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EFFECTS OF ADDING AN ENHANCED MATERIAL INSTRUCTIONAL MODEL TO A COLLABORATIVE GROUPING INSTRUCTIONAL STRATEGY IN A COLLEGE PREPARATORY CHEMISTRY COURSE

A Thesis Project

by

CHINYERE FIDELIA, SHAW-NNAJIOFOR

Submitted to the Graduate School of the
University of Texas-Pan American
In partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

August 2009

Major Subject: Chemistry

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August 2009

ABSTRACT

Shaw- Nnajiofor, Chinyere F., Effects of Adding an Enhanced Material Instructional Model to a Collaborative Grouping Instructional Strategy in a College Preparatory Chemistry Course. Master of Science (MS). May 2009, 49 pages, 6 tables, 3 illustrations, references, 15 titles.

This research study investigated comparable academic achievement outcomes between an experimental group (EG) and a control group (CG) in a college preparatory chemistry course using a mixture of instructional pedagogies. The subjects comprised native and non-native English speakers, often identified as Limited English Proficiency (LEP) students. The study found no statistically significant difference between the pre-test scores of EG and CG students and a significant difference between the post-test scores of students in the experimental group compared to those of the control group. No significant difference was observed when comparing the test scores of the post-tests of the LEP-EG students to non-LEP students of both groups. Significant differences were observed comparing the post-test scores of the LEP students in the EG and CG groups. Therefore, the study inferred that students exposed to the mixture instructional model showed a significant improvement in their test scores, and the LEP-EG students' performance was at the same level as the non-LEP students of both EG and CG students in the post-test. Furthermore, significant improvement was observed and recorded when comparing the post-test and pretest test scores among LEP students from both groups. Conclusively, the study proved that the mixture of Enhanced Material Instructional Model and the Collaborative Grouping Instructional Strategy is an effective instructional method to increase all students' academic achievement in college preparatory chemistry.

DEDICATION

The completion of my Masters of Science studies would not have been possible without the love and support of my family: my mother, Angela Mokwe, and my children, Francis, Anthony, Victor-Marius, Olivia, and Linda. I am very grateful to Jonas E. Nnajiofor, my sisters Stella Maduakor and Rita Mokwe, and my brothers Paschal Mokwe, Emmanuel Mokwe, and Sylvester Mokwe and their families, who wholeheartedly inspired, motivated, and supported me to accomplish this degree .Thank you for your love and patience. To my friends, Mr. and Mrs. Tunji Arowolo and Rev. Fr. Andre Kazadi, I say thank you for all your support and encouragement.

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TABLE OF CONTENTS

CHAPTER 1 INTRODUCTION

Historical Background

The recent low academic performance of students, particularly in the areas of mathematics and science, has been of great concern to educational systems around the world. Governments everywhere have been embarking on substantial programs of reform in an attempt to develop more effective school systems and raise levels of student learning and achievement (Hopkins and Levin, 2000). A research study reported that the unfortunate paradox inhibiting government policy initiatives from realizing the targeted goals is noted in the instructional pedagogies involved in the delivery of curriculum contents to students by teachers (Hopkins and Levin, 2000).

The authors argue that the communities of educational change, researchers, and practitioners have finally begun to learn something about how ongoing improvement in student academic achievement can be fostered and sustained in schools. However, government policies on education have not taken adequate account of this knowledge concerning school development. Consequently, an enormous potential source of synergy has been lost, and student learning continues to lag behind its potential.

Government Policies

How Do Government Policies Affect Student Academic Achievements?

This question takes on new importance since there are many initiatives that rely on presumed relationships between various education-related factors and learning outcomes. The Executive Summary News Report forwarded by President Bush (2007) argues that the federal government's policies have influenced American schools since 1965.

It was reported that the federal government and most states' education systems had funded several hundred education programs spread across 39 federal agencies at a cost of $120 billion annually to influence the growth on educational excellence for "all" students. The report noted, regrettably, that despite all the billions of dollars spent, academic achievement gaps between rich and poor and between Anglos and minorities were not only wide, but in some cases had grown wider. Previous studies suggest that schools bring little influence to bear upon a child's achievement that is independent of the student's background and general social context (Coleman et al., 1966, Jencks et al., 1972).

Other evidence suggests factors such as class size (Glass & Smith, 1978; Hosteller, 1995), teacher qualifications (Ferguson, 1991), school size (Haller, 1993), and other school variables may play important roles in what students learn and how they learn it (Hammond, L.D, 1999). The statistical result of a 50-state policy survey on certified teachers ("highly qualified teachers") shows significant positive impact on student test scores in mathematics and science relative to teachers who were not certified in their subject area, but hold a degree in science, mathematics, or mathematics education (National Commission on Teaching & America's Future, and the National Educational Longitudinal Studies (NELS), 1988). Another research study affirmed that teacher instructional techniques and educational experiences determine the level of student achievement (Goldwater &Brewer, 1999).

In a conclusive research study statement on "Educational Policy Implementation on Shifting Political Climate" (Chrispeels, H. J; 2003), government policies had either negative or positive influence on students in our schools. One example of such government policy influence was documented by a research study that found that the government policies enacted in California creates coherence in the California education system and directly empowers the local school leaders to shape and interpret the policies that influence the classroom practices. Many policy makers are troubled that school outputs are linked with the student characteristics of race, income, and English proficiency (Kershaw, 1992). Poverty and race seem to have caused a noticeable substantial gap in academic performance of students among whites and other races as early as nine years of age (Nicola, A; 1995).

No Child Left Behind

The No Child Left behind (NCLB) Act was a bill passed in 2001 and signed into law by President Bush in 2002. The Act requires all schools to promote their students' Adequate Yearly Progress (AYP) according to a state-determined accountability system. Schools that fail to get the sufficient number of students to meet AYP (as measured by statewide tests tied to challenging content standards, e.g., TEKS (Texas Essential Knowledge and Skills), will be labeled "low performing." After two years of low performance, schools and districts that receive NCLB Title 1 funds will be subjected to a series of negative sanctions. The low performing school will be mandated to grant permission to parents of low-income students in grades 3-12, who would wish to transfer their children to private schools, other district public schools, or pay for intensive tutoring for those students. Federal funding will follow the child to his or her new school. Thus, states, districts, and school systems who fail to meet AYP performance criteria will lose federal funding.

Schools are held accountable for their effectiveness with annual state reading and mathematics assessments in grades three through eight. Beginning in 2008-2009, disaggregated results from science assessments at three grade levels will factor into the school improvement calculations (U.S. Department of Education, 2007). Since the inception of this policy, heavy emphases are placed on raising all student academic achievements nationwide by the year 2014. Educators have been called upon to carry out scientific research on how to help all students graduating from high school to acquire skills and general literacy in reading, mathematics, science, and social studies by the year 2014. The acquisition of skills will assist youths to become college ready and prepared for the ever-changing and challenging global job market. This demand has changed school culture and reduced quality of learning in general (Downey, 2003).

The NCLB Act and other government educational policies have resulted in an "aimless rush to cover textbooks, scope and sequence page by page by teachers within a prescribed time, in a valiant attempt to peruse through all factual material rather than through the construction of meaning from the activities"(Wiggins, 2005). Worse still is the impact of the Texas Education Accountability System, which has forced teachers to teach the Texas Assessment of Knowledge and Skills (TAKS) test objectives in order to achieve an excellent rating. These emergent accountability pressures from the federal government to the state educational systems have resulted in the students' low academic achievement currently observed in public schools throughout the United States.

This effect also can be observed across public schools in Texas, especially in the academic achievement gap between LEP and non-LEP students in schools within the Region One Education Service Zone. Region One Education Service Center is an educational service center for all public and private schools in the Rio Grande Valley education zone. This agency is committed to lead and serve all school communities in Cameron, Hidalgo, Jim Hogg, Starr, Webb, Willacy, and Zapata counties in enhancing students' academic success and school proficiency by providing students with quality education services.

According to the Regional Texas Assessment of Knowledge Skills data and accountability summary reports (RBG: TAKS 2007), LEP students meeting expectations in science from the Region One Education Service Center declined considerably over the years. The comparable reports between the percent of non-LEP and LEP students who met standard had shown that the fifth grade students in non–LEP classes scored 83% versus 52% scored by LEP students. Eighth grade non-LEP students scored 69% versus 21% scored by LEP students. Tenth grade non–LEP students scored 52% versus 14 % scored by LEP students, and eleventh grade non-LEP students scored 71% versus 30%. The same report indicated that many campuses in the Region One Education Service Zone failed to meet AYP during the 2006-2007 academic years. Nineteen campuses were rated unacceptable, while 238 out of 519 campuses in the Region One Education Service Zone were merely rated acceptable.

The Texas Assessment of Knowledge and Skill (TAKS) Policy

Recently, the Texas Education Agency (TEA) has reformed their high school graduation requirements in response to the reauthorization of the No Child Left Behind

Act, which incorporates the following expectations: 1) All students must achieve proficiency in science by the 2019-20 school years, 2) Every child must perform at or above their grade level by 2014, 3) Annual state assessments and disaggregated data must show evidence that achievement gaps among students groups have been closed, and 4) Learning instruction must move limited English proficient students to fluency. Therefore, the TEA responded by declaring that from 2007–2011, the end of course examinations in four subject areas (Mathematics, English Language Art, Reading, and Science) will replace the TAKS tests in high schools. Each test would account for 15% of the students' final grade.

The new recommended graduation requirements for every student graduating from high school in Texas states that students entering ninth grade by 2007 will take four mathematics classes (Algebra I, Algebra II , Geometry, and any other mathematics class), four science classes (4x4 graduation plan) in addition to the existing requirement for English language arts (English I, II, III, IV), and three and one-half social studies classes (world history – 1.0, world geography – 1.0, United States history – 1.0, and United States government - 0.5). The 4x4 Recommended High School Graduation Plan (RHSGP) for science includes biology, chemistry, physics, and another laboratory-based science. The RHSGP will require 26 credits from all high school graduates as opposed to the 24 credits previously required. Earlier, the RHSGP required students to graduate with four English classes, three sciences classes (which included biology and any other two sciences), while minimum high school graduation required biology and integrated physics and chemistry (IPC) plus another science course (Texas Education Code, §74:12, 2005).

In the previous plan, three credits of mathematics (Algebra I, Algebra II, and Geometry), and three and one-half social studies credits were required. Thus, it was called the 3x3 plan (Texas Education Code, §28.025, 2005*)*.

The new requirements had mounted enormous challenges on high school students who continued to perform at lower rates in the mathematics and science sections of the TAKS test. These changes were intended to expose high school graduates to more coherent, rigorous, and relevant content of science and mathematics, and demanded that all teachers in core academic subject areas must be highly qualified. Highly qualified teachers are those with bachelor degrees who obtained or are in the process of obtaining full state certification in accordance with the requirements set forth in the state public and charter schools in the core academic subjects of their teaching assignment by the end of the 2005-2006 school year. The highly qualified teachers include new teachers in core academic subjects and all teachers whose salary is paid in whole or in part with Title I, Part A funds (NCLB, Title IX, §9101, 2002). Many educators and some public school stakeholders have argued that accountability system requirements do not align closely with the current school system in Texas. NCLB policy requires a system to be based on the state academic standards and assessments that include sanctions and rewards. The system must be based on AYP for all schools in the nation.

The NCLB mandate has resulted in teachers teaching for the test to help their students meet the state basic standard and receive exemplary, recognized, and accepted school status. The NCLB Act failed to produce the long term, consistent gains that are the hallmark of successful schooling (Downey, 2003), and sent waves of discouragement among teachers and students of schools rated unacceptable. The good intentions and mandates of our leaders to reform successfully the national education system had not yielded the desired results. The NCLB Act is an accountability instrument designed to ensure that all students are fully prepared to meet the global job market demands while helping them grow to purposeful citizens.

This implies that there is a need for all stakeholders to develop a comprehensive plan to meet the needs of all students in our classrooms today. Proper evaluation of the cause of low performance by many students should be embarked upon, and appropriate steps taken should be taken to fix what has been broken.

TAKS and English Language Proficiency

The analytical study of the 2007 TAKS release student data by Region One Education Service Center for grades 5, 8, 10, and 11 showed that the percentage of LEP students who met standard on the state standardize test (TAKS)were 52%, 21%, 14%, and 30%, respectively. Non–LEP students who met standard were 83%, 69%, 52%, and 71% versus all students in Texas, with average scores of 75%, 60%, 47%, and 66%, respectively (RBG:TAK, 2007). This comparable analysis of TAKS data depicted large achievement gaps in the performance in science between English speaking students and Limited English Proficient students across all grade levels tested. The TAKS data analysis from this Education Service Center showed wide achievement gaps existing between the English-speaking students and the limited English proficiency students' performances in science across all grade levels tested in the 2006-2007 academic year.

It is, therefore, imperative for educators in this region as well as those of other educational regions of the state, to review and use best research-proven effective instructional methods to make science content accessible to all students. "All" students denotes regular students, native English speakers, gifted and talented, non-native English speakers, migrant students, special education, and low economic status students.

Teachers should be provided with enough time to plan, modify, and enhance available resources and materials to ensure deeper understanding of the science concepts taught to all students. Theories are suppositions that may or may not be true, and scientists believe that concepts are perceived regularities of patterns and are basic units of theory development (Zikmund, 2002). There is a need for chemistry teachers to develop teachable strands or propositions from the TEKS objectives, to explain the logical linkage or relationships among certain chemical concepts, and identify the theoretical relationships among chemical-organized knowledge that will help teachers to teach chemistry content in ways that make sense to students.

Consequently, for the college preparatory chemistry students to make sense of abstract chemistry concepts and theories, science teachers need to plan, modify, enhance, and align available teaching materials to their instructional techniques to foster abstract thinking and guide students to connect what they learn to the real world. Research has shown that teaching students' explicit thinking in the contexts in which they will use them greatly improves students' understanding of the abstract concepts (Whites, Frederickson, Brown, 1999).

Much cognitive psychology research on "how people learn" concurred that teachers are the primary resource of student learning. The authors argue that teachers can help students develop strategies and tactics for accomplishing learning goals (Derry, 1989; Irwin, 1991; Kiewra, 1981; Pressley, 1986). The questions are: 1) Do our textbooks support us?. 2) What instructional strategy is effective to assess what students already know? 3) Do teachers know how to engage students on the learning task intellectually?, and, 4) What instructional strategy is effective to maintain equity in the classroom today? The provision of answers to these questions will bring us face-to–face with the problem of finding effective instructional strategies that meet the needs of all students. How could science teachers reach the goals of good, strong content in science classes, conduct laboratory experiments 40% of class time, and conduct educational field trips with students? Furthermore, how could science teachers instruct students in the use of scientific processes and the use of many intervention initiative programs purchased by their school districts within the 50-minute class periods, as well as help all students attain proficiency in science by the year 2019?

CHAPTER II RESEARCH REVIEW

Literature Review

Many previous studies and Meta-analyses have primarily focused on the comparative efficacy of innovative constructivist instructional pedagogies. These learning models depend on students' previous knowledge or schema. The research study affirmed that when facts and skills are embedded in natural or spatial memory, students would understand and remember best what they learned (Caine & Caine, 1991). This study argued that the brain processes information in parts and in whole simultaneously. Therefore, students need time to process information they learned.

The research concluded that teaching must be multifaceted to allow students to express preferences. The constructivist instructional model is a student-centered instruction model, where students are guided to formulate questions and provide answers to their own questions in a non-threatening environment.

Constructivist instructional models provide active engagement and interactive activities, where students are challenged to pursue their own interests and connect isolated ideas with global concepts, providing opportunities for the teacher to act as a facilitator of the students learning compared to the traditional instructional methods described as a direct-lecture-method. In the direct lecture methods, students' learning consisted of rote memorization of new knowledge by listening to lectures and reading books. Thus, student progress in this traditional, teacher-directed method was measured by the students' ability to recite what they had heard and read (Bernstein and Richard, 1983).

The traditional method was blamed in many research studies as a factor that contributed to lack of students' interest and low academic performance in schools. The TEA recently appointed a team of researchers from the University of Texas A&M to carry out a meta analysis study of 61 research studies on effective instructional strategies to increase K- 12 students' achievement in science. The summary of their findings and their recommendations were ranked as follows in order of decreasing effectiveness: 1) Enhanced context strategies, 2) Collaborative grouping strategies, 3) Questioning strategies, 4) Inquiry strategies, 5) Manipulation strategies, 6) Assessment strategies, 7) Instructional technology strategies, 8) Enhanced material strategies and, 9) Direct instruction strategies (Nelly, 2006). They reported that a major goal for teachers and parents is to produce educated and concerned citizens. The research study pointed out that scientific literacy is a critical component of these efforts to educate our youths.

Enhanced Context Instructional Strategies

The meta-analysis study summary opined that the science curriculum must be made relevant to students by framing lessons in contexts that give facts and meaning, help students learn what matters to their lives, and offer them opportunities to solve real life complex problems. The enhanced context model includes, but is not limited to, a look at the big idea, case study, (what I know, what I want to know, and what I learn) KWL, solving real life problem models, field trips, field investigations, current events, concrete models, and video clips.

Collaborative Grouping Instructional Strategies.

The collaborative grouping strategy occurs when teachers arrange students in flexible groups to work on various tasks as a means to explore ways of solving a given problem or collaborate on meaningful projects. Students learn to work with others rather than compete with each other. The group selection might be random, homogenous, or heterogeneous based on students' interests. The meta--analysis study summary argued that collaborative grouping provides opportunities for students to work in diverse groups and improve social, communication, and problem solving skills. The size range consists of a small group of three or four students. It includes laboratory exercises, inquiry projects, learning/instructional games, paired or whole group discussion, distance learning, reciprocal questions, school-home projects, jigsaw, benchmarks, and other assessments.

Question Instructional Strategies

The results of the meta-analysis concluded that modeling a good question asking technique helps students learn to ask problem solving and good inquiry questions (Neeley, 2006). This includes randomized questions, increased wait time, addition of pauses, increased high cognitive level questions, open-ended questions, reciprocal questions, and questions for rational thinking. The researchers reported that these strategies are used to establish relevance, recapture of students' attention, recall previous knowledge, make connections, and apply knowledge and creativity.

Inquiry Instructional Strategies

The Neeley Shirley summary report of the meta-analysis study reported that inquiry strategy consists of exploration, asking questions, and constructing explanations about natural phenomena. They stated that inquiry exposes students to an authentic experience by engaging them in the practices of scientists. The authors warned not to confuse inquiry strategies with hands-on strategies. Levels of inquiry include guided-inquiry, structured-inquiry, student-directed inquiry, and illustration.

Manipulative Instructional Strategies

This method includes strategies that permit students to work directly with manipulative physical objects in order to experience science. It can be used for students of all ages to learn using concrete models that are accessible to auditory, visual, tactile and kinesthetic senses. These include how to develop skills, operate apparatus, build electrical circuits, make simple machines manipulate computer simulations, etc.

Assessment Method Instructional Strategies

These strategies include diagnostic assessments, formative assessments, homework, review games, and summative assessment. The authors concluded that appropriate assessment techniques should be chosen to conform to instructional needs. The formative assessment is an assessment planned with the end in mind, and is an assessment for learning. It is used to assess the previous knowledge, which includes teacher ongoing class observation, diagnostic testing design to assess level of understanding, while summative assessment is an assessment of learning that assesses what students understand and are able to do at the end of the lesson, end of unit, or end of course. Examples are post-tests and standardized tests (Stiggins, R; 2006).

Instructional Technology Strategies

The meta-analysis study summarized that the use of instructional technology strategies enabled teachers to facilitate communication, collaboration, critical thinking, data interpretation, problem solving skills, and promotion of student responsibility for their learning. It includes internet research, video conferencing, PowerPoint presentations; excel graphing capabilities, and Microsoft word processing capabilities.

Enhanced Material Instructional Strategies

These methods include, but are not limited to, concrete models, innovative charts, enhanced concepts maps, mind maps, enhanced graphic organizers, modified laboratory activities, and rewritten annotated material. Also included are re-sequenced lessons to align to 5E models (the 5E model is an inquiry instructional method involving five steps of Explore, Engage, Explain, Elaborate and Evaluate), computer simulations, creating thematic units to combine concepts from different disciplines, internet based projects, PowerPoint presentations, and the use of structured videos.

Direct Method Instructional Strategies

The researchers reported that direct instruction strategies focus on the deliverance of explicit, highly scripted lessons, teaching concepts, principles and strategies (Lozoff and Cowardin, 2001). Lozoff and Cowardin argued that only a few scientific studies had been carried out in direct instructional strategy. The meta-analysis researchers reported further that the few studies reviewed dealt with teaching of elementary science. It was described as a spectrum of methods that stretch from nothing but lecture and instruction (Klahr, 2006). The literature review of the Effective K-12 Science Instruction, element of research-based science education, ended with the recommendation to consider that not every strategy can, or should be, applied in every teaching situation. They argued that instructional strategies are tools to be used in designing and implementing instruction in a way that supports and nurtures student learning. The authors advised that it would be important to note that strategies may be used concurrently to enhance students' achievement in science.

Research Evidence and Effective Method of Teaching Chemistry

Strategies to enhance students' achievement in science involve making learning relevant and accessible to all students by presenting contextual lessons that make sense and relate to real world examples. The research studies on active teaching techniques in chemistry claimed that methods such as role-playing, teacher modified laboratory, group-work, learning exploration, students' games, models and analogies, concept maps, innovative charts, and organizers were useful teaching methods for students' understanding (Karamustafaoglu et al., 2003; Ozmen, 2002; Demirecioglu, 2002). The use of cooperative learning teams was reported to have produced a positive effect on students' success in an organic chemistry course (Carpenter and McMillan, 2003).

Similarly, the use of learning groups in a physical chemistry course to redirect students to view the learning community as one that facilitated learning through sharing applied multiple approaches to solve problems and different strategies to explain concepts (Towns, Kreke, and Fields, 1997). However, students in a general chemistry course, who were members of a cooperative learning group, did not show significantly higher grades than students in the lecture environment (Banedee and Vidyaptai, 1997).

CHAPTER III. RESEARCH DESIGN AND METHODS

English Language Proficiency and Effective Science Instruction

A research study on science teaching to non-native English Language speaking students suggested that the language skills needed by limited English proficient students in order to achieve success in a science course included: (1) clear communication of academic tasks using speech appropriate for the language level (Krashen, 1983; Echevarria, Vogt, Short, 2006) to (2) sequencing of instruction to align with the progression of students' language development levels (Hill & Flynn, 2006), and (3) scaffolding content instruction to provide students concrete structures such as patterns, models, and charts, thus extracting and patterning the data in a particular field and generally organizing and presenting data in written and iconic form to linguistic skills (Ceary, 1975; Echevarria, Vogt, & Short, 2008). The researchers suggested that teachers could not assume that students come equipped with these skills. Therefore, teachers are required to teach students science study skills in addition to the science concepts and theories.

These demands place constraints on the organization of the course content and on the materials that can be successfully used to teach science to a diverse group of students. High-level science materials, such as lectures and lesson notes modifiable to fit the level of the students' abilities, were highly recommended. This research called for a set of integrated materials that provide individualized learning activities, which require increasingly complex communication skills. The authors concluded that the close cooperation of science and language specialists is needed to produce such materials in many scientific areas.

A sheltered instruction observation protocol (SIOP) research study on increasing non-native speakers' academic achievement suggested that teachers should use instructional strategies that have been found to improve English learners' academic achievement (Vogt & Echevarria, 2006). Bachman explained that language ability consists of language knowledge and meta-cognitive strategies (Bachman, 1990). Language knowledge consists of areas of linguistic and textual knowledge involved in the language use. Linguistic and textual knowledge (organization knowledge, grammar knowledge, pragmatic knowledge) consist of how sentences are organized into texts rather than the functional or sociolinguistic knowledge that are concerned with how target languages are used to achieve a variety of communicative functions.(Bachman & Palmer, 1996).

Bachman and Palmer argued that language learners need to know a lot of vocabulary, grammar, sound system, and spelling of the target language to enable them to draw on the knowledge effective for communicative purposes under normal time constraints. Therefore, the degree of proficiency to which the language learners are able to read, write, listen, and speak in the target language and the strategy competency depends on building students' response systems and using effective strategy that helps students develop academic language to comprehend content objectives (Seidlitz, 2008). The limited English students can only have the language ability expected of them to perform in another content area if they are proficient in all components of language ability (listening, speaking, reading, and writing). Unfortunately, the LEP students in high school college preparatory chemistry courses in the Rio Grande Valley area are either fresh from their country of their native language (primarily Spanish) to the chemistry classroom or, at most, have been in U.S. classrooms for five years.

Jim Cummins (1991) differentiated between social languages, which he called Basic Interpersonal Communication Skills (BICS) from the components of academic language proficiency (CALP). He explained that BICS is the language skill needed in social situations, and CALP is the component of academic language proficiency that refers to formal academic learning language. Cummins said that CALP is a level of language learning that is essential for students' success in school. He argued that it took LEP students one to two years to master BICS, and a longer period of five to seven years to learn CALP. This may help to explain the wide gap that exists in the academic achievement of non-native and native English speakers in science in general and chemistry in particular.

(TEA, as in AEIS Science TAKS data, 2007).

Researchers have prescribed necessary and effective ways to make academic content comprehensible to all students, especially the LEP students, while communicating academic language. They argued that all students learn better when academic content and language objectives are clearly defined, targeted, sequenced, scaffold, and integrated (Short, 2000; Seidlitz, 2008). Researchers have opined when expectations for academic tasks are modeled and made clear, through consideration of learning strategies, visuals, graphic organizers, and enhanced materials, enhanced context, interaction/discussion in cooperative groups, sentence stems and innovative charts mind maps, that learning opportunities are created for all students, irrespective of their academic language levels (Collier, 1992; Crandall, 1987; Echevarria, Vogt, and Short, 2007; Krashen, 1993; Snow et al., 1990; Seidlitz, 2008). When the thinking and learning strategies are explicitly modeled, students can build on their background experiences, knowledge, and strength (Cummins, 1991; Collier, 1995).

Enhanced Material Instructional Strategy

The enhanced material strategies require teacher-modified or enhanced instructional materials to increase students learning (Neeley, 2006). Students are challenged to control their own learning, build their own understanding, and retain the information learned through active engagement using innovative and enhanced instructional materials. The enhanced instructional methods provide students with effective concrete strategies to access academic language and comprehend the academic content. It is structured to make sense of what students are learning in the classroom and connect it to the real world beyond the classroom (National Science Education Standard, 2005). Students are given opportunities for solving real life complex problems and skills by applying scientific knowledge in solving day-to-day problems that affect their health, safety, social well-being, and the environment. This teacher-modified instructional material model using charts, verbal visual word association, KLW, foldable, frayer model, sentence stems, small group presentations, structured whole class discussion, and concept maps, provides students with the opportunity of meaningful engagement to control their own learning and helps them to transfer their previous experiences to the new knowledge.

The enhanced material strategies help students become expert thinkers of the learning community. There are many evidences in the research literature that has shown that creating graphic organizers such as maps, charts, innovative concept posters, and word walls are effective ways to help students learn abstract concepts (Robinson & Kiewra, 1995). When students doodle on papers or draw while listening, it seems that they are not paying attention. However, for many learners, creating images can become a powerful tool for recording ideas and making meaning of what they hear in class (Margulies, 2005).

A researcher, Williams (1998), noted that modern teachers would be expected to illustrate abstract concepts of chemistry, "the invisible atoms, formulas and chemical combinations with models and charts (Youmans, as cited in Williams, 1996). Youmans (1850) reported that charts, which are part of the main components of the enhanced material model, could help all students understand chemistry, just as the way charts of planets aid in the understanding of astronomy and maps in the understanding of geography.

Benjamin Bloom's taxonomy was quoted in the statement that successful learning activities is procedural and involve simple, factual recall of material to application and evaluation of concepts (Anderson & Krathwohi, 2001; Cochra, Conklin, & Modin, 2007). Students learn interactively and work collaboratively on projects to gather, organize, and analyze information, solve problems, and communicate information by using complex multimedia and advanced networking technologies (Ringstaff & Kelley, 2002). Therefore, there is a great need to modify and enhance available teaching materials and teach in ways that relate to students' daily lives for them to make sense of the abstract chemistry concepts and connect those concepts to real life situations.

Research Question

What are the effects of using a mixture of an enhanced material instructional strategy and a collaborative grouping instructional method on the academic improvement of limited English proficient students (LEP) and non-limited English proficient students (NLEP) in a college preparatory chemistry course?

Hypotheses

Null Hypothesis

H_{01}: There is no significant difference between the academic improvement of the experimental group LEP students' test scores and LEP students of the control group

H_{02}: The improvement in LEP students' chemistry test scores by using the mixture of instructional strategies over collaborative grouping instructional method will be the same.

Alternative Hypothesis

H_1: The students in the mixture of the enhanced material instructional strategy and collaborative grouping instructional method will show a larger improvement in their chemistry test scores.

H_2 The improvement in LEP students' chemistry test scores by using the mixture of instructional strategies over collaborative grouping instructional method will be greater.

Methods

Participants

The college preparatory chemistry classes used for this research consist of Native and non-native English language speakers. Twenty-three students of my fourth period CP chemistry class participated as an experimental group (EG) and were exposed to a combination of enhanced material teaching strategy and collaborative grouping strategy (district-wide initiative strategies for science teaching). The control group was my third period CP chemistry class with similar students' characteristics as the experimental group (Both class periods were comprised of 35% LEP students, 55% non-LEP students, and 10% special needs students, respectively.). The control group was exposed to the district-wide adopted collaborative grouping instructional strategy only.

Instruments

The instruments were two sets of teacher-designed pre-tests and post-tests, each comprising 40 multiple-choice questions, which were constructed from the district Exam View System. The test items covered the content objectives and students' expectations from the acids and bases unit taught. The pretest was administered at the beginning of the sixth week of study. The post-test was used to assess and measure the level of understanding of knowledge and skills of chemistry concepts taught at the end of the learning cycle. For both students groups, individual students' raw scores from the tests were used for informed judgment as per the level of understanding of the chemistry concepts. Objectives taught between the two groups were made respectively, using one way ANOVA (analysis of variance). Acids and Bases teaching module, Enhanced material resources included: TEKS content objectives and students' expectations, illustration chart models, three feet by four feet post-it posters, McAllen ISD time lines, common laboratory apparatus, acids/bases indicators , acids and bases (hydrochloric acid, sulfuric acid, litmus papers, titration setups, sodium hydroxide), home chemicals (lemon juice, vinegar, ammonia, purple cabbage juice), C-scope Curriculum, computer lab, science lab, data projectors, Eik machine (digital projector), paper and pencils, crayons and markers, multi-colored construction paper, group folders, and randomization cards for equitable student response, masking tape, scissors, and school glue. .

Experimental Design

The independent variables are the mixture of enhanced material instructional method, collaborative grouping instructional method, and the two student groups: Limited English Proficient students (LEP) and Native English Speaking students (Non LEP). The dependent variable is improvement in various student groups' grades in the pre-test and post test of the college preparatory chemistry course. The dependent variable, academic improvement of the two groups, is categorized into two sub variables: pre-test and post test. Therefore, a 2x2 factorial design was considered.

EG	R	O1	X	O2
CG	R	O 3	X	O4
EG	R	O6	X	O7
CG	R	O7	X	O8

Table 1: 2x2 factorial research design,

Definition of terms and symbols on experimental design table 1.

X = exposure of the students' groups to the experimental treatment

O = observation or measurement of dependent variable. If more than one observation or measurement is taken, the subscripts (O_1, O_2, etc.) are given to show temporal order.

R = random assignments of test units

EG = treatment or experimental group

CG = controlled group

O_1, O_2 = pre-test observations for regular students

O_3, O_4 = post-test observations for regular students

O_5, O_6 = pre-test observations for LEP students

O_7, O_8 = post-test observations for LEP students

Procedure

By enhanced material instructional strategy, we mean an instructional model that includes: modified laboratory exercises, visual charts, mind or veer maps, foldable, oral presentations, vocabulary games, concept coloring charts, rewritten or annotated text materials, concept maps, graphic organizers to clarify concepts, modify activities from the available materials, lessons to align to 5E model, computer simulations, integrated structured video streaming, and field investigations (real world connection). The collaborative grouping instructional strategy consists of a small group of four students engaged sometimes in: inquiry projects, peer collaborations, jigsaw vocabulary games, internet projects, group PowerPoint presentations, problem-based learning group work, collaborative work on lab stations using the 5E model, and small group reading. Both class periods are comprised of 35% LEP students, 55% regular native English speakers, and 10% special needs students (SPED), respectively. Learning module content, grading criteria, class notes, PowerPoint, laboratory exercises, demonstrations, high student expectations, content objectives, language objectives, and student textbooks were similar in both groups.

Permission to use the researcher's chemistry class period students in the study were approved prior to data collection from McAllen Independent School District, campus administration, parents/guardians, and students. The informed consent documents for the research that might appear in government publication were submitted and approved by the school and the district. The voluntary participation and informed consent forms were submitted, approved, and distributed to students and parents/guardians. These forms were signed by both parties and returned to the researcher prior to the commencement of the research treatment application. The duration for the topic "Acids and Bases" of the college preparatory chemistry was eighteen days.

Data Analysis

The analysis of variance test (ANOVA) was employed. Since the sample size is less than 30, two independent variables are considered. A bivariate test of ANOVA was performed to test the two alternative hypotheses. For non-LEP students, (O3 - O1) divided by (O4 - O2) = Enhancement in test scores of the EG/Enhancement in the test scores of CG. If (O3 - O1) minus (O4 - O2) > 0, then the enhanced material method mixture was better than the collaborative method only. The variation of academic improvement of students in the treatment group to the control group was simultaneously determined by analyzing the pre-tests and post-tests of various student groups and comparing it with the critical alpha value using ANOVA. If the critical alpha is greater than the observed, then there would be a 95% confidence interval to accept the alternative hypotheses H_1 and H_2 above and reject the null hypotheses H_0. Inferences drawn would support that the mixture of instructional methods proved to be more effective in increasing all students' achievement in chemistry

CHAPTER IV MEASUREMENTS AND RESULTS

Descriptive analysis of the individual student scores within and between group means was conducted. The analysis of variance test (ANOVA) was deployed. Because the sample size is less than 30, and since there are two independent variables and two dependent variables to consider, I employed a bivariate test of one-way analysis of variance (ANOVA) to test the two alternative hypotheses.

Table II. Pre-test and post-test of the Control group (CG), Experimental group (EG), the performance gain (post-test-pre-test scores of each student) for LEP & Non-LEP.

S/N	STUDENTS	PRE-TEST	POST-TEST	POST-TEST MINUS PRETEST	ANOVA Code LEP = 1 Non-LEP = 0	ANOVA Code EG/CG EG = 0 CG = 1
1	EG	44	70	26	0	0
2	EG	76	84	8	0	0
3	EG	48	76	28	1	0
4	EG	70	100	30	0	0
5	EG	64	94	30	1	0
6	EG	76	90	24	0	0
7	EG	68	80	12	1	0
8	EG	50	80	30	0	0
t9	EG	60	84	24	1	0
10	EG	68	90	22	0	0
11	EG	72	92	20	0	0
12	EG	80	100	20	0	0
13	EG	72	92	20	0	0
14	EG	76	100	24	0	0
15	EG	64	80	16	1	0
16	EG	68	100	22	0	0
17	EG	24	72	48	1	0
18	EG	67	98	31	0	0
19	EG	32	70	38	1	0
20	EG	72	84	12	0	0
21	EG	76	96	20	0	0

22	EG	36	76	40	0	0
23	EG	60	74	14	1	0
24	CG	30	60	30	0	1
25	CG	64	80	16	1	1
26	CG	60	76	16	0	1
27	CG	44	56	11	1	1
28	CG	70	84	14	0	1
29	CG	70	88	18	0	1
30	CG	24	48	24	1	1
31	CG	72	80	8	0	1
32	CG	60	72	12	1	1
33	CG	76	90	14	0	1
34	CG	64	74	6	0	1
35	CG	70	88	18	0	1
36	CG	32	48	12	1	1
37	CG	76	80	16	1	1
38	CG	72	92	20	0	1
39	CG	80	96	16	0	1
40	CG	76	84	8	0	1
41	CG	48	70	22	1	1
42	CG	60	88	24	0	1
43	CG	76	96	20	0	1
44	CG	44	60	16	0	1

Table II Continuation.

Descriptive Analysis of pre-test LEP and non-LEP of the Control group (CG), experimental group (EG), the LEP and Non-LEP.

Groups		N	Mean	SD
LEP	Control Group	7	49.71*	18.31
	Exp. Group	8	56.25*	8.69
Non-LEP	Control Group	14	68.148*	9.26
	Exp. Group	15	66.26*	10.39
Total		44	61.16*	15.8

Table III results of Pre-test

**There are no large differences between the average performance of students in various groups.*

Practically, there is a slight difference between the mean scores of various student groups (Table III, the pre-test results). The non-LEP students in the control grouping have a mean score of 68.14 compared to a mean score of 66.26 of the non–LEP students in the experimental group, a slight mean difference of 1.88. However, the pre-test mean scores of the LEP students of the experimental group is 56.25. Thus, this has a slight mean difference of 6.54 compared to the mean scores of the LEP students in the control group.

Table IV One way analysis of variance summary of pre-test students' scores for LEP and non-LEP of experimental group and control group, respectively

PRETEST

Groups	Source Of Variation	Sum of Squares -SS	df	Mean Square-MS	F-Ratio	Sig.
Pre-test EG/CG	Between Groups	27.841	1	27.841	.107	.746*
	Within Groups	10978.045	42	261.382		
	Total	11005.886	43			
pre-test LEP EG/CG	Between Groups	65.186	1	65.186	.204	.659*
	Within Groups	4157.214	13	319.786		
	Total	4222.400	14			

* *Square of the mean difference is not significant at the .05 level. ($p > 0.05$).*

The one-way ANOVA summary indicated that between groups, variation for pre-test scores of EG versus the CG students and LEP-EG versus LEP-CG students, respectively, are not significant ($P > 0.05$). The observed sources of variation between and within groups' mean squares scores from the pre-test scores for the LEP student groups in the EG and CG has a probability value of 0.659. The observed probability value is therefore greater than the critical probability value ($P > 0.05$). Consequently, the difference of variation in the mean squares between non-LEP students in the experimental group and non-LEP students of the control group (NLEP/EG and NLEP/CG) is not statistically significant because the observed p-value is at 0.746, which is greater than the critical p-value ($P > 0.05$). Therefore, the null hypothesis is true.

Table V: The Results of Post-Test Descriptive Analysis

Groups		N	Mean	SD
LEP	Control Group	7	62.00	12.38
	Exp. Group	8	81.00	8.69
NLEP	Control Group	14	83.42	9.94
	Exp. Group	15	88.93	10.39
Total		44	81.46	13.46

*Mean scores of various student groups improved compared to their pre-test test mean scores, respectively.

Table VI: The Results of Post Hoc Analysis

Group Comparisons		Mean Difference	Std Error	*p*
LEP-EG	LEP-CG	19.00	5.33	.005*
	NLEP-EG	-7.93	4.51	.308
	NLEP- CG	-2.43	4.56	.951
LEP-CG	NLEP- EG	-29.93	4.71	.000*
	NLEP- CG	-21.43	4.77	.000*

*The between group mean differences of the post-test scores of students is significant for the LEP-EG and LEP-CG ($p<.05$) students, while the differences for LEP-EG/versus N-LEP-EG as well as LEP-EG versus N-LEP –CG are not statistically significant ($p>.05$). Moreover, the mean differences between the post-test scores of the LEP-CG students versus NLEP-EG, and LEP-CG versus NLEP-CG are at the significance level P-value of 0.001, respectively, indicating that the difference in the academic performance of the two groups are statistically significant.

Table VII: The Results of Analysis of Variance

Source: Main Effect	Df	SS	MS	F	*p*	Eta(η)
Between Groups	3	3544.55	1181.52	11.14	.000*	.675
Within Groups	40	4242.36	106.06			
Total	43	7786.91				

**The effect size, eta (η), was about .68, much larger than typical.*

The effect size, which indicates the strength of the relationship or the magnitude of the differences between group mean of the students' post-test scores, is 0.68, which is larger than the typical *eta* (η) $= | 0.37|$.

CHAPTER V DISCUSSION AND IMPLICATION

Interpretation of Results

This study provided insight into the need to use a variety of instructional pedagogies in making chemistry content comprehensible and accessible to diverse students while helping them develop abstract academic language knowledge in chemistry. The effectiveness of teaching chemistry using enhanced material instructional strategy concurrently with the collaborative grouping strategy has proven to be an effective strategy.

The ANOVA results of the pre-test data indicated that there was no statistical significant difference in the previous knowledge between the experimental group and the control group students in the acids and bases module students' academic performance study. However, the LEP-EG mean average was slightly higher than that of LEP-CG. This might be due to the different language levels of the LEP population in the study groups. The between group mean differences of the post-test scores of students is significant for the LEP-EG and LEP-CG ($p<.05$). The p-value of 0.005 of the comparable mean scores analysis between LEP students in the experimental group and LEP students in the control group indicated that the LEP-EG students showed a greater improvement in their test scores than the LEP-CG students. The p-value of .005 is too low to support the null hypothesis. Therefore, the alternative H_2 is accepted. Consequently, the mean differences between the post-test scores of the students of LEP-CG versus NLEP-EG, and

LEP-CG versus NLEP-CG, are at the significance levels or P-value of .001, respectively. Therefore, the alternative hypotheses are accepted.

It was interesting to note from the ANOVA data analysis (Table, VI) that the LEP students of the experimental group performed at the same level as the native English speakers (NLEP) in both control and experimental. Despite the small sample size, however, the effective size or the strength of the group interaction is at eta significant level of 0.68, which is much larger than the typical.

Implication of the ANOVA Summary

The findings implied that adding the enhanced material instructional strategy to the collaborative grouping instructional strategy in teaching college preparatory chemistry is directly related to students' academic improvement in chemistry, especially the limited English proficient students. The results from the one-way ANOVA showed that the mixture of the instructional strategy is very effective to increase"all" students' academic achievement. The comparable analysis of student pre-test scores indicated no observed statistical significant differences between different groups of students in the experimental and control groups prior to the application of the treatment. This implies that the mixture of the instructional strategy has positive impact on the participant students' increased academic achievements in the college preparatory chemistry than the students of the control group exposed only to the collaborative grouping instructional model.

The emergent role of the teacher as the primary resource for students' academic achievement in using a variety of instructional strategies aligned to other available teaching materials is a key factor in increasing student success in schools.

Therefore, visual representations, interactive, and well-structured teaching strategies as applied in this study enhanced learning and have created positive impact on the chemistry learners. The results of this study support the research study conducted by Anderson and Smith (1983), which states that in concept teaching, "a picture is worth a thousand words." The authors stated that seeing and handling specific examples or picture of examples helps students to learn concepts. The success of using enhanced material to increase students' academic achievement took root from a similar research study that suggests that students of all ages can better learn any complex concepts in history, science, and mathematics if the concepts are illustrated in diagrams or graphs (Anderson & Smith, 1987).

In relation to students' achievement, this study verifies that teachers should use less teacher-directed methods when students' deeper understanding of content objectives is required. It has proven that framing abstract science content with visual representation, audio, enhanced context, and connection to students' real world is a valuable mechanism for making content accessible and comprehensible for native and non-native English speaking students. The mixture of the enhanced material method to the collaborative grouping method in teaching college preparatory chemistry facilitated integration across content and helped the students' retention of information learned and recall of learned information when needed. This may explain greater academic improvement observed by the limited English proficiency students.

CHAPTER VI SUMMARY AND CONCLUSION

The findings from this study proved that there is no one instructional strategy that is a cookie cutter instructional method to improve diverse students' academic achievement in science and chemistry, in particular. The improvement gain or positive impact observed in the test scores of the participants of the experimental group compared to that of the control group is related to the way the chemistry information is learned and processed, which always affect its recall (Woolfolk, 1999). This model supports the meta-cognitive teaching model, where a teacher understands how students think and enhances the teaching materials to match instructional strategies to maximize the students' abilities and effort to increase understanding. In terms of student achievement using this model, a teacher has to target intentionally meeting the needs of all students in the classroom by integrating language objectives to the content objectives, embedding the systematic use of innovative interactive teaching methods in the lesson plan prior to lesson development.

This study also proved the claim that students must be cognitively engaged in order to learn. They have to focus attention on the important aspects of material to enhance learning (Derry, 1989). A teacher must therefore sequence and scaffold abstract information from the textbooks, and guide students to develop independency in solving problems that relate to their learning. It is only then can we lead students to take charge of their own learning and become intrinsically motivated to learn.

The results of this study confirm a research statement that any form of diagramming or visual representation of relationships among ideas presented in any text, and mapping these relationships by comparison/contrast connections, improves recall (Ambusher & Anderson, 1981). Given the good classroom climate that this instructional method provided in the researcher's classroom among the students of experimental groups, this researcher adopted the same method for the rest of the class periods, except for the control group, even when teaching pre-calculus to twelfth grade students. This researcher achieved maximum student participation in class assignments as well as fewer discipline problems throughout the 2007-2008 academic year of this research study.

In conclusion, adding enhanced material instructional strategy to the collaborative grouping instructional strategy is an effective instructional method to improve all students' academic achievement in chemistry while enhancing positive teacher–student relationships and student to student cordial class interactions. Students were motivated by their group work. The limited English proficient students saw that effort and teamwork is what it takes to cut across language barriers. The native English speakers realized that LEP students have other abilities that helped their group to be academically successful. It was a win–win situation for everyone. The teacher had peace, while the students transformed their understanding of concepts taught into beautiful charts and maps, and displayed their work throughout the classroom. Concisely, enhanced material instructional strategy, with collaborative grouping instructional strategy, is a useful strategy that will help both students and teachers attain their desired goal in the process of teaching and learning.

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APPENDIX A

Name: ______________________________ Class: ________________________ Date: ____________

PRE- TEST C.SHAW'S CHEMISTRY MAY 5, 2008

Multiple Choice
Identify the letter of the choice that best completes the statement or answers the question.

____ 1. Which of the following is a weak base?
- a. acetate ion
- b. hydroxide ion
- c. hydronium ion
- d. hydrogen ion

____ 2. Which compound is produced by a neutralization?
- a. $H_2O(l)$
- b. $HNO_3(aq)$
- c. $Ca(OH)_2(s)$
- d. $H_3PO_4(aq)$

____ 3. In the reaction $HClO_3 + NH_3 \rightarrow NH_4^+ + ClO_3^-$, the conjugate acid of NH_3 is
- a. $HClO_3$.
- b. ClO_3^-.
- c. NH_4^+.
- d. not shown.

____ 4. The members of a conjugate acid-base pair
- a. appear on the same side of the chemical equation.
- b. appear on opposite sides of the chemical equation.
- c. might appear on the same side or on opposite sides of the equation.
- d. are not included in the chemical equation.

____ 5. Acetic acid is found in significant quantities in
- a. lemons.
- b. vinegar.
- c. sour milk.
- d. apples.

____ 6. Bases make litmus paper turn
- a. blue.
- b. red.
- c. yellow.
- d. black.

____ 7. In the equation $HClO_4 + NH_3 \rightarrow NH_4^+ + ClO_4^-$, ClO_4^- is a weak base and $HClO_4$ is a
- a. strong acid.
- b. strong base.
- c. weak acid.
- d. weak base.

____ 8. The name of a binary acid
- a. has no prefix.
- b. begins with the prefix *bi-*.
- c. ends with the suffix *-ous*.
- d. begins with the prefix *hydro-*.

____ 9. Bases taste
- a. soapy.
- b. sour.
- c. sweet.
- d. bitter.

____ 10. An electron-pair donor is a
- a. traditional base.
- b. Brønsted-Lowry acid.
- c. Brønsted-Lowry base.
- d. Lewis base.

____ 11. What acid is manufactured in largest quantity?
- a. hydrochloric acid
- b. phosphoric acid
- c. nitric acid
- d. sulfuric acid

____ 12. A base is weak if its tendency to
- a. attract a proton is great.
- b. attract a proton is slight.
- c. donate a proton is great.
- d. donate a proton is slight.

Name: ______________________ ID: A

____ 26. Which of the following is amphoteric?
a. H_3PO_4
b. H^+
c. HPO_4^{2-}
d. PO_4^{3-}

____ 27. In the reaction $HSO_4^- + H_2O \rightleftharpoons H_3O^+ + SO_4^{2-}$, the ion HSO_4^- acts as a(n)
a. acid.
b. base.
c. spectator species.
d. salt.

____ 28. Which of the following gases does NOT dissolve in atmospheric water to produce acidic solutions?
a. NO
b. NO_2
c. O_2
d. CO_2

____ 29. Which of the following is perchloric acid?
a. HClO
b. $HClO_2$
c. $HClO_3$
d. $HClO_4$

____ 30. Which of the following is amphoteric?
a. H_2SO_4
b. SO_4^{2-}
c. H^+
d. HSO_4^-

____ 31. In a conjugate acid-base pair, the acid typically has
a. one more proton than the base.
b. one fewer proton than the base.
c. two fewer protons than the base.
d. the same number of protons as the base.

____ 32. Hydroxides of Group 1 metals
a. are all strong bases.
b. are all weak bases.
c. are all acids.
d. might be either strong or weak bases.

____ 33. An electron-pair acceptor is a
a. Brønsted-Lowry base.
b. Lewis acid.
c. Lewis base.
d. traditional acid.

____ 34. Which acid is used in batteries?
a. hydrochloric acid
b. phosphoric acid
c. nitric acid
d. sulfuric acid

____ 35. An amphoteric species is one that reacts as a(n)
a. acid only.
b. base only.
c. acid or base.
d. None of the above

____ 36. Acids make litmus paper turn
a. red.
b. yellow.
c. blue.
d. black.

____ 37. What is the basic assumption in the Arrhenius theory?
a. Because acids and bases conduct electric current, they must not produce ions in solution.
b. Because acids and bases conduct electric current, they must produce ions in solution.
c. Only acids conduct electric current in solution.
d. Only bases conduct electric current in solution.

____ 38. In the reaction $HClO_3 + NH_3 \rightleftharpoons NH_4^+ + ClO_3^-$, the conjugate base of $HClO_3$ is
a. ClO_3^-.
b. NH_3.
c. NH_4^+.
d. not shown.

____ 39. Which acid turns yellowish on standing?
a. acetic acid
b. nitric acid
c. phosphoric acid
d. hydrochloric acid

Name: ______________________ ID: A

____ 40. A Bronsted-Lowry base is a(n)
a. producer of OH^- ions.
b. proton acceptor.
c. electron-pair donor.
d. electron-pair acceptor.

Short Answer

41. Use the following equation to explain how acid rain damages marble structures:

$CaCO_3(s) + 2H_3O^+(aq) \rightarrow Ca^{2+}(aq) + CO_2(g) + 3H_2O(l)$

42. What determines the behavior of an amphoteric compound?

BIOGRAPHICAL SKETCH

Chinyere Fidelia, Shaw-Nnajiofor received a B.SC in Physics from Imo State University Nigeria in 1989, a Post Graduate Diploma in Petrol-chemical Engineering from River State University of Science and Technology Nigeria in 1998, and M.Ed-Secondary from university of Texas Pan American in 2004.Chinyere is a certified Principal (grades EC-12) from State board of education since 2007.She is a Texas State Board certified secondary Mathematics and secondary composite science classroom teacher. Currently she is a science and mathematics coordinator for Pharr-Alamo San Juan independent school district (PSJA ISD).She has worked as K-12 science and mathematics educator since 1982. Chinyere was recipients of several teaching and academic achievements awards. She was Nigerian INTEL-ISEF science fair director, Lolo chinyere Nnajiofor loves learning and teaching. She has served in many administrative capacities as senior science inspector in science and higher education department, ministry of education, Umuahia, Abia state of Nigeria from 1993 to 1998. She has worked as a secondary school classroom teacher in the Rio Grande Valley for nine years prior to serving in PSJA ISD central administration, she taught 9th grade biology, high school chemistry, Pre-calculus and 7-12 mathematic. Lolo Chinyere.also served as a site coordinator for 21st century community of learners after school program. She wrote a grant titled "capital investment fund" and managed the grant fund by providing after school programs for at-Risk students. Chinyere served as site coordinator for UIL (university interscholastic League. She has served as, a lay reader, a financial secretary to Aba diocese catholic women. Chinyere was raised in Umuchu, Aguata LGA, Anambra State, Nigeria in one of a large and happy, polygamous family of 17 children. She served the catholic faithful, in many church callings, including Lay reader, Secretary and

Catechist at our lady of Perpetual Help, McAllen Texas. She is blessed with five children .Three boys and two girls.