents' profile variates and level of knowledge of the particulate nature of matter using inferential statistical tests like Pearson Product Moment Correlation and chi-square test where appropriate. Comparative analysis was conducted using t-test for independent samples to determine difference in level of knowledge of teacher-respondents according to grade level taught and sex.

Instrumentation

The study employed a questionnaire for the profile variates and a diagnostic test that was embedded in the questionnaire as its main data gathering tool. Two-tier diagnostic tests had been one of the most common materials preferred in detecting the knowledge levels and scientific understanding for a particular subject matter or concept (Kabapınar, 2003).

Part 1 solicited respondents' profile such age, sex, grade level taught, number of years of teaching experience, educational background and number of in-service/training attended.

Part II is a diagnostic test called Particulate Nature of Matter Inventory composed 20 two-tier items. The test items have been borrowed from the works of Aydeniz (2017) and Kirbulut and Beeth (2013). The first tier is a multiple choice which is intended to measure the knowledge of teacher-respondents of the particulate nature of matter. The level of knowledge was interpreted using the guide below based on total score obtained.

Table 1

Interpretation for Level of Knowledge

Score	Interpretation
20	Full knowledge
14 – 19	Above average knowledge
7 – 13	Average knowledge
1 – 6	Below average knowledge
0	No knowledge

On the other hand, the second tier asked teacher-respondents to write down their reasons for choosing a particular option in the first tier. In this way, teacher-respondents' scientific understanding in relation to their answers to the first tier was determined (Morell and Wilson, 2016). Each correct answer to the first tier and second tier indicate full scientific understanding and was given two score points. Expected total score was 40 points.

Table 2

Assignment of Points

Question in Research Instrument		Points
Tier 1	Tier 2	
Correct	Correct	2
Correct	Incorrect	1
Incorrect	Incorrect	0
Incorrect	Correct	

Based on the total score of 40 points for correct combination of the first tier and second tier, the level of scientific understanding was interpreted using the guide reflected in Table 3 below.

Table 3

Interpretation for Level of Scientific Understanding

Score	**Interpretation**
40	Full scientific understanding
39 - 21	Partial scientific understanding
20 - 1	Unscientific understanding
0	No understanding

Validation of Instrument

The diagnostic test used in this study had undergone content validation. Content validation was done by an expert in chemistry together with some suggestions from the panel members during the pre-oral presentation.

Internal consistency reliability method was used in determining the reliability of the diagnostic test using Cronbach Alpha coefficient method using the answers of the teacher-respondents on the first tier multiple choice. Using SPSS version 23, the coefficient obtained was 0.75 which meant the diagnostic test was reliable.

Sampling Procedure

The researcher wrote a letter addressed to the Superintendent of the DepEd City Division of Catbalogan, Catbalogan City, Samar for the approval to conduct this study together with an endorsement to the principals. Once approval was granted, the researcher asked a copy of the list of all public elementary schools under the supervision of the DepEd City Division of Catbalogan City, Samar. Based on the list (kindly refer to Appendix A), the study employed total enumeration of 112 teachers.

Data Gathering Procedure

The researcher visited the schools according to the list and asked from the principle the names of grade 3 and grade 6 teachers who were teaching science. Due to limited population, total enumeration was employed.

The researcher personally administered copies of the research instruments to some of the identified teacher-respondents to ensure 100 percent retrieval. Each respondent was given half-day to accomplish the instrument. The accomplished instrument was be retrieved by the researcher to ensure that there were no blanks or unanswered items.

There were instances when the researcher personally give the questionnaire to some teacher-respondents and leave them to be able to go other schools for the same purpose, that is, to administer the questionnaire and to catch up vehicles in going home to Pinabacdao where the researcher resides. The questionnaires were retrieved the following day.

At other times, when the teacher-respondent(s) was/were absent the researcher gave the question to the principal and retrieve the same the following day. It took the researcher almost a week in the administration and retrieval of the accomplished questionnaire.

Statistical Treatment of Data

After gathering the accomplished questionnaire, data were organized, tallied, analyzed and interpreted using the appropriate statistical measures and procedures.

Frequency Count. This statistical tool was employed in reporting the profile variates of the teacher-respondents and number of responses on the Particulate Nature of Matter Inventory.

Percentage. This statistical tool was used in presenting the proportion of teacher-respondents having the same profile variates and responses of the Particulate Nature of Matter Inventory.

Mean. This statistical measure was utilized to determine the quantitative characteristics or profile of respondents.

Pearson Product Moment Coefficient Correlation. This statistical tool was used to determine the relationship between teacher-respondents' age and level of knowledge of the Particulate Nature of Matter.

t-test for Independent Samples. This was used to test the difference in scientific understanding of the Particulate Nature of Matter between grade 3 and grade 6 teacher-respondents.

Chi-square test. This was employed to determine the relationship between level of knowledge of the particulate nature of matter and sex, grade level taught, number of years of teaching experience, educational background and number of in-service/training attended.

Cronbach alpha. This statistical too was employed to determine the reliability of the diagnostic test.

Lastly, all statistical analysis were facilitated using SPSS version 23 and treatment was two-tailed at significance level of .05.

Chapter 4

PRESENTATION, ANALYSIS AND INTERPRETATION OF DATA

This chapter presents the data obtained, the analysis undertaken and the interpretation of gathered data in connection with the specific questions of the study.

Profile of Teacher-Respondents

This section discusses the profile of the teacher-respondents in terms of their age, sex, grade level taught, number of years of teaching experience, educational background and number of in-service training attended.

Age and Sex. Table 4 presents the age and sex distribution of the teacher-respondents.

Table 4

Age and Sex of Respondents

Age (yrs)	Male		Female		Total	
	f	Percent	f	Percent	f	Percent
20 - 25	1	0.9	10	8.9	11	9.8
26 – 31	2	1.8	28	25.0	30	26.8
32 – 37	4	3.6	22	19.6	26	23.2
38 – 43	2	1.8	22	19.6	24	21.4
44 – 49			18	16.1	18	16.1
50 - 55			3	2.7	3	2.7
Total	**9**	**8.0**	**103**	**92.0**	**112**	**100**
Mean	**32.56**		**35.74**		**35.48**	
SD	**5.94**		**7.95**		**7.83**	

Of the one hundred twelve teacher-respondents, nine or 8 percent are males while 10 or 92 percent are females. Of this number of respondents, the oldest is aged 50 to 55 years old females at three or 2.7 percent. This is followed by 18 or 16.1 percent with age of 44 to 49 years old. The youngest of the teacher-respondents is 20 to 25 years old at 11 or 9.8 percent. This is followed by 30 or 26.8 percent with age of 26 to 31 years old. The rest of the respondents have age within the 32 to 43 years old range.

The mean age of the respondents is 35.48 years which means that majority were in their middle age as supported by a standard deviation of 7.83 years. This imply teacher-respondents are still at the age where they are capable of learning new concepts and knowledge about science concepts like the particulate nature of matter.

Grade Level Taught. Table 5 presents the grade level handled by teacher-respondents.

Table 5

Grade Level Taught

Grade Level	Frequency	Percent
3	56	50.0
6	56	50.
Total	**112**	**100**

Of the one hundred twelve teacher- respondents, 56 or 50 percent are handling grade 3 classes and another 56 or 50 percent are handling grade 6 classes.

Number of Years of Teaching Experience. Table 6 shows the distribution of respondents in terms of their teaching experience.

It can be gleaned from the table that the longest teaching experience is 22 years and above by one or 3.2% of the teacher-respondents. This is followed by another four or 3.6% of the respondents at 18 to 21 years.

The result obtained a computed t-value of 1.047 with a p-value of 0.298. It is very clear that the p-value is higher than the 0.05 significance level implying no significant difference in level of knowledge of the particulate nature of matter between male and female teacher-respondents. Hence, the hypothesis "there is no significant difference in level of knowledge of the particulate nature of matter between male and female teacher-respondents" is accepted.

Respondents' Level of Scientific Understanding the Particulate Nature of Matter

Table 13 presents the level of scientific understanding of teacher-respondents of the particulate nature of matter.

Table 13

Level of Scientific Understanding of the Particulate Nature of Matter of Teacher-Respondents

Level of Scientific Understanding	f	Percent
No understanding	112	100
Total	**112**	**100**

As cab be gleaned from the table, all of the respondents (110%) have unscientific understanding of the particulate nature of matter.

Unscientific Understanding the Particulate Nature of Matter

Table 14 presents the unscientific understanding of the particulate nature of matter and percentage of respondents having such unscientific understanding.

Grade Level Taught. Reflected in Table 11 is the result of the t-test for independent samples conducted between grade 3 and grade 6 respondents regarding their knowledge of the particulate nature of matter.

Table 11

Comparison in Level of Knowledge of the Particulate Nature of Matter According to Sex

Grade Level	n	Mean	SD	t-comp	p-value
Grade 3	56	5.5536	2.28	0.999	0.320
Grade 6	56	5.1429	2.05		

Significance level = 0.05; df = 110; two-tailed

The result reveals a computed t-value of 0.999 with a p-value of 0.320. It is very clear that the p-value is greater than the 0.05 significance level indicating no significant difference in level of knowledge of the particulate nature of matter between grade 3 and grade 6 teacher-respondents. The hypothesis "there is no significant difference in level of knowledge of the particulate nature of matter between grade 3 and grade 6 teacher-respondents" is accepted.

Sex. Table 12 provides the result of the t-test for independent samples for level of knowledge of the particulate nature of matter according to sex.

Table 12

Comparison in Level of Knowledge of the Particulate Nature of Matter According to Sex

Sex	n	Mean	SD	t-comp	p-value
Male	9	5.875	1.893	1.047	0.298
Female	103	6.260	2.216		

Significance level = 0.05; df = 110; two-tailed says "there is no significant relationship between age of respondents and level of knowledge of the particulate nature of matter" is accepted.

Table 10

Correlation Between Respondents' Profile Variates and Level of Knowledge of Particulate Nature of Matter

Profile variates	r_{xy}/χ	p-value	Evaluation	Decision
Age	0.059	0.539	NS	Accept H_o
Sex	9.15	0.518	NS	Accept H_o
Grade Level Taught	7.582	0.670	NS	Accept H_o
Years of Teaching	173.062	0.806	NS	Accept H_o
Educational Background	22.953	0.817	NS	Accept H_o
Number of Trainings	22.688	0.828	NS	Accept H_o

Legend: α = 0.05; two-tailed; S – Significant; NS – Not Significant

Level of knowledge and profile variates obtained the following chi-square values and p-values: 9.15 and 0.518 with sex; 7.582 and 0.670 with grade level taught; 173.062 and 0.806 with years of teaching; 22.953 and 0.817 with educational background; and 22.688 and 0.828 with number of trainings attended. All the p-values are greater than the stipulated 0.05 significance level. These values imply no significant relationship between paired variables. So, the hypotheses "there are no significant relationships between level of knowledge of the particulate nature of matter and sex; grade level taught; number of years of teaching; educational background; and number of in-service trainings attended" is accepted.

Difference in Level of Knowledge of the Particulate Nature of Matter of Teachers

The level of knowledge of the particulate nature of matter according to grade level taught and sex of respondents are presented below.

five or 4.5 percent of the masteral graduates and four or 3.6 percent of the BSED graduates have below average knowledge of the particulate nature of matter.

Table 9

Respondents' Level of Knowledge of the Particulate Nature of Matter

Scores	Frequency				Interpretation
	DIT graduates	BEED graduates	BSED graduates	Masteral graduates	
20	0	0	0	0	Full knowledge
14 - 19	0	0	0	0	Above average knowledge
7 – 13	7	21	0	0	Average knowledge
1 - 6	35	40	4	5	Below average knowledge
0	0	0	0	0	No knowledge
Total	**42**	**61**	**4**	**5**	**112**
Mean	**4.95**	**5.52**	**4.75**	**7.00**	**5.35**
SD	**1.85**	**2.34**	**0.957**	**2.74**	**2.18**

With a mean score of 5.35, it could be concluded that as a whole the teacher-respondents have below average knowledge of the particulate nature of matter.

Relationship Between Respondents' Level of Knowledge of the Particulate Nature of Matter and Profile Variates

Table 10 presents the results of the correlation analysis conducted between level of knowledge of the particulate nature matter and profile variates of respondents.

As can be gleaned from the entries of the table, age and knowledge of the particulate nature of matter obtained a Pearson r coefficient of correlation of 0.059 with a p-value of 0.539. The p-value is greater than the 0.05 significance level which imply no significant relationship between the two variables. Hence, the hypothesis which

As depicted in the table, 61 or 54.5 percent are BEED graduates, 42 or 37.5 percent are DIT graduates, five or 4.5 percent have masteral degree and four or 3.6 percent are BSED graduates.

<u>**Number of In-service Training Attended**</u>. Table 8 presents the in-service training attended by the teacher-respondents.

Table 8

Number of In-service Training Attended

Number of Trainings	Frequency	Percent
0	76	67.9
1	10	8.9
2	25	22.3
3	1	0.9
Total	**40**	**100**

Of the 112 respondents, 76 or 67.9 percent have not attended any in-service training. Twenty five or 22.3 percent have attended two in-service training while one or 0.9 attended thrice.

Respondents' Level of Knowledge of the Particulate Nature of Matter

Table 9 presents the level of knowledge of teacher-respondents of the particulate nature of matter.

Of the 61 BEED graduates, 40 or 37.5 percent have below average knowledge while 21 or 18.8 percent have average knowledge of the particulate nature of matter. For the 42 DIT graduates, 35 or 31.3 have below average knowledge while seven or 6.3 percent have average knowledge of the particulate nature of matter. On the other hand,

Table 6

Number of Years of Teaching Experience

Years	Frequency	Percent
1 and below	1	0.9
2 - 5	35	31.3
6 – 9	37	33.0
10 – 13	26	23.2
14 – 17	8	7.1
18 – 21	4	3.6
22 and above	1	0.9
Total	**112**	**100**
Mean	**8.08**	
SD	**4.54**	

On the other hand, the shortest years of teaching experience is one year and below by one or 0.9 percent of the respondents.

The mean years in the teaching service is pegged at 8.08 years with standard deviation of 4.54 years.

Educational Background. Table 7 presents the distribution in terms of teacher-respondents' educational qualification.

Table 7

Educational Background of Respondents

Educational Attainment	Frequency	Percent
DIT graduates	42	37.5
BEED graduate	61	54.5
BSED graduate	4	3.6
Masteral graduate	5	4.5
Total	**112**	**100**

to 55 years old females at three or 2.7 percent. This is followed by 18 or 16.1 percent with age of 44 to 49 years old. The youngest of the teacher-respondents is 20 to 25 years old at 11 or 9.8 percent. This is followed by 30 or 26.8 percent with age of 26 to 31 years old. The rest of the respondents have age within the 32 to 43 years old range.

The mean age of the respondents is 35.48 years which means that majority were in their middle age as supported by a standard deviation of 7.83 years. This imply teacher-respondents are still at the age where they are capable of learning new concepts and knowledge about science concepts like the particulate nature of matter.

Grade Level Taught. Table 5 presents the grade level handled by teacher-respondents.

Table 5

Grade Level Taught

Grade Level	Frequency	Percent
3	56	50.0
6	56	50.
Total	**112**	**100**

Of the one hundred twelve teacher- respondents, 56 or 50 percent are handling grade 3 classes and another 56 or 50 percent are handling grade 6 classes.

Number of Years of Teaching Experience. Table 6 shows the distribution of respondents in terms of their teaching experience.

It can be gleaned from the table that the longest teaching experience is 22 years and above by one or 3.2% of the teacher-respondents. This is followed by another four or 3.6% of the respondents at 18 to 21 years.

Chapter 5

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the summary of major findings, the conclusions drawn and the recommendations that were formulated based on the results of the study.

Summary of Findings

The following are the salient findings of the study:

1. Of the one hundred twelve teacher-respondents, nine or 8 percent were males while 10 or 92 percent were females. Of this number of respondents, the oldest was aged 50 to 55 years old females at three or 2.7 percent. This was followed by 18 or 16.1 percent with age of 44 to 49 years old. The youngest of the teacher-respondents was 20 to 25 years old at 11 or 9.8 percent. This was followed by 30 or 26.8 percent with age of 26 to 31 years old. The rest of the respondents had age within the 32 to 43 years old range. The mean age of the respondents was 35.48 years which meant that majority were in their middle age as supported by a standard deviation of 7.83 years.

2. Of the one hundred twelve teacher- respondents, 56 or 50 percent were handling grade 3 classes and another 56 or 50 percent were handling grade 6 classes.

3. The longest teaching experience was 22 years and above by one or 3.2% of the teacher-respondents. This was followed by another four or 3.6% of the respondents at 18 to 21 years. On the other hand, the shortest years of teaching experience was one

year and below by one or 0.9 percent of the respondents. The mean years in the teaching service was pegged at 8.08 years with standard deviation of 4.54 years.

4. About 61 or 54.5 percent were BEED graduates, 42 or 37.5 percent were graduates of other course who have earned educations units, five or 4.5 percent have masteral degree and four or 3.6 percent were BSED graduates.

5. Of the 112 respondents, 76 or 67.9 percent have not attended any in-service training. Twenty five or 22.3 percent have attended two in-service training while one or 0.9 attended thrice.

6. Of the 61 BEED graduates, 40 or 37.5 percent have below average knowledge while 21 or 18.8 percent have average knowledge of the particulate nature of matter. For the 42 DIT graduates, 35 or 31.3 have below average knowledge while seven or 6.3 percent have average knowledge of the particulate nature of matter. On the other hand, five or 4.5 percent of the masteral graduates and four or 3.6 percent of the BSED graduates have below average knowledge of the particulate nature of matter. With a mean score of 5.35, it could be concluded that as a whole the teacher-respondents have below average knowledge of the particulate nature of matter.

7. Age and knowledge of the particulate nature of matter obtained a Pearson r coefficient of correlation of 0.059 with a p-value of 0.539. The p-value was greater than the 0.05 significance level which imply no significant relationship between the two variables. Hence, the hypothesis which says "there is no significant relationship between age of respondents and level of knowledge of the particulate nature of matter" was accepted.

8. Level of knowledge and profile variates obtained the following chi-square values and p-values: 9.15 and 0.518 with sex; 7.582 and 0.670 with grade level taught; 173.062 and 0.806 with years of teaching; 22.953 and 0.817 with educational background; and 22.688 and 0.828 with number of trainings attended. All the p-values were greater than the stipulated 0.05 significance level. These values implied no significant relationship between paired variables. So, the hypotheses "there are no significant relationships between level of knowledge of the particulate nature of matter and sex; grade level taught; number of years of teaching; educational background; and number of in-service trainings attended" was accepted.

9. The result of t-test for independent samples revealed a computed t-value of 0.999 with a p-value of 0.320. It was very clear that the p-value was greater than the 0.05 significance level indicating no significant difference in level of knowledge of the particulate nature of matter between grade 3 and grade 6 teacher-respondents. The hypothesis "there is no significant difference in level of knowledge of the particulate nature of matter between grade 3 and grade 6 teacher-respondents" was accepted.

10. The result obtained using t-test for independent samples was a t-value of 1.047 with a p-value of 0.298. It was very clear that the p-value was higher than the 0.05 significance level implying no significant difference in level of knowledge of the particulate nature of matter between male and female teacher-respondents. Hence, the hypothesis "there is no significant difference in level of knowledge of the particulate nature of matter between male and female teacher-respondents" was accepted.

11. All or 100% of the respondents have unscientific understanding of the particulate nature of matter.

Conclusions

The following are the conclusions derived from the findings enumerated above.

1. Majority of the teacher-respondents were females with mean age at 26 to 31 years old. As a whole, the mean age was 35 year old which meant that majority were in their middle age, handling grade 3 and grade 6 science classes, teaching experience of 8 years, BEED graduates and had not attended an in-service training.

2. Majority of the teacher-respondents had below average knowledge of the particulate nature of matter.

3. Age and knowledge of the particulate nature of matter were not significantly related.

4. Level of knowledge was not significantly related to sex; grade level taught; years of teaching; educational background; and number of trainings attended.

5. There was no significant difference in level of knowledge of the particulate nature of matter between grade 3 and grade 6 teacher-respondents.

6. There was no significant difference in level of knowledge of the particulate nature of matter between male and female teacher-respondents.

7. All teacher-respondents had unscientific understanding of the particulate nature of matter.

Recommendations

The following are the recommendations of the study based on the conclusions above.

1. Elementary teachers teaching science should improve and build their content knowledge related to the particulate nature of matter by attending content-based conferences and training.

2. DepEd school administrators should initiate a massive training as intervention program for teachers teaching science on the particulate nature of matter as in-service trainings for teachers teaching science.

3. School administrators should send their science teachers to content-based conferences and seminars.

4. Higher education institutions (HEIs) offering Bachelor of Elementary Education should assesse and evaluate the curriculum particularly on the science courses of the curriculum.

5. It is suggested that this study be replicated by involving junior and senior high school teachers.

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APPENDICES

APPENDIX A

Distribution of Teachers

District	Name of School	Male	Female
Catbalogan I	Albalate ES	1	1
	Bangon ES	0	2
	Cagudalo PS	0	2
	Cacusipan ES	0	2
	Cagutian PS	0	2
	Caramayon PS	0	2
	Catbalogan I CS	1	3
	Catbalogan I SPED Center	0	2
	Lobo PS	0	2
	Palanyagon PS	0	2
	Salug ES	0	4
	Totoringon PS	0	2
Catbalogan II	Basia ES	0	2
	Bunu-anan ES	0	4
	Catbalogan II CS	1	3
	Darahuway Dako ES	0	2
	Darahuway Guti ES	0	2
	Guinsurungan ES	0	2
	Ibol ES	0	2
	Madalunot ES	0	2
	Majaba ES	0	2
	Pangdan ES	1	0
Catbalogan III	Bliss ES	0	4
	Catbalogan III CS	0	2
	Cawayan ES	0	2
	Lagundi ES	0	2
	Libas PS	0	2
	Loyagoy ES	0	2
	Manguihay ES	0	2
	San Andres ES	0	4
	Socorro ES	1	0

Continuation:

District	Name of School	Male	Female
Catbalogan IV	Buri ES	0	2
	Cabugawan ES	0	2
	Catbalogan IV CS	1	1
	Iguid ES	0	2
	JPCSM ES	0	2
	New Mahayag ES	0	2
	Old Mahayag ES	1	2
	Pupua ES	1	1
	San Roque ES	1	1
	San Vicente Es	0	2
	Silanga ES	0	3
Catbalogan V	Bagongon ES	0	2
	Buluan ES	0	1
	Cagutsan ES	0	2
	Canhawan ES	0	2
	Catbalogan V CES	1	4
	Cinco ES	0	2
	Mombon ES	0	2
	Rama ES	0	1
	Total	**9**	**103**

December 20, 2017

CRISTITO A. ECO, CESO V
Schools Division Superintendent
DepEd, City Division of Catbalogan
Catbalogan, City

Dear Sir:

Warmest Greetings!

I would like to ask your permission to allow me to conduct my study for validation among the teachers in the City Division of Catbalogan. This is in view of my thesis, entitled, **"GRADES 3 AND 6 STUDENTS' SCIENTIFIC UNDERSTANDING OF THE PARTICULATE NATURE OF MATTER"** as part of the requirements for the Degree Master of Arts in Teaching Major in Chemistry. Attached herewith is the survey questionnaire of this study.

The survey would last only 10-15 minutes and would be arranged at a time convenient to the teachers' schedule (e.g. during break). Participation in this study is entirely voluntary and there are no known or anticipated risks. All information provided will be kept in utmost confidentiality and would be used only for academic purposes.

In this regard, I would also request to get the list of elementary schools and the names of grades 3 and 6 teachers in your division.

Your approval to conduct this study will be greatly appreciated. Thank you in advance for your interest and assistance with this research.

Respectfully yours,

JOAN M. QUITALIG
Researcher

Recommending Approval:

FELISA E. GOMBA, Ph. D.
VPAA/Acting Dean, College of Graduate Studies

APPROVED:

CRISTITO A. ECO, CESO V
Schools Division Superintendent

QUESTIONNAIRE

Name: ______________________________
(Optional)

I. PROFILE

Direction: Kindly provide the required information by writing or putting a check (√) mark on the appropriate space provided.

1. Age (in years): _______ 2. Gender: [ ] Male [ ] Female

3. Grade level taught: [ ]Grade 3 [ ]Grade 6

4. Years in teaching science: ____________

5. Educational background:

[ ] College graduate with education units
[ ] BEED graduate
[ ] BSED graduate
[ ] Masteral graduate
[ ] with Doctoral units
[ ] Doctoral graduate

6. Seminars attended related to science teaching:

Title	Sponsoring Agency	Date/No. of hours	Category (Local/Regional/National/International)

PART II. PARTICULATE NATURE OF MATTER INVENTORY

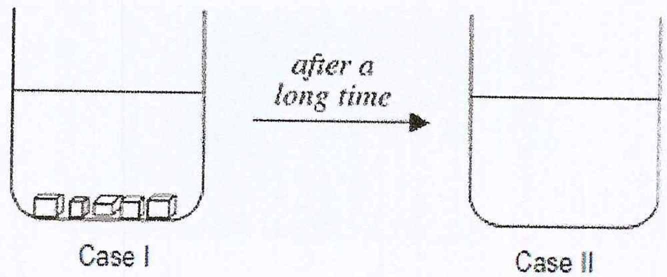
DIRECTION: This part is consists of 20 open ended two tier multiple choice questions. Please read the questions carefully and select the correct answer of your of choice by encircling the letter, then explain why you have chosen the particular answer.

1.1 Green leaves are comprised of living cells and these cells contain atoms. The chlorophyll pigment is the cause of the green color of leaves and each chlorophyll pigment contains magnesium atom. Accordingly:

A. The atoms in the leaf are alive.
B. The atoms in the magnesium are alive.
C. The atoms in the leaf and magnesium are alive.
D. The atoms in the leaf and magnesium are non-living.

1.2 For me, the reason is: ____
____
____

2.1 Crystals of sugar are placed in a beaker of water (Case I). If the mixture is left to stand long enough, the sugar crystals eventually can no longer be seen and yet the water will taste sweet (Case II).



A. True B. False

2.2 For me, the reason is: ______________________________
____
____

3.1 At room temperature (25⁰C), there is an open plastic bottle half-filled with water. If this bottle were left for several days in this room, what would happen to the level of water in the bottle? (Note: The humidity in the air should be considered too little.)

A. The level of water increases.
B. The level of water decreases.
C. The level of water stays the same.

3.2 For me, the reason is: ______________________________
____
____

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

	A. Air B. Heat C. Oxygen D. Water vapor E. Oxygen gas and hydrogen gas

4.2 For me, the reason is: ______________________________
____
____

5.1 The atoms of iron are moving in the solid phase.

A. True B. False

5.2 For me, the reason is: ______________________________
____
____

6.1 Which statements below is true regarding to the properties of gold atoms?

I. Gold atoms are shiny and hard.

II. If gold is heated, its atoms heat up as well.
III. Most of the volume of gold atoms is empty space.
IV. When gold is shaped its atoms changes in their arrangement.

A. Only I B. Only II C. Only III D. Only IV E. I, II, III and IV

6.2 For me, the reason is: ____

7.1 Which statement below is true regarding the properties of water?
A. The size of the water molecules is same in the solid, liquid and gas phase.
B. The size of the water molecules in the solid phase is the smallest, in the gas phase is the largest.
C. The size of the water molecules in the solid phase is the largest, in the liquid phase is the smallest.
D. The size of the water molecules in the liquid phase is the largest, in the solid phase is the smallest.

7.2 For me, the reason is: ____

8.1 Liquids take the shape of their container. Accordingly, the shape of water molecules changes depending on the shape of the container.

A. True B. False

8.2 For me, the reason is: ____

9.1 Which of the following statement is TRUE regarding ice and water molecules?
A. Both ice and water molecules are solid.
B. Both ice and water molecules are liquid.
C. Molecules cannot be in solid or liquid phase.
D. Ice molecules are solid, water molecules are liquid.

9.2 For me, the reason is: ____

10.1 The smallest particle of alcohol is a drop of alcohol, the smallest particle of sugar is a sugar crystal.

A. True B. False

10.2 For me, the reason is: ____

11.1 When water is placed inside the freezer in the refrigerator, it freezes and turns into ice. During this, water molecules __________.

I. Cool down
II. Freeze
III. Shrink
IV. Expand
V. Do not change

A. IV only B. V only C. I and II D. I, II and III E. I, II, III and IV

11.2 For me, the reason is: ____
____
____

12.1 When a piece of sugar melts through heating, sugar molecules _______

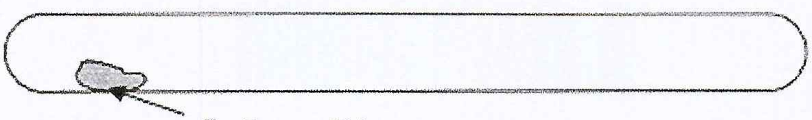
I. Heat up
II. Melt
III. Expand
IV. Do not change
V. Shrink

A. Only III B. Only IV C. I and II D. II and III E. I, II and III

12.2. For me, the reason is: ____
____
____

13.1 Iodine has chemical symbol 'I' and atomic number 53; it is an element in group VIIA of the Periodic Table. It is a dark grey-dark purple solid at room temperature.

A 1.0 g sample of solid iodine is placed in a tube and the tube is sealed after all of the air is removed. The total mass of the tube and the solid iodine is 27.0 g.



The tube is then heated until all of the iodine evaporates then the tube is filled with iodine gas. The mass of the tube and iodine after heating will be ______

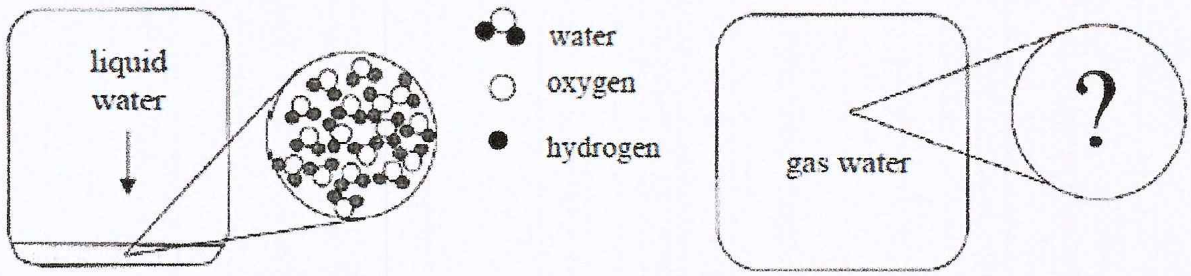
A. 27.0 g B. less than 27.0 g C. more than 27.0 g

13.2 For me, the reason is: ____
____
____

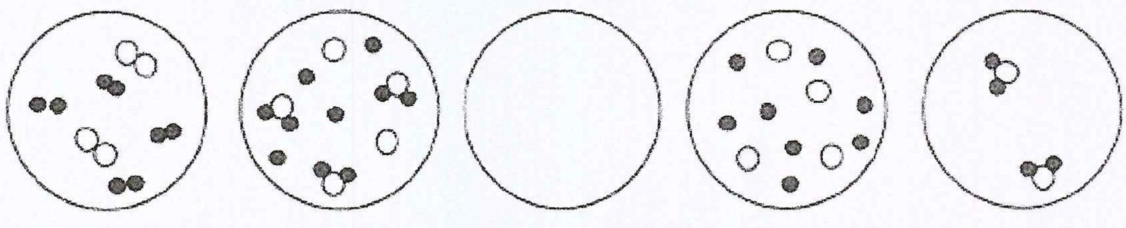
14.1 When ice is placed in a glass of water, the ice floats. This is because ice is _______
A. less dense than water. B. more dense than water.

14.2. For me, the reason is: ____
____
____

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



What would be the magnified view after water has evaporated?



A B C D E

15.2 For me, the reason is: ____

____

____

16.1 Sulfur has chemical symbol of 'S' and atomic number 16; it is an element in group VIA of the Periodic Table. It is a lemon yellow solid at room temperature. A sample of solid sulfur has the following properties:

I. brittle II. melting point of 113°C

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

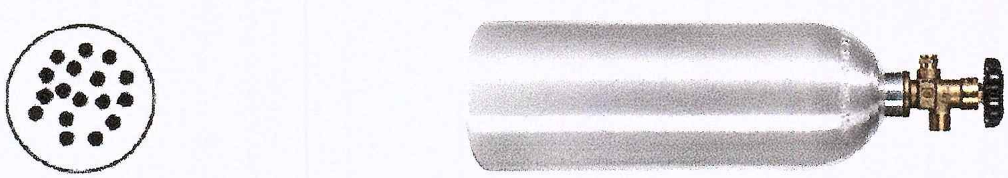
A. I only B. II only C. I and II only D. None of these

16.2 For me, the reason is: ____

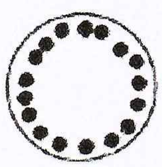
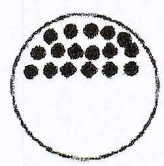
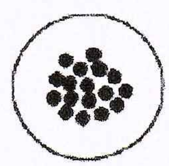
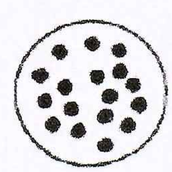
____

____

17.1 The figure shown below represents the cross-sectional area of a closed steel tank containing hydrogen gas at 20⁰C and 3 atm. The balls in the drawings represent the distribution of hydrogen molecules.



Which of the following diagrams represent the distribution of hydrogen molecules if the temperature is lowered to -5⁰C? (Note: At -5⁰C, hydrogen is still a gas.)

A.  B.  C.  D. 

17.2 For me, the reason is: ____

____

____

18.1 Copper wire is solid at room temperature. Suppose there is a very powerful microscope and you can see in details the arrangement of the copper particles, you also have a very very small twizzer and you isolate or remove just one copper particle. Now you are asked like this: "Is the single copper particle a solid?

A. YES B. NO

18.2 For me, the reason is: ____

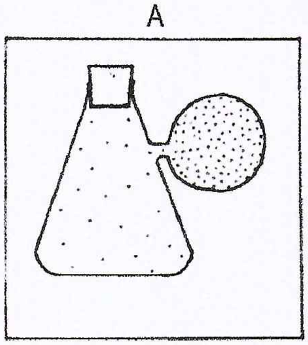
____

____

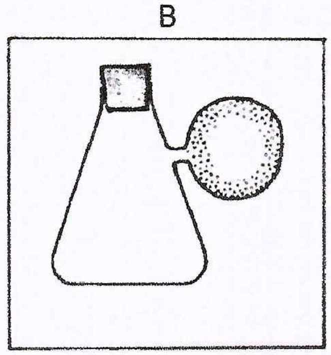
19.1 A flask containing air was connected to a rubber balloon. Then the flask with air inside was heated with a flame and the balloon inflated.

Which of the following diagrams illustrate the most probable distribution of the air molecules?

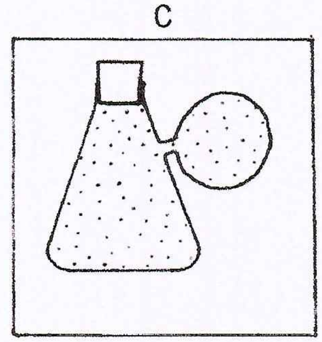
A



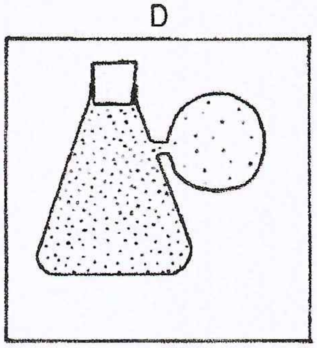
B



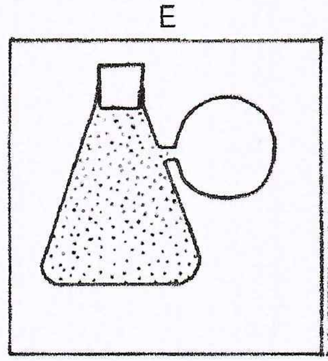
C



D



E

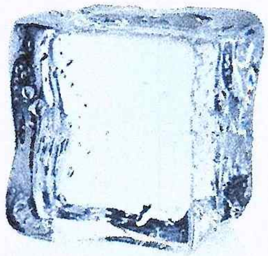


19.2 For me, the reason is: ____

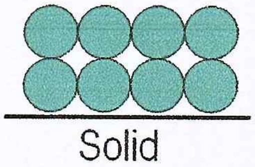
____

____

20.1 In a solid state the particles are orderly arranged, less ordered in a liquid state and completely disordered in a gaseous state.



Ice



What is/are present in between the particles in the solid state? Explain.

A. Air B. Nitrogen C. Water vapor D. Nothing

20.2 For me, the reason is: ______________________________

____

____

CURRICULUM VITAE

CURRICULUM VITAE

Name	: Joan M. Quitalig
Address	: Brgy 2, Poblacion, Pinabacdao Samar
Date of Birth	: July 13, 1992
Place of Birth	: Brgy 2, Poblacion, Pinabacdao Samar
Age	: 25
Sex	: Female
Civil Status	: Single

EDUCATIONAL BACKGROUND

Elementary	: Pinabacdao Central Elementary School Pinabcadao, Samar 1998-2004
Secondary	: Pinabacdao National High School Pinabacdao, Samar 2004-2008
Tertiary	: Samar State University Catbalogan, Samar 2008-2012
Graduate	:Samar State University Catbalogan, Samar 2014-2018 Master of Arts in Teaching Chemistry

WORK EXPERIENCE

August 2013 to present	: Secondary School Teacher I Department of Education-Samar Division, Catbalogan City, Samar

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