A Program Evaluation of Hudson Middle School's

Eighth Grade Earth Science

Chemistry Curriculum

by

Diane Schofield

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Robert Peters

Dr. Robert Peters

The Graduate School

University of Wisconsin-Stout

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The Graduate School
University of Wisconsin-Stout
Menomonie, WI

Author: **Schofield, Diane E.**

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ABSTRACT

The purpose of this study was to conduct a pilot evaluation program for units that use the Understanding by Design format at Hudson Middle School. Using the Chemistry unit for eighth grade Earth Science at Hudson Middle School, the purpose of this evaluation was to gather data that could drive curriculum improvement and help the science instructors determine effective and efficient assessment tools. This study was accomplished through a comprehensive review and critical analysis of literature, surveys of the ninth grade Pre-chemistry teachers at Hudson High School and student achievement on Chemistry unit pre-tests and post tests. Analysis of data led to recommendations for this type of evaluation that could be applied to other units in the same format, as well as ways to adjust this evaluation process to provide more accurate and useful information for teachers and other stakeholders.

The Graduate School

University of Wisconsin Stout

Menomonie, WI

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CHAPTER I: INTRODUCTION

Introduction

Eighth Grade Science at Hudson Middle School focuses on Earth Science.

The District Description for this course reads as follows:

> *Earth Science is a course in which students will learn that science is a process of acquiring knowledge and solving problems and that earth science deals particularly with the physical earth and space. They will use the scientific method to gain information about the earth: its composition, its location in the universe, and the changes which occur in and around the planet. (Hudson Middle School Eighth Grade Course Handbook, 2007)*

Within this curriculum there are ten units of study. Each unit has specific science objectives and standards. Students must demonstrate a level of proficiency with each of these objectives to have the best possible preparation for future science courses. One of the ten units is chemistry. This unit has the most direct impact on students once they enter the ninth grade science course which is pre-chemistry. Therefore, the eighth grade chemistry unit is very important for the transition to ninth grade science.

Brief Description of the Chemistry Unit:

> *Students will explore the world of chemistry through hands on activities that make connections between atoms, elements and compounds. Students will begin to understand how to read and use the periodic table of elements. Students will have some perspective on how everything is made from tiny elemental atoms combining in specific order and structure to produce a unique substance.* (Current Eighth Grade Chemistry Unit UBD, Appendix A)

Students who complete eighth grade science continue their science education as freshmen by taking pre-chemistry and pre-physics. To focus this evaluation we are interested particularly in the chemistry unit that is taught within the eighth grade Earth Science curriculum. Students go on to their freshmen year to a required pre-chemistry science course. Therefore, important questions are: how well are eighth grade students prepared

for this next course and are the eighth grade science teachers using "an effective unit curriculum plan and assessment strategies that work"?

Other Factors Leading to this Program Evaluation

-Hudson School District has initiated an intense focus on assessment and last year Diane Schofield was part of a pilot committee that received "Assessment Literacy" training. This training program provided strategies to promote student learning and to promote teacher effectiveness through assessment.

-The Districtwide Science Curriculum began its six-year evaluation cycle, reported on the *Hudson Program Improvement Calendar,* in the fall of 2006. (Hudson Schools, 2006).

-Hudson Middle School uses a "Unit by Design" format for all units.

So with each of these separate components it is very important to evaluate the science instruction and assessment tools used currently.

-Instruction using "best practices" is deemed to have the most value for student learning and teacher effectiveness. Best practices are linked to a strong standards-based curriculum. As Stiggins, Arter, Cappuis, and Chappius state in *Classroom Assessment for Student Learning,*

> "A curriculum that has been aligned to state or provincial standards allows you to use accountability test data to identify which portions of your curriculum students do well on and which portions students do not do well on, and to adjust teaching and resources accordingly" (p.77, 2006).

-Students who have a basic introduction to chemistry will be more successful in a Pre-Chemistry class.

-Good assessment tools that have clear targets, clear purpose and student involvement are effective. Stiggins, Arter, Cappuis, and Chappius focus on the "Keys of Quality Classroom Assessment, where students are involved at all steps. High-quality classroom assessment equal accurate information–clear purposes, clear learning targets, and an appropriate design–used effectively to help students learn" (p.12, 2006).

Statement of the Problem

The Chemistry unit for eighth grade earth science at Hudson Middle School is being used as a pilot for the evaluation of the science curriculum. The purpose is to gather data that can drive curriculum improvement and help the science instructors determine whether standards are being met and effective assessment tool are being used.

Purpose of the Study

The purpose of this study is twofold: To conduct a program evaluation of Hudson Middle School's eighth grade chemistry curriculum and to review the assessment tools used by the eighth grade science teachers during the 2006-2007 school year to determine if they support student learning and the current unit curriculum.

Hudson School District has begun an intense focus on assessment and assigned a team of individuals to "Assessment Literacy" training. It is the hope of the district that this training will provide strategies to promote student learning and to promote teacher effectiveness through assessment. With this in mind, the focus of this evaluation is the chemistry unit that is taught within the eighth grade earth science curriculum. There are important curriculum and instruction issues that need to be evaluated in regards to student preparation for the required ninth grade pre-chemistry course.

Assumptions of the Study

-Students who have a basic introduction to chemistry will be more successful in a pre-chemistry class.

-Good assessment tools that have clear targets, clear purpose and student involvement are effective. Stiggins, et. al. focus on the "Keys of Quality Classroom Assessment," in *Classroom Assessment for Student Learning.* "Students are involved at all steps. High-quality classroom assessment equal accurate information–clear purposes, clear learning targets, and an appropriate design–used effectively to help students learn" (p.12, 2006).

Definition of Terms

The following is a list of terms that need to be defined for a clear understanding of this study.

Academic Standards. As defined by the Wisconsin Department of Public Instruction, academic standards specify what students should know and be able to do, what they might be asked to do to give evidence of standards, and how well they must perform. They include content, performance, and proficiency standards.

- Content standards refer to what students should know and be able to do.
- Performance standards tell how students will show that they are meeting a standard.
- Proficiency standards indicate how well students must perform. (http://www.dpi.state.wi.us/standards/)

Understanding by Design Units. A format for writing unit curriculum based on Wiggins and Mc Tighe's book *Understanding by Design.* This method uses a backward design approach. This means that in designing unit curriculum you begin with deciding the largest and most important learning concepts and work to create learning targets, the assessments that will provide evidence that these targets have learned by students and finally create the instructional lessons.

Formative Assessment. As defined by Stiggins et al (2004) are,

> "Assessments for learning happen while learning is still underway, they diagnose student needs, assist in planning the next steps in instruction, provide students with feedback they can use to improve the quality of their work and help students see and feel in control of their journey to success" (p.31).

Summative Assessment. As defined by Stiggins et al (2004) are "those assessments that happen after learning is supposed to have occurred to determine if it did" (p.31).

Limitations of the Study

A limitation to this evaluation is that it is a pilot program of one single unit taught by one single eighth grade science teacher at Hudson Middle School. Students that are involved in this study are a sample of convenience. Therefore, some bias may arise. In this case, the teacher who teaches this chemistry unit also chose the sampling of students and is the author of the chemistry curriculum. Also, this individual is the evaluator of the program. By surveying other faculty, a bias may occur in their responses if they do not value such evaluations, feel a threat to other faculty from this evaluation, or if their values include concerns that the failure of standard-setting organizations does not allow flexibility of curriculum.

The Literature Review will be focused on a broader look at curriculum, unit design and instruction due to the difficulties in finding similar science and chemistry programs and curriculum with similar populations of students. Teacher differences, resources available, student-body composition, and community support often contribute to program effectiveness. These factors influence programs in unpredictable ways, which may not be accounted for in the literature. An absolute comparison is not possible.

Methodology

There are important curriculum and instruction issues that need to be evaluated in regards to student preparation for the required ninth grade pre-chemistry science course. To effectively evaluate this unit, the following questions need to be answered: What specific chemistry content prepares eighth graders for the freshman chemistry curriculum? Currently, how well are eighth grade students prepared for this next course, and are the eighth grade science teachers using the "best practices" and assessment strategies?

The eighth grade chemistry unit curriculum and assessments can be evaluated using several tools. For this study, eighth grade chemistry students were given a pre-test and post-test to collect data on what students know and learn through the chemistry unit. Furthermore, the Hudson High School ninth grade pre-chemistry teachers will be surveyed to give input on which chemistry objective eighth grade students need to master prior to the ninth grade pre-chemistry course.

CHAPTER II: LITERATURE REVIEW

Introduction

The Review of Literature will examine the science standards that the state of Wisconsin expects all students to master by the end of their eighth grade year and how those standards are used within the Hudson Middle School's adaptation of the "Understanding by Design" model to develop curriculum and unit design. The Review will also examine the purpose of science curriculum and the learning targets that teachers use to guide their instructional choices, as well as the power of pre-testing and post-testing students. This will also include a look at the use of formative and summative assessments within units. Finally, an investigation of the ways in which curriculum can be improved to benefit all stakeholders.

Wisconsin State Science Standards

The Department of Public Instruction (DPI) for the state of Wisconsin has developed a comprehensive list of standards for students to master at certain grade levels. The DPI considers these to be a model for academic standards and created these standards in four core academic areas (mathematics, social studies, language arts and science) and fourteen other areas, such as health, dance and technology. Within each area, the standards are broken down into fourth, eighth and twelfth grade levels. The science standards are laid out in standards A through H, with sub-standards found under each heading. The DPI introduces these standards by stating:

> "The study of science allows Wisconsin students to experience the richness and excitement of the natural world. As adults they will face complex questions requiring

> scientific thinking, reasoning, and the ability to make informed decisions. Scientific knowledge prepares students for the future and helps them acquire skills needed to hold meaningful and productive jobs. These content and performance standards recognize that science is for all students-the essence of science literacy." (http://dpi.wi.gov/standards/sciintro.html, Introduction, paragraph one)

These standards are guidelines that the Hudson School District refers to when making curricular decisions. The link to these standards can be found on the district website and every unit that is written within the eighth grade earth science curriculum refers to the specific Wisconsin State Standards that apply to that unit of study. These standards are only guidelines and the DPI refers to them as such in their explanation of the standards that states, "The standards set clear and specific goals for teaching and learning, and they are not meant to supplant curriculum. Instead, they should help school districts to develop curriculum units that focus on specific academic results." (http://dpi.wi.gov/standards/sciintro.html, Clarity and Specificity, paragraph one) The Wisconsin State Science Standards can be found in their entirety in appendix A. For this evaluation of the eighth grade chemistry unit curriculum, the following Wisconsin DPI standards are the requirements that were to be considered when developing the earth science curriculum. These are not meant to be the specific goals of the chemistry unit itself, but a more general approach to the entire eighth grade earth science experience.

1. What are the science themes to develop questions about science-related issues and problems? (http://dpi.wi.gov/standards/scia8.html, A. 8.1)

2. What are the limitations of science systems and what are the reasons that specific science themes are included in or excluded from those systems? (http://dpi.wi.gov/standards/scia8.html, A. 8.2)
3. What are the explanations and models that support and critique the organization of the evidence that is in conflict with those models? (http://dpi.wi.gov/standards/scia8.html, A. 8.3)
4. What is the evidence that models the development for events based on the evidence available to scientists? (http://dpi.wi.gov/standards/scia8.html, A. 8.4)
5. What is the new evidence accumulated as the result of how models and explanations change? (http://dpi.wi.gov/standards/scia8.html, A. 8.5)
6. What are the themes of evolution, equilibrium and energy that help predict future events or changes in the natural world? (http://dpi.wi.gov/standards/scia8.html, A. 8.6)
7. What are the major changes that have occurred over time in conceptual models and the explanation in the area of earth and space, life, environmental and physical sciences? What are the identifying factors of the people cultures, and conditions that led to these developments? (http://dpi.wi.gov/standards/scib8.html, B. 8.1 & B. 8.2)
8. What are the types of reasoning and evidence used outside of science to draw conclusions about the natural world? (http://dpi.wi.gov/standards/scib8.html, B. 8.4)
9. What are the ways in which scientific knowledge is useful and also limited when applied to social issues? (http://dpi.wi.gov/standards/scib8.html, B. 8.6)

10. What observations, descriptions and measurements can identify physically and chemically identify the properties of elements? (http://dpi.wi.gov/standards/scid8.html, D. 8.1)

Curriculum Development and Unit Design

Terry J. Foriska's book, Restructuring Around Standards; A practitioner's Guide to Design and Implementation, defines curriculum development as a way for organizations to bring an "understanding of who they are, where they have been, where they are now, and where they want to go" (1998, p.29). In other words, curriculum is the connection between what the students already understand, what they have previously experienced, and what students must understand in the future. Keeping these important factors in mind, curriculum writing must be a clear and descriptive plan that can assist students, teachers, administration and community to achieve the best results for student learning. At Hudson Middle School the curricular units have been developed so that every unit that is taught throughout the year by all teaching staff is written using the Understanding by Design format. This process of writing units and lesson plans is based on the ideas of backward design, which are laid out in Wiggins and McTighe's book, Understanding by Design. The basic scheme centers on this quote they use from Stephen R. Covey's widely read book, The Seven Habits of Highly Effective People,

> "To begin with the end in mind means to start with a clear understanding of your destination. It means to know where you're going so that you better understand where you are now so that the steps you take are always in the right direction" (1998, p. 7).

Therefore, the outcomes of student learning are the beginning points for designing effective curriculum.

The first step in writing a unit using this format is to determine what students should know. The big ideas or the priorities for the learning in a unit are what Wiggin and McTighe refer to as "enduring understanding" (1998, p. 9-10). These are the large, most essential concepts or skills a student needs to understand at the end of the unit. The question we primarily use when writing a new unit at Hudson Middle School is, "In ten years what will this student still need to understand, no matter their career or stage in life?" Then, it is important to determine the concepts and skills that are significant for the students to learn, and, finally, what is worth having students experience. Therefore, the primary goal of writing a unit using this format is to define the curricular priorities.

Curricular priorities are derived from standards, objectives and future instruction. This is a complicated process which involves an in-depth look at the standards set out by the Wisconsin DPI at the grade level, any specific standards set by the school district and any future curriculum objectives that will need background knowledge, concepts or skills. Wiggin and McTighe offer four criteria to assist in the selecting of the concepts and skills to be taught for understanding (1998, p. 10-11):

1. To what extent does the idea, topic or process represent a "big idea" having enduring value beyond the classroom?
2. To what extent does the idea, topic or process reside at the heart of the discipline?
3. To what extent does the idea, topic or process require un-coverage?

4. To what extent does the idea, topic or process offer potential for engaging students?

Once the curricular priorities are set for a unit then the curriculum author needs to determine what will give acceptable evidence that the student understands the concept or skill. Assessment of student learning is critical in determining what the student understands. Therefore, in working our way backwards, by determining how we are going to assess our students learning of the "enduring understanding" and the other curricular priorities, we create the best possible type of assessment tools. The assessment tools themselves must be well designed and a true and accurate measure of understanding. Henning-Stout warns that, "Assessment strategies relying upon curriculum-based tasks can support learning only if there is a link between curricular content and the acquisition of real knowledge" (1994, p. 46). Assessments should not be misconstrued as only meaning end of the unit test. Assessment tools can be used throughout the learning process as a gauge of student understanding so that instruction can be developed, modified or clarified so that the ultimate goals of student learning of concepts and skills can be accomplished. Wiggins and McTighe give these examples of a "continuum of assessment methods including checks of understanding (such as oral questions, observations, and informal dialogs); traditional quizzes, tests, and open-ended prompts; and performance tasks and projects" (1998, p. 13). The selection of assessment tools will provide direct evidence of students understanding of the curricular priorities.

After the development of clearly identified "enduring understandings" or curricular priorities and the appropriate assessment tools to give evidence of student learning it is finally acceptable to plan the learning experiences and instruction. Again

Wiggins and McTighe give some questions that need to be considered as curriculum authors work through this stage of development

1. What enabling knowledge (facts, concepts, and principles) and skills (procedures) will students need to perform effectively and achieve desired results?
2. What activities will equip students with the needed knowledge and skills?
3. What will need to be taught and coached, and how should it best be taught, in light of performance goals?
4. What materials and resources are best suited to accomplish these goals?
5. Is the overall design coherent and effective? (1998, p.13)

At Hudson Middle School the teachers are expected to do a significant amount of curriculum writing. Hudson School District adopted the Understanding by Design format for all of units taught in the secondary schools. A group of teachers and administration attended intense training sessions at the University of Wisconsin – River Falls during the 2002-2003 school year. These staff members were immersed in the details of writing curricular units with the backward design. Then, during the following school year, the trained individuals taught other staff members at both Hudson High School and Hudson Middle School. The training was led by staff who had attended the formal Understanding by Design training the year before. At that time, the Hudson Middle School staff set a building goal that every sixth, seventh and eighth grade unit taught would use the Understanding by Design format by the end of the 2005-2006 school year. During the 2005-2006 school year, a fire in one of the classrooms at the middle school caused classes to be canceled for four days. However, since only a portion of the school was

directly impacted by the fire, the school days were used by teachers to finish their curriculum writing. Now all of the instructional units at Hudson Middle School are completed in the Understanding by Design format. The eighth grade earth science unit for chemistry was written during this time. At the time of its conception the "enduring understandings" and other objectives along with the connections to the specific Wisconsin Science Standards were already in place. The assessment tools were minimal and the instruction plan was not clearly defined. Therefore, as part of the expectations of the HMS administration, this unit was completed by the end of the 2005-2006 school year. This pilot program to evaluate this unit is the first time since its conception that this unit curriculum has been evaluated. A copy of this original chemistry unit can be found as Appendix A.

Quality Assessment

Assessment tools are valuable to students, teachers, administration and parents if they are of sufficient quality. Quality assessment tools can provide evidence of student learning. Stiggins, et. al focus on these "Keys of Quality Classroom Assessment," in *Classroom Assessment for Student Learning:* "Students are involved at all steps. High-quality classroom assessment equal accurate information–clear purposes, clear learning targets, and an appropriate design–used effectively to help students learn" (2006, p.12).

The purpose of assessment needs to be defined to all stakeholders. An assessment tool can be used to find out what students already know, what students have not learned, or, at the end of instruction, what objectives, targets, curricular priorities or standards students have mastered. According to Butler and McMunn,

> "Assessment is the act of collecting information about individuals or groups of individuals in order to better understand them. The twin purposes of assessment are to provide feedback to students and to serve as a diagnostic and monitoring tool for instruction" (2006, p. 2).

There are two main types of assessment that define the assessment tool's purpose. Formative assessments are assessments that are used for learning. Student learning continues through a formative assessment. Examples of formative assessment includes peer reviews, pre-tests, informal discussion, lab activities, any type of assessment where the purpose is to gauge where student learning is and the information is used to promote student learning. Atkin and Coffey define them in this way:

> "The key to formative assessments is the capacity to change what was planned in order to meet the needs exposed by the evidence. The prospects are improved by finding a way to so elicit evidence that key features of the learning are illuminated; this can be called assessment for learning. However, there is little point in doing this if the evidence is not used to fashion what happens next; only when such refashioning occurs does the assessment become formative assessment" (2003, p. 6).

Stiggins, et. al reiterate this point with their definition that formative assessments are assessments for learning that happen while learning is underway. These are the assessments that we conduct throughout teaching and learning to diagnose student needs, plan our next steps in instruction, provide students with feedback they can use to improve the quality of their work, and help students see and feel in control of their journey to success (2004, p.31). The basic principles of formative assessment are not new in the

classroom, however, formative assessment are much more valuable to teachers that are aware of the purpose of such assessments. These assessments become an even greater tool for student learning when students understand the purpose of formative assessments and then they can use the results to control their own learning. Summative assessments are tools that provide evidence of student achievement at the end of the instruction period. In this case, the unit test is the summative assessment. This type of assessment must be designed to demonstrate student learning through the most applicable form. There are four main types of assessment tools: selected response (multiple choice, matching), extended written response (essay), performance (processes like a lab skill) and personal communication. These types apply to both summative and formative; however, the correct type of assessment is extremely important to clearly show students have achieved the learning and understanding for the curricular priorities or learning targets. Butler and McMunn sum up the two purposes of assessment best by stating, "In the classroom, teachers use formative assessment on a daily basis and then use summative assessments as a culminating experience, which give information on students' mastery of content, knowledge, or skill" (2006, p.3).

Similar to the district training that the Hudson School District adopted for the Understanding by Design format for all of units taught in the secondary schools, a group of teachers and administration attended intense training sessions on *Developing Leadership in Classroom Assessment Literacy* during the 2005-2006 school year. The four part seminars were directed by Carol Commodore and focused on the work of Stiggins, Arter, Cappuis, and Chappius. Then, during the following school year, the trained individuals educated other staff members at Hudson Middle School. Since all of

the instructional units at Hudson Middle School are completed in the Understanding by Design format, the focus on quality assessment is the next step in editing and improving the curriculum and instruction for all instructional units. At this point, the eighth grade earth science unit for chemistry has not had such an intense development and editing of the current assessment tools. The expectation of the HMS administration is that all units now be revamped to include the qualities of good assessment tools from the training and that in the near future (no exact date has been set) the assessments of all students in the same class (because there are three sections from the three houses with three different teachers of eighth grade science) have common, summative assessments. This pilot program will also evaluate this unit's assessment tools.

Pre-testing and Post testing

A powerful formative assessment is the pre-test. This type of assessment is used prior to any instruction. The goal of the pre-test is to determine what students might already understand, what concepts or skills students have no experience with and to assist in the instructional choices of the teacher to promote student learning of the "enduring understandings" and the curricular priorities. A post-test or a summative assessment can be compared with pre-test results to measure student learning. These tools are central when evaluating a unit's curriculum. Posavac & Carey (2003) state, "The pre-test and post-test design is used when stakeholders want to know whether participants improved while being served by a program" (p 155). In this case the unit pre-test and post-test were developed with a variety of questions concerning pre-chemistry content by the teacher who not only wrote the unit curriculum in the Understanding by Design format, but also was the students' instructor. In *Fundamentals of Educational Research*, Thomas

Crowl (1993) cites advantages to development of evaluators' own questions on a measurement tool: "One of the most common situations in which a self-made test may be more appropriate than a published test is when a researcher is investigating students' academic achievement as a function of some kind of instructional intervention" (p. 309). Crowl also warns that the results must be interpreted carefully to remain valid (pp. 163-169). The objectives that were used to develop the pre-test and post-test questions were designed around the content that is part of the "enduring understandings" and unit objectives for the eighth grade chemistry unit. This method is useful because "...it is important to judge a program relative to its particular structure and what it is designed to achieve," (Posavac & Carey, 2003, p. 26). As a pilot program evaluation, the use of the pre-test and post-test results will be one strand of the information that will be used to evaluate the eighth grade chemistry unit curriculum and benefits and limitations of these tools will be discussed in the conclusions.

Curriculum Improvement

There is no doubt that curriculum writing is an important process to achieve student learning. It is necessary to have a well developed plan that has a focus on the standards, objectives and curricular priorities, along with assessment tools *for* and *of* learning and, finally, the actual instruction and lesson plans that will provide the experiences that students must have to achieve learning. However, it is just as important that unit curriculum is a document that is constantly revised and improved. This is one of the reasons that teachers in the Hudson School District take on a large part of the curriculum writing. As reflective practitioners, teachers are not only improving their instructional techniques, but they must understand and develop the design of their units to

reflect the goals of all stakeholders; students, administration, community, etc. The National Association for Research in Science Teaching produced a collection of research, stories and resources in *Assessment in Science; Practical Experiences and Education Research.* The book is intended to "link "best practice" ideas to sound science education research" (p. xi, 2006). A particular section focuses on changes in chemistry curriculum.

Approach to Chemistry Teaching and Learning

In the last decade, science educators, including chemistry teachers and curriculum developers, have advocated that science in general, and chemistry in particular, should be taught not only to prepare students for academic careers in chemistry, but also to help them become scientifically literate citizens in a society that is highly affected by and aware of scientific advances and its technological manifestations. Consequently, chemistry should be taught with appropriate emphasis on its relevance to everyday life and its role in industry, technology and society.

Recently, the chemistry curriculum changed dramatically – from focusing on a disciplinary approach to a multidimensional approach. This new approach included six dimensions: (1) the conceptual structure of chemistry, (2) the processes of chemistry, (3) the technological manifestation of chemistry, (4) chemistry as a personally relevant subject, (5) the cultural aspect of chemistry, and (6) the societal implications. This approach was highly aligned with content standards that were already applied in chemistry curricula in the United States, in the UK and in Israel.

> The introduction of these new dimensions into chemistry education was a call for a radical change in the teaching of chemistry, especially the use of different pedagogical standards tailored to the diverse cognitive abilities and aptitudes of students. The overall objective was to create a classroom learning environment that allowed students to interact physically and intellectually with appropriate instructional materials through hands-on, inquiry-oriented activities. Hofstein and Walber (1995) suggested that instructional techniques in science should be matched with the learners' characteristics, learning styles, and interests, in order to maximize the effectiveness of teaching and learning processes as well as to increase student motivation. Clearly, in practice, it is difficult to respond to each student's needs and learning style; however, much can be achieved if teachers employ a wide repertoire of instructional strategies. This enables many students to study chemistry in ways that are more aligned with their own interests and learning styles. (2006, p. 139-140)

National and State standards change over time. School districts change their expectations of what students are learning. Global technology advances have made science curriculum an ever-changing document. The student population's abilities and disabilities have also caused a great amount of change in instructional strategies. Educational research has documented methods of instruction that promote student learning. The definition of best practices is ever-changing. All of these factors justify the need for curriculum improvement on a regular basis.

Hudson School District has a commitment to evaluating curriculum. The district has in place a six-year evaluation and renewal cycle (see appendix B). The four main

steps are evaluation, design, implement and monitor. According to the Hudson Program of Improvement Calendar (see appendix C), science began its evaluation stage last year. Since teachers have curriculum writing duties in the Hudson School District they are an important member of the entire evaluation cycle. This pilot program evaluation of individual units primarily focuses on how the teachers could evaluate their own units so that they have specific data and evidence to support a broader evaluation of the K-12 science curriculum.

CHAPTER III: METHODOLOGY

Introduction

Hudson School District has begun an intense focus on assessment and assigned a team of individuals to "Assessment Literacy" training. It is the hope of the district that this training will provide strategies to promote student learning and to promote teacher effectiveness through assessment. Combining the assessment component with the Unit by Design format should ultimately create strong curricular units that promote a high level of student learning.

Since each unit is formatted in this way, any of the ten eighth grade science units could be used for evaluation. The chemistry unit for eighth grade earth science at Hudson Middle School was chosen as a pilot for the evaluation of the science curriculum, because of the direct connection to the ninth grade pre-chemistry course. Therefore, the chemistry unit that is taught within the eighth grade Earth Science curriculum provides important curriculum and instruction issues that need to be evaluated in regards to student preparation for the required ninth grade, pre-chemistry science course. To effectively evaluate this unit the following questions need to be answered: What specific chemistry content prepares eighth graders for the freshman chemistry curriculum? Currently, how well are eighth grade students prepared for this next course, and are the eighth grade science teachers using quality assessment strategies?

Specific Goals of the Program:

Objective #1: Prepare all eighth grade science students for pre-chemistry in ninth grade

Measurability of Objective: Students who are prepared or not prepared can be identified by the pre-chemistry teachers. Pre-chemistry teachers are able to find areas in

which students are deficient as a whole. By surveying these teachers with open-ended survey questions, the preparedness of eighth grade students can be assessed. This method will be manageable since only five science teachers are teaching the pre-chemistry course at Hudson High School.

Objective #2: Students will be able to determine the Earth's composition and find those elements on the periodic table.

Measurability of Objective: Students are specifically assessed on this objective through a multiple choice assessment test. Sample questions can be found in the methodology section.

Objective #3: Students will be able to calculate how many protons, electrons and neutrons are in each type of element.

Measurability of Objective: Students are specifically assessed on this objective through a multiple choice assessment test. Sample questions can be found in the methodology section.

Objective #4: Chemistry unit assessment tools are appropriate and are used for student learning.

Measurability of Objective: Chemistry unit assessment tools need to be evaluated for appropriateness, effectiveness, student-friendly language, as well as student understanding of his or her own learning, and the learning targets addressed by each assessment tool. This evaluation can be carried out by individuals who have been trained within the Assessment Literacy group. They are experts in evaluating assessment tools for and of learning. An example of such an assessment tool for learning would be a Periodic Table Warm-Up. This is where each student would be given a white board with

a dry erase marker. Then, the teacher asks students to draw an element's atom that shows the number of protons, neutrons and electrons. This would allow the teacher to check student learning when the student is able to correctly draw the number of protons, neutrons and electrons in the correct location and the students' ability to use atomic number, electron configuration and elemental symbols.

Instrumentation:

A pre-test and post-test will be developed with a variety of questions concerning pre-chemistry content. Posavac & Carey (2003) state, "The pre-test and post-test design is used when stakeholders want to know whether participants improved while being served by a program" (p 155). They also warn that the results must be interpreted carefully to remain valid (pp. 163-169). The following expert stakeholders will be the interested parties and will be informed of the results of the student testing:

School administrators (Director of Learning Services, Middle School Principle)

Eighth grade science teachers

Ninth grade science teachers

Eighth grade students will be given a post-test on the information taught during their eighth grade science chemistry unit. The test will focus on the subject of pre-chemistry in order to ensure that the students have enough knowledge to be able to pass to the ninth grade and understand the pre-chemistry curriculum. The questions will be written by the instructor and designed around topics studied and discussed throughout the year. The instructor will ensure that there will be no questions on the pretest unless they are to be addressed in class. The pre-test and post-test will identify the strengths and gaps in the curriculum which will assist in the design of a more valuable eighth grade

science chemistry unit curriculum. The unit will also be evaluated by experts for the incorporation of the use of high quality assessment tools. The Hudson Middle School's concern about the eighth grade science class and the need to prepare students for ninth grade chemistry is the focus of this evaluation and to develop a curriculum that best fits the needs of the students. An explanation of the goals of the chemistry curriculum in eighth and ninth grade will be sent as a letter to the stakeholders. The test results will also be included as well as a clarification of what will be done with the results. A survey of the ninth grade pre-chemistry teachers that addresses student preparedness and specific objectives for the eighth grade chemistry unit curriculum will be given to all ninth grade pre-chemistry teachers.

Data Collection Procedures:

Pre-test and post-test questions will be developed from the eighth grade chemistry unit and will demonstrate content mastery for ninth grade pre-chemistry. In *Fundamentals of Educational Research*, Thomas Crowl (1993) cites advantages to development of evaluator's own questions on a measurement tool: "One of the most common situations in which a self-made test may be more appropriate than a published test is when a researcher is investigating students' academic achievement as a function of some kind of instructional intervention" (p. 309). In this case, the intervention is use of effective assessment and best practices in the science classroom. The investigator will measure the results of the eighth grade earth science pre-test / post-test results. The eighth grade earth science pre-test will be conducted prior to any chemistry material being taught. The pre-test will cover only the material that will be taught during the eighth grade chemistry unit. A post-test will be given as a final unit exam and will cover

material that was taught during the eighth grade chemistry unit. This post-test has been regularly given as the final unit exam. In the future, this post-test may be used by ninth grade pre-chemistry teachers to identify student retention of the basic chemistry curriculum and find out what students understand about chemistry prior to their instruction. The pre-test results will be compared with the post-test results to determine whether students learned the material to a high, medium or low degree. A simple correlation of means will be used to determine if the students have improved, stayed the same or declined in skill. A .05 will be used to determine whether results are significant. The results will be used to develop and adapt the chemistry curriculum. It will also help determine what things may be done in order to produce a smooth transition for the eighth grade earth science class going into the ninth grade pre-chemistry class.

The following are some possible pre-test questions that will be given to students. The questions will be designed by the eighth and ninth grade science and pre-chemistry teachers, based on district and state standards, and are questions that the students will need to eventually understand in order to be prepared for the ninth grade pre-chemistry class. The unit's curricular priorities will be kept in mind in the development of these questions. The questions that follow have been taken from a current eighth grade science chemistry unit test as an example of possible questions.

1) Matter is

a) anything that takes up space and has mass

b) a chemical property

c) a physical property

d) anything that has length and density

2) Atoms are made up of

a) atoms

b) elements

c) subatomic particles

d) electrons

3) Matter is made up of

a) ions

b) elements

c) subatomic particles

d) electrons

4) Electrons are found in _____ around the nucleus of an atom.

a) Energy levels

b) Nucleus

c) Boundary between the nucleus and electron cloud

d) Nothing

5) An electron is a subatomic particle that

a) Has no charge

b) Has a positive charge

c) Has a negative charge

6) Overall, the nucleus of an atom

a) Has no charge

b) Has a positive charge

c) Has a negative charge

7) A system for classifying elements is

a) Atomic structure

b) Chemical properties

c) Physical properties

d) By texture

e) The periodic table

8) Symbols indicating the elements a compound contains and the relative number of each element ("recipe") are known as the

a) Compound elements

b) Diatomic molecule

c) Chemical formula

d) Ionic compound

9) What is the atomic number for Carbon?

a) 6

b) 20

c) 29

d) 48

10) How many electrons are in one atom of Silicon?

a) 5

b) 6

c) 13

d) 14

The following are some possible post-test questions that can be asked of the eighth grade science students who will be passing into the ninth grade pre-chemistry class. These questions will be designed with the ninth grade pre-chemistry curriculum in mind. Therefore, the ninth grade instructors will be able to use this post-test data to accurately design their pre-chemistry course around the misconceptions and content knowledge of their new students.

1) How many neutrons are in one atom of Bromine?

a) 35

b) 45

c) 80

d) 79

2) What is the mass of one neutron?

a) about 1 gram

b) about 1 milligram

c) about 1 nanogram

d) about 1 atomic mass unit

3) What is the mass of one proton?

a) about 1 gram

b) about 1 milligram

c) about 1 nanogram

d) about 1 atomic mass unit

4) What is the mass of one electron?

a) about 1 nanogram

b) about 1/1840 grams

c) about 1/1840 amu

5) What type of bond is formed when electrons are shared between atoms?

a) ionic compound

b) covalent compound

6) What type of bond is formed when electrons are transferred between atoms?

a) ionic compound

b) covalent compound

7) MgS is a compound that is formed by ionic bonding. In the compound, what is the charge on Mg?

a) cousins

b) elements

c) ions

d) covalent

e) none of the above

8) MgS is a compound that is formed by ionic bonding. In the compound, what is the charge on S?

a) positive 1

b) positive 2

c) negative 1

d) negative 2

9) KCI is a compound that is formed by ionic bonding. In the compound, what is the charge on K?

   a) positive 1

   b) positive 2

   c) negative 1

   d) negative 2

10) KCI is a compound that is formed by ionic bonding. In the compound, what is the charge on CI?

   a) positive 1

   b) positive 2

   c) negative 1

   d) negative 2

Data Analysis:

Pre-tests and post-tests will be correlated to determine gaps in content from eighth grade Earth Science to ninth grade pre-chemistry. The data collected from the test scores and feedback from the ninth grade pre-chemistry teachers' surveys will identify the necessary changes to the curriculum in the eighth grade chemistry unit; the evaluation will also suggest ways to improve the assessment strategies that are needed for student learning. At the conclusion of this evaluation, the findings will be used to change the curriculum and update the Unit by Design for the eighth grade chemistry unit. *(Appendix A)* The Wisconsin DPI standards will be used for the baseline objectives in determining the assessment tools and instruction. Throughout this process information will be shared and taken into consideration that will ultimately address any concerns about the transition

of eighth grade earth science students into ninth grade pre-chemistry and create a comprehensive eighth grade chemistry unit.

CHAPTER IV: RESULTS

Introduction

The purpose of this study is to conduct a program evaluation of Hudson Middle School's eighth grade Chemistry curriculum and the eighth grade science teachers' assessment tools used during the 2006-2007 school year to determine ways to improve the unit's curriculum format, assessment, and instruction to promote student learning. This chapter will provide the results of the eighth grade students' pre-test scores compared to post-test scores, evaluation of the assessment tools, and the responses to a survey received from the ninth grade Pre-Chemistry teachers at Hudson High School.

Demographic Information

The city of Hudson had a population in year 2000(census) of 8,775. Hudson is a growing community and had an estimated population in July 2005 of 11,367 (+29.5% change). Therefore, the district enrollment has been increasing sharply. Here is a table of the district enrollment for the last three years.

School District of Hudson

Level	9/17/04	9/16/05	01/13/06
Elementary (K-5)	2,071	2,154	2,183
Middle School	1,106	1,092	1,099
High School	1,519	1,603	1,591
District Total	**4,696**	**4,849**	**4,873**

The median household income is about $51,000. Hudson population at the time of the census had males: 4,240 (48.3%) and females: 4,535 (51.7%) with the ethnic make-up:

- White Non-Hispanic (97.2%)
- Hispanic (1.0%)

- Two or more races (1.0%)
- American Indian (0.6%)

Hudson Middle School (HMS) has the typical middle school set up. The building is divided into the three grades, sixth, seventh and eighth, and then each grade is divided into houses. The house system divides students into approximately equal groups. Students with special needs of the same area are typically found in the same house, but that is not always the case when scheduling conflicts occur. At HMS the eighth grade has three houses; this means that there are three separate eighth grade Earth Science classes. The student population in each house, in theory, is a random sample of the general eighth grade student population at HMS. Since this evaluation is a pilot program, the pre-testing and post testing of students for this chemistry unit occurred in the Norman House. This is a sample of convenience, since the author of the eighth grade chemistry unit and the investigator is the Earth Science teacher in the Norman House. Every Norman House science students received a consent form to participate in this study. Ninety-eight students and guardians signed the consent form. With the consent form signed, students still had the option of participation or not participating in the study. Students that had turned in their consent form still had the ability to not participate by simply not handing their pre-test or post-test into the pile of tests collected for this study.

All students were given a pre-test and a post test. Both the pre-test and the post-test assessed the same objectives of the eighth grade chemistry unit. Each test was given as multiple choice scan-tron test and all students were able to use a Periodic Table of Elements to complete the test. A total of one hundred eighteen students took the Chemistry pre-test. During the pre-test phase, ninety-three (78.8%) students completed

and handed in their test with consent to use for this study. Students that did not consent to their tests being used for this study still took the pre-test for their own information. These students did not hand their test into the pile of tests that were completed by students that gave consent for use.

This test had a total of thirty-eight items that assessed student performance on all the targets for the Understanding by Design chemistry unit curriculum. At the conclusion of the approximately two-week instruction period, students took a final unit test. This test had a total of fifty-five items that assessed student performance on the targets for the Understanding by Design chemistry unit curriculum. The number of items on the post-test is larger because even though the same type of questions were asked on each test, the post-test asked more questions of the same type than were asked on the original pretest. A total of one hundred twenty students took the chemistry post-test. During this phase, ninety-five (79.2%) students completed and handed in their tests with consent to use for this study. One possible reason for the number difference between pre-test student consent and post-test student consent would be absences. The percentage of students consenting to the study and taking both the pre-test and post-test are relatively close. However, for this study two tests were randomly removed from the post-test data pool to give n=93. Since there is no comparison of individual student's pre-test and post-test data, it is assumed that a random selection will still give the same cross-section of students, so that the comparison is on an entire class pre-test to post- test basis. Finally, due to the two tests having a different number of items, the two tests have been compared based upon a total of thirty-eight question, the number of questions from the pre-test.

The pre-test and post- test data should define student improvement from prior to instruction to after student learning. A simple correlation of means is used to determine if the students have improved, stayed the same or declined in skill. And we will use a .05 to determine whether results are significant.

The pre-test and post-test were evaluated as assessment tools. The evaluation examined each individual question on each test and linked them to either the enduring understandings or learning targets from the chemistry unit curriculum.

The pre-chemistry teachers at Hudson High were surveyed to receive direct feedback about their opinions of the curriculum for the eighth grade chemistry unit. The teachers were asked about the present "enduring understandings", the objectives or targets in the current curriculum, the connection to the science standards and the preparation levels of the their current (2006-2007 school year) students. Five surveys were sent to the Pre-chemistry teacher and two (40%) were returned.

Data Collected

Norman House Student Performance on the Chemistry Pre-Test (Appendix D)

Norman House Student Performance on the Chemistry Post-Test (Appendix E)

Results of Pre-test/Post test Questions that Assessed the Curricular Priorities (Appendix F)

Figure 1

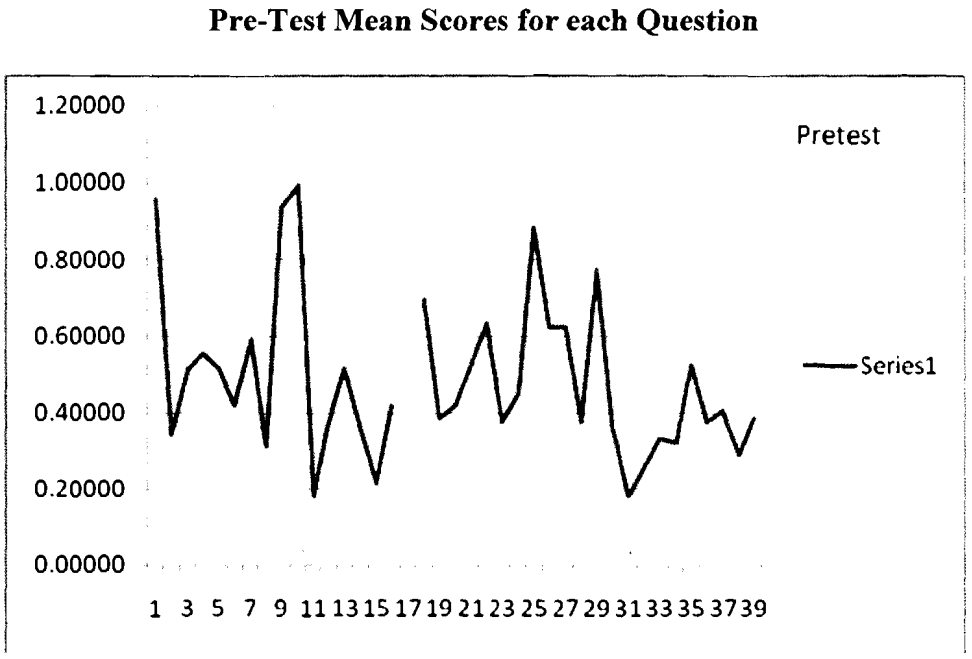
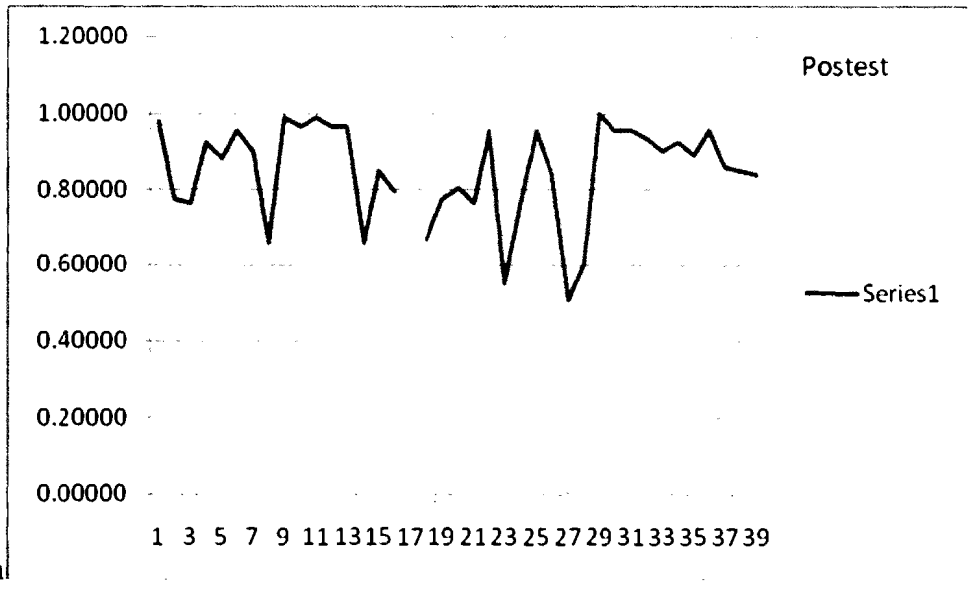


Figure 2



Pre-test and Post test Data Comparisons

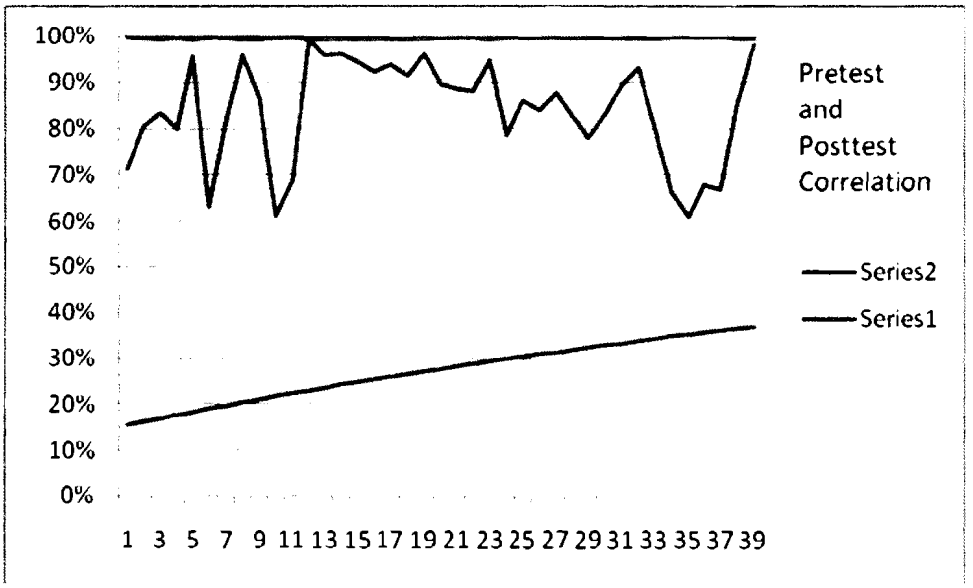
Table 1

Norman House Student Performance on the Chemistry Pre-Test vs. Post-Test

Post-test % of Correct Answers	Pre-test % of Correct Answers	Post-test % - Pre-test % =	Correlation Coefficient
80.88%	48.55%	80.88%-48.55% = 32.33%	0.193353

Figure 3

Pre-test Posttest Correlation & Correlation Coefficient



Results of the Survey of the Ninth Grade Pre-chemistry Teachers

Part I.
The following Enduring Understanding should be included in the eighth grade chemistry unit taught at Hudson Middle School.

Table 2

Everything in the universe (that we know of) is composed up of elements.

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	0	0
Somewhat disagree	0	0
Not sure	0	0
Somewhat agree	0	0
Totally agree	2	100%

Table 3

Elements are atoms that have a certain arrangement based on protons, neutrons and electrons.

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	0	0
Somewhat disagree	0	0
Not sure	0	0
Somewhat agree	0	0
Totally agree	2	100%

Table 4

Elements are easily identifiable in everday life.

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	0	0
Somewhat disagree	0	0
Not sure	0	0
Somewhat agree	0	0
Totally agree	2	100%

Part II.
The following objectives/targets should to be included in the eighth grade chemistry unit taught at Hudson Middle School.

Table 5

Students will be able to find different elements on the periodic table.

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	0	0
Somewhat disagree	0	0
Not sure	0	0
Somewhat agree	0	0
Totally agree	2	100%

Table 6

Students will be able to read and understand all of the parts of the periodic table.

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	0	0
Somewhat disagree	0	0
Not sure	0	0
Somewhat agree	0	0
Totally agree	2	100%

Table 7

Students will be able to calculate how many protons, electrons and neutrons are in each type of element.

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	0	0
Somewhat disagree	0	0
Not sure	0	0
Somewhat agree	0	0
Totally agree	2	100%

Table 8

Students will understand why the elements are arranged as they are in the periodic table.

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	0	0
Somewhat disagree	0	0
Not sure	0	0
Somewhat agree	0	0
Totally agree	2	100%

Part III.
The following Wisconsin State science standards should to be included in the eighth grade chemistry unit taught at Hudson Middle School.

Table 9

A.8.5 Show how models and explanations, based on systems, were changed as new evidence accumulated (the effects of constancy, evolution, change, and measurement should all be part of these explanations)

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	1	50%
Somewhat disagree	0	0
Not sure	0	0
Somewhat agree	1	50%
Totally agree	0	0

Table 10

A.8.6 Use models and explanations to predict actions and events in the natural world

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	0	0
Somewhat disagree	0	0
Not sure	0	0
Somewhat agree	1	50%
Totally agree	1	50%

Table 11

A.8.7 Design real or thought investigations to test the usefulness and limitations of a model

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	0	0
Somewhat disagree	0	0
Not sure	2	100%
Somewhat agree	0	0
Totally agree	0	0

Table 12

B.8.1 Describe how scientific knowledge and concepts have changed over time in the earth and space, life and environmental, and physical sciences

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	0	0
Somewhat disagree	0	0
Not sure	0	0
Somewhat agree	2	100%
Totally agree	0	0

Table 13

B.8.2 Identify and describe major changes that have occurred over in conceptual models and explanations in the earth and space, life and environmental, and physical sciences and identify the people, cultures, and conditions that led to these developments

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	0	0
Somewhat disagree	0	0
Not sure	1	50%
Somewhat agree	1	50%
Totally agree	0	0

Part IV.
The following statements describe how prepared students are for the pre-chemistry course taught at Hudson High School after students have complete the eighth grade chemistry unit taught at Hudson Middle School.

Table 14

Students have the necessary background chemistry knowledge to be successful in pre-chemistry.

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	0	0
Somewhat disagree	1	50%
Not sure	0	0
Somewhat agree	1	50%
Totally agree	0	0

Table 15

Students have the necessary science skills to be successful in pre-chemistry.

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	0	0
Somewhat disagree	1	50%
Not sure	0	0
Somewhat agree	1	50%
Totally agree	0	0

Table 16

Students understand that everything in the universe (that we know of) is composed up of elements.

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	0	0
Somewhat disagree	1	50%
Not sure	0	0
Somewhat agree	1	50%
Totally agree	0	0

Table 17

Sudents understand that elemenst are atoms that have a certain arrangement based on protons, neutrons and electrons.

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	0	0
Somewhat disagree	2	100%
Not sure	0	0
Somewhat agree	0	0
Totally agree	0	0

Table 18

Students understand that elements are easily identifiable in everyday life.

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	0	0
Somewhat disagree	0	0
Not sure	1	50%
Somewhat agree	1	50%
Totally agree	0	0

Table 19

Students are able to find different elements on the periodic table.

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	0	0
Somewhat disagree	1	50%
Not sure	0	0
Somewhat agree	1	50%
Totally agree	0	0

Table 20

Students are able to read and understand all of the parts of the periodic table.

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	1	50%
Somewhat disagree	1	50%
Not sure	0	0
Somewhat agree	0	0
Totally agree	0	0

Table 21

Students are able to calculate how many protons, electrons and neutrons are in each type of element.

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	1	50%
Somewhat disagree	1	50%
Not sure	0	0
Somewhat agree	0	0
Totally agree	0	0

Table 22

Students understand why the elements are arranged as they are in the periodic table.

Response	Frequency (N=2, missing=3)	Percentage
Totally disagree	1	50%
Somewhat disagree	1	50%
Not sure	0	0
Somewhat agree	0	0
Totally agree	0	0

CHAPTER V: DISCUSSION

Introduction

The chemistry unit for eighth grade earth science at Hudson Middle School is being used as a pilot for the evaluation of the science curriculum. The purpose is to gather data that can drive curriculum improvement and help the science instructors determine whether standards are being met and best practices used. The evaluation focused on the unit curriculum written in the format of Understanding by Design, the connection to the Wisconsin State Science Standards, and the quality of assessment tools used to show evidence of student learning. Keeping these factors in mind, surveys were sent to the pre-chemistry teachers at Hudson High School. Students who complete eighth grade science continue their science education as freshmen by taking pre-chemistry and pre-physics. Therefore, the opinions of these teachers are vital to create curriculum that accomplishes the student learning that is necessary for success at the next level. Students were also given a pre-test and a post- test to track the current level of improvement in student understanding of the unit's curricular priorities after instruction using the initial unit curriculum. The purpose of this study is to make conclusions about the unit's current design and to determine if this type of evaluation will produce curriculum improvement that can be applied to other units.

The Literature Review focused on the Wisconsin State Science Standards applied to science curriculum, unit design, instruction, and how those standards are used within the Hudson Middle School's adaptation of the "Understanding by Design" model to develop curriculum and unit design. The literature discussed the terms and views of

experts on quality assessments, both formative and summative. The formative and summative assessments were used in this evaluation through the use of pre-testing and post-testing students. At the end of the literature review, curriculum improvement was examined, including ways in which curriculum can be improved to benefit all stakeholders and the reasons why curricular improvement is necessary.

Limitations of the Study

Again, the limitation to this evaluation is that it is a pilot program of one unit taught by one eighth grade science teacher at Hudson Middle School. In this case, the teacher of this chemistry unit chose the sampling of students and is the author of the chemistry curriculum. Also, this individual is the evaluator of the program. A total of five pre-chemistry teachers were surveyed and only two responses were returned. A number of possible explanations exist for the return of only two responses. A few of the possibilities include: the teacher was unavailable at the time the surveys were given; the teacher was not teaching the pre-chemistry course the semester that the surveys were given out and therefore decided they should not complete it; a teacher may have been concerned that the data will be used against them in some way. However, the department head and the author of the Pre-chemistry unit taught at Hudson High School was one of the two surveys returned. Ninety-three students returned consent forms and participated in the pre-test prior to any eighth grade chemistry instruction and ninety-five students returned consent forms and participated in the post- test after they had received the two-week chemistry unit instruction. Student attendance may have caused the differences between the pre-test numbers and the post-test numbers. Finally, the assessment tools that were used did not assess all of the current curricular priorities and the number of

questions differed between the two tests. This is not optimal, but sufficient for this evaluation.

The Literature Review focused on a broader look at curriculum, unit design and assessment due to the difficulties in finding similar science and chemistry programs and curriculum with similar populations of students. Teacher differences, resources available, student-body composition, and community support often contribute to program effectiveness. These factors influence programs in unpredictable ways, which may not be accounted for in the literature. An absolute comparison is not possible.

Conclusions

An important aspect of the chemistry unit curriculum is choosing the correct and most important curricular priorities for a particular unit. In this case, the curricular priorities are laid out as "enduring understandings", learning targets and a list of the Wisconsin State Science Standards that apply to this eighth grade unit. The Department of Public Instruction (DPI) for the state of Wisconsin has developed a comprehensive list of standards for students to achieve mastery in at certain grade levels. These standards are guidelines that the Hudson School District refers to when making curricular decisions.

Table 23

Current Curricular Priorites for the Eighth Grade Chemistry Unit

Enduring Understandings
1. Everything in the universe (that we know of) is composed up of elements.
2. Elements are atoms that have a certain arrangement based on protons, neutrons and electrons.
3. Elements are easily identifiable in everyday life.

Learning Targets
1. Students will be able to find different elements on the periodic table.
2. Students will be able to read and understand all of the parts of the periodic table.
3. Students will be able to calculate how many protons, electrons and neutrons are in each type of element.
4. Students will understand why the elements are arranged as they are in the periodic table.

WI State Science Standards
1. A.8.5 Show how models and explanations, based on systems, were changed as new evidence accumulated (the effects of constancy, evolution, change, and measurement should all be part of these explanations)
2. A.8.6 Use models and explanations to predict actions and events in the natural world
3. A.8.7 Design real or thought investigations to test the usefulness and limitations of a model
4. B.8.1 Describe how scientific knowledge and concepts have changed over time in the earth and space, life and environmental, and physical sciences
5. B.8.2 Identify and describe major changes that have occurred over in conceptual models and explanations in the earth and space, life and environmental, and physical sciences and identify the people, cultures, and conditions that led to these developments

According to the surveys of the pre-chemistry teachers at the high school, the above enduring understandings are acceptable. These teachers were also given an opportunity to make suggestions for any other curricular priorities; however, in both returned surveys no such suggestions were given. Therefore, as Wiggins and McTighe state, "the important understandings, that we want students to 'get inside of' and retain after they've forgotten many of the details" (p. 10, 1998), the current enduring understanding are acceptable to the survey respondents.

The current learning targets received the same responses as the enduring understandings. The teachers from the high school agreed that the four targets were acceptable. Again, no suggestions were made. These targets are fairly general and it is assumed that each lesson plan must have other more detailed learning targets. However, it can be concluded that these are the main targets that must be reached to provide students the basic understanding of chemistry.

As for the Wisconsin State Science Standards, they had a mixed review from the high school teachers. This may be no surprise because these standards are only guidelines and teacher differences influence personal interpretation of such standards in unpredictable ways. Standard A8.5, for example, received a mixed review. One teacher agreed and one teacher disagreed with it being included in the eighth grade chemistry curriculum. Within the standard it alludes to the historic explanation of how models and systems change overtime. The model of the atom most certainly has changed drastically over time and because of the model we have today, the periodic table has a distinct set up based on the characteristics of protons, neutrons and electrons. These standards can still be applied to this unit. Standards A8.6 and B8.1 were agreed upon by both high school teachers as having a place in this units curriculum. However, A8.7 received a "not sure" response from both respondents. This is most likely due to the nature of these standards based on a teacher's instructional choice. It is a difficult skill for students at this level to design a real or thorough investigation to test the usefulness of a model. This is certainly true in the case of chemistry and even more so for a student who is receiving their first experiences with atoms, elements and compounds. This standard does not relate to the type of instruction that correlates with the other curricular priorities.

The current eighth grade chemistry unit has been used by all eighth grade earth science teachers for the last two consecutive years (2005-2006 & 2006-2007). The survey of pre-chemistry teachers at the high school asked them for their opinions on the preparedness of their students this year for the pre-chemistry course. These results were concerning because of two main themes; first the results for four of the statements were mixed, while the teachers disagreed with the other statements. These statements came directly from the "enduring understandings" and the learning targets. For all of the curricular priorities currently in eighth grade Chemistry unit, the Pre-Chemistry teachers were in agreement that they were correctly applied to this curriculum. However, according to the ninth grade teachers, the ninth grade students were not prepared with that content understanding. Furthermore, this feedback is perplexing when you examine pre-test and post-test data from this year. It is important to remember, however, that the student improvement was based on the 8^{th} grade curriculum and not the 9^{th} grade curriculum. According to the pre-test and post-test data, it was found that a positive correlation existed with the post-test scores significantly higher than the pre-test score. The margin of error is less than 0.05. Therefore, the data accurately reflects student improvement and achievement at a high level. This is reflected by the blue line, which represents the correlation coefficient, in figure 4.3, which increases. So these two pieces of data may seem to conflict. One possibility for the discrepancy is that between the eighth grade chemistry unit and the pre-chemistry course, some of the chemistry understanding is lost, possibly due to the length of time between instruction. The time between the 8^{th} grade chemistry unit and 9^{th} grade pre-chemistry may be as much as 16 months, including a summer vacation.

Another possible problem would be in the pre-test and post-test assessment designs. These two tests did not accurately assess all of the curricular priorities. Some of the questions on both the pre-test and post-test do not align with the curricular priorities as stated in the current curriculum. This is not to say that these items are less important, but rather that they do not align with these specific curricular priorities. The enduring understanding #3 and learning target #4 were not assessed in either the pre-test or post-test. Also, the number of items assessed for learning targets #1 and #3 has a different number of items between the pre-test and post-test. Further, the design of the assessments must be sound. In this case, a selected response type assessment was used. Stiggins, et. al, (2004) state that "selected response assessments are ideal for knowledge-level learning targets and some patterns of reasoning" (2004, p.125). Therefore, the learning targets for this unit are aligned with this type of assessment. However, the "enduring understandings" needed to be assessed in a different form, like an extended written response. This may explain why all three enduring understandings were given a mixed review by the ninth grade teachers. Still, the responses on the specific learning targets were most disturbing because three out of the five responses rated these areas as not preparing students for the pre-chemistry course.

This type of evaluation provided significant information about one eighth grade Earth Science unit. It allowed an opportunity for middle school and high school science teachers to begin the very complex conversation about student preparation from one grade level to another. This is a key perspective that was missing at the time that the current unit curriculum was written. This type of professional conversation has identified a possible disconnect between what eighth grade science teachers observe in student

learning and what the ninth grade teachers expect at the high school level. Due to this evaluation, those expectations of the ninth grade teachers may have an impact on the type of instruction the eighth grade teachers use in the future. The literature review of curriculum development using the "Understanding by Design" format supports the Hudson School District preference of using this format. Since, both the high school and middle school use this same type of format for unit curriculum, the vernacular and process were understood by both parties, which allowed an easy discussion about the aspects of the unit's components. The evaluation was strengthened by the professional development goals of the district. The curriculum format allowed for very specific measureable objectives for this evaluation. In addition, the Quality Assessment training has made the use of assessment tools, especially pre-testing and post testing, a valuable data gathering method that can accurately demonstrate student learning.

Finally, because this evaluation could be conducted by the teacher who wrote the unit curriculum, it was achievable in this case. Certainly, the evaluation would be better with the involvement of more stakeholders, however, time and schedule would make the process long and cumbersome. This type of evaluation can be improved upon and applied to all instructional units at Hudson Middle School.

Some of the drawbacks to applying this evaluation to other units are how involved it is. Surveys, pre-testing and post-testing, and reviewing literature may be too involved for application to all nine remaining earth science units. The pre-test and post-test method of checking for student learning and the professional conversation between grades and teachers will be the most beneficial aspect of such evaluations being applied to entire curriculums. The entire science curriculum for the Hudson School District is

undergoing its evaluation cycle. The schedule allows for one year of evaluation. This type of evaluation could not be applied by all teachers to all instructional units and produce useful information to use for the other steps of the evaluation cycle in this year, but certainly throughout the evaluation cycle the more evaluations of units, like this one, the more enhanced the overall science curriculum evaluation will be.

Recommendations

The current eight grade chemistry unit curriculum can be improved upon. This evaluation demonstrated that the curricular priorities are in line with the expectation of the high school pre-chemistry teachers, but that students do not demonstrate the skills and understanding once they begin the pre-chemistry course. Therefore, the specific instruction of learning targets needs to be improved. The basic curriculum format can be improved upon by focusing on the detail of each learning target. Another recommendation would be to continue this professional conversation between the high school and middle school to compare specific techniques for assessing teaching and student learning. The students at the eighth grade level may be able to demonstrate their understanding of chemistry in a selected response format, but at the ninth grade level the expectation is deeper and students need to be able to complete a performance task with their knowledge. Finally, the pre-test and post-test assessment tools should match in number of questions and curricular priorities assessed so that they can give accurate and useful data to the teachers. These are some possibilities that can be explored through more discussion.

As for the other earth science units, their evaluation can be completed using a similar evaluation, but on a smaller scale. This process provides an individual instructor

with valuable information about student learning and curricular priorities chosen for that unit. It would be an undertaking by the teacher and not at the district level. This type of professional development will improve the teacher's understanding of the curriculum and where it fits in the broader science education of students in the district. Another benefit will be that teachers have a deeper understanding of the standards, learning targets and enduring understandings for each unit. This process should be an on-going cycle of evaluation for teachers. It is similar to the cycle that the Hudson School district has for the total content area evaluation, except that it will need to be flexible and teacher driven. Considering the district's other professional development goals for its staff, requirements and deadlines for such unit evaluation would be detrimental as they would interfere with the other professional development goals. By having more than general expectations for this type of professional development, some teachers may become frustrated and the district's initiatives may be met with resistance. This type of evaluation can be carried out without specific district responsibilities because this is a part of the teacher's professional role. Teachers must evaluate their own curriculum, unit by unit, in ways that work and in a timeline that is manageable with all of the other important tasks that teachers do.

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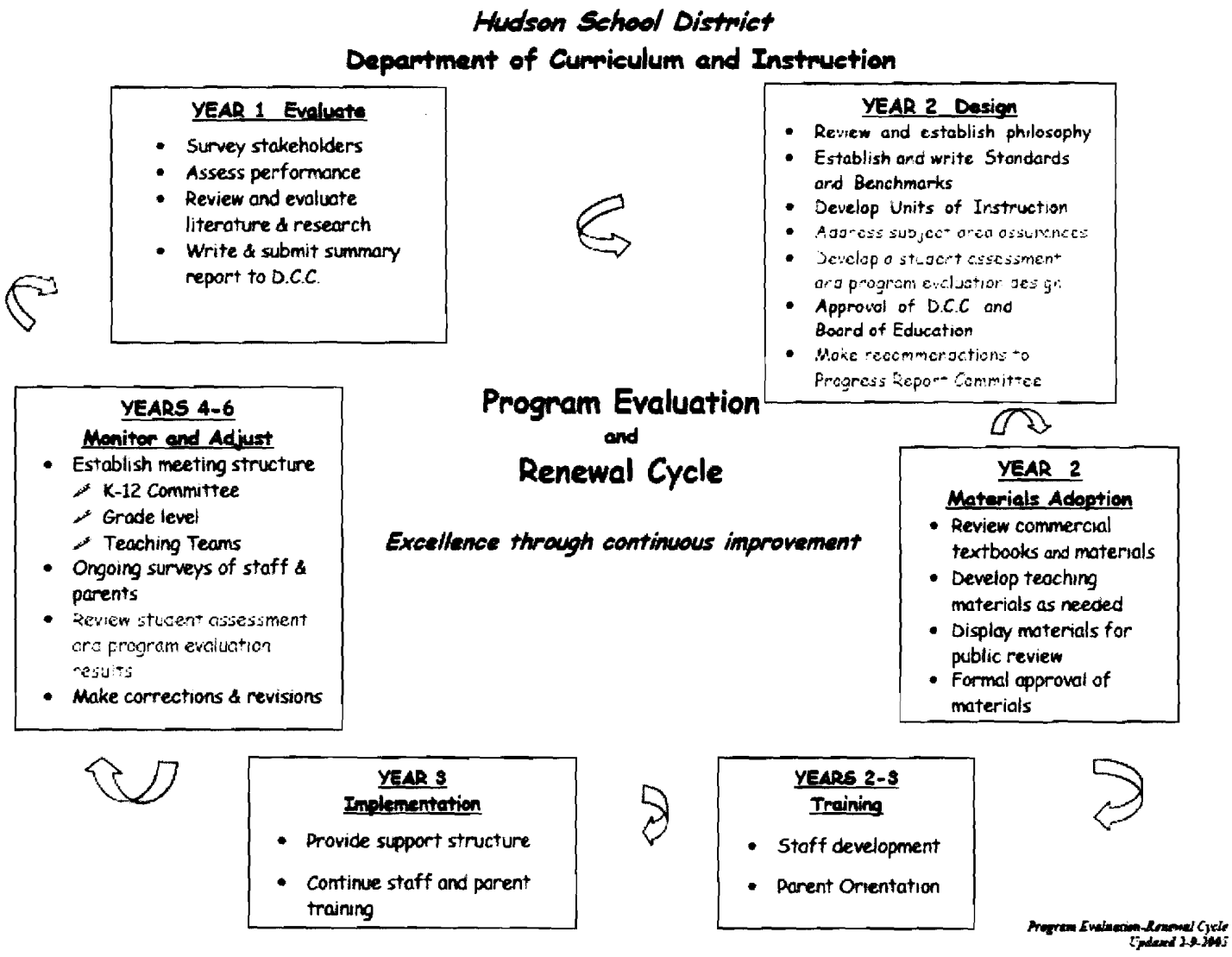
Appendix A: *Current Eighth Grade Chemistry Unit UBD*

The Unit by Design is copyrighted, therefore it cannot be included as part of this Thesis.

Appendix B: *Hudson School District Evaluation Cycle.*



Appendix C: *Hudson School District Program Improvement Calendar.*

Hudson Program Improvement Calendar

Phase	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10
(Year 1) **EVALUATE**	Media & Technology Vocational Ed. Physical Ed.	K-12 Social Studies	K-12 Science* K-12 Health	Art Music World Language	K-12 Mathematics	K-12 Language Arts
(Year 2) **DESIGN**	K-12 Language Arts	Media and Technology Vocational Ed. Physical Ed.	K-12 Social Studies	K-12 Science* K-12 Health	Art Music World Language	K-12 Mathematics
(Year 3) **IMPLEMENT**	K-12 Mathematics	K-12 Language Arts	Media and Technology Vocational Ed. Physical Ed.	K-12 Social Studies	K-12 Science* K-12 Health	Art Music World Language
(Year 4) **MONITOR**	Art Music World Language	K-12 Mathematics	K-12 Language Arts	Media and Technology Vocational Ed. Physical Ed.	K-12 Social Studies	K-12 Science* K-12 Health
(Year 5) **MONITOR**	K-12 Science* K-12 Health	Art Music World Language	K-12 Mathematics	K-12 Language Arts	Media and Technology Vocational Ed. Physical Ed.	K-12 Social Studies
(Year 6) **MONITOR**	K-12 Social Studies	K-12 Science* K-12 Health	Art Music World Language	K-12 Mathematics	K-12 Language Arts	Media and Technology Vocational Ed. Physical Ed.
On-Going	Elem Lang. Arts *Reading / Literature*	Elem Lang. Arts *Spelling*	Elem Lang. Arts *Writing*	Elem Lang. Arts *Vocabulary*	Elem Lang. Arts *Handwriting*	Elem Lang. Arts *Listening / Speaking*

* K-12 Science includes Environmental Education

Hudson Curriculum; Program Improvement Calendar; 9/28/06

Appendix D: Norman House Student Performance on the Chemistry Pre-Test

Question	# correct	# incorrect	mean score (n= 93)
1	89	4	0.95699
2	32	61	0.34409
3	48	45	0.51613
4	52	41	0.55914
5	48	45	0.51613
6	39	54	0.41935
7	55	38	0.59140
8	29	64	0.31183
9	87	6	0.93548
10	92	1	0.98925
11	17	76	0.18280
12	35	58	0.37634
13	48	45	0.51613
14	33	60	0.35484
15	20	73	0.21505
16	39	54	0.41935
17	65	28	0.69892
18	36	57	0.38710
19	39	54	0.41935
20	49	44	0.52688
21	59	34	0.63441
22	35	58	0.37634
23	42	51	0.45161
24	82	11	0.88172
25	58	35	0.62366
26	58	35	0.62366
27	35	58	0.37634
28	72	21	0.77419
29	34	59	0.36559
30	17	76	0.18280
31	24	69	0.25806
32	31	62	0.33333
33	30	63	0.32258
34	49	44	0.52688
35	35	58	0.37634
36	38	55	0.40860
37	27	66	0.29032
38	36	57	0.38710

Appendix E: Norman House Student Performance on the Chemistry Post-Test

Question	# correct	# incorrect	mean score (n= 93)
1	91	2	0.97849
2	72	21	0.77419
3	71	22	0.76344
4	86	7	0.92473
5	82	11	0.88172
6	89	4	0.95699
7	84	9	0.90323
8	61	32	0.65591
9	92	1	0.98925
10	90	3	0.96774
11	92	1	0.98925
12	90	3	0.96774
13	90	3	0.96774
14	61	32	0.65591
15	79	14	0.84946
16	74	19	0.79570
17	62	31	0.66667
18	72	21	0.77419
19	75	18	0.80645
20	71	22	0.76344
21	89	4	0.95699
22	51	42	0.54839
23	72	21	0.77419
24	89	4	0.95699
25	78	15	0.83871
26	47	46	0.50538
27	56	37	0.60215
28	93	0	1.00000
29	89	4	0.95699
30	89	4	0.95699
31	87	6	0.93548
32	84	9	0.90323
33	86	7	0.92473
34	83	10	0.89247
35	89	4	0.95699
36	80	13	0.86022
37	79	14	0.84946
38	78	15	0.83871

Appendix F: Results of Pre-test/Post test Questions that Assessed the Curricular Priorities

Enduring Understandings

1. Everything in the universe (that we know of) is composed up of elements.

Pre-test Questions	Post Test Questions
1	1
3	3

2. Elements are atoms that have a certain arrangement based on protons, neutrons and electrons.

Pre-test Questions	Post Test Questions
2	2
4	4
5	5
6	6
7	7
11	14
12	15
13	16
14	17
30	39

3. Elements are easily identifiable in everyday life.

Pre-test Questions	Post Test Questions
Not Assessed	Not Assessed

Learning Targets

1. Students will be able to find different elements on the periodic table.

Pre-test Questions	Post Test Questions
9	9
10	10
17	11
	12
	11
	20

2. Students will be able to read and understand all of the parts of the periodic table.

Pre-test Questions	Post Test Questions
16	19
24	28
27	33
30	34

32	44
33	45
34	46

3. Students will be able to calculate how many protons, electrons and neutrons are in each type of element.

Pre-test Questions	Post Test Questions
15	18
25	29
26	30
31	31
	32
	39
	40
	41
	42
	43
	44

4. Students will understand why the elements are arranged as they are in the periodic table.

Pre-test Question	Post Test Question
Not Assessed	Not Assessed