This is to certify that the
thesis entitled

EVALUATING THE USE OF LAYERED CURRICULUM AND TECHNOLOGY TO INCREASE COMPREHENSION AND MOTIVATION IN A MIDDLE SCHOOL CLASSROOM

presented by

AMY LYNN MAURER

has been accepted towards fulfillment
of the requirements for the

Master of Science	degree in	Interdepartmental Physical Science

Major Professor's Signature

10 Aug 09

Date

TITLE: EVALUATING THE USE OF LAYERED CURRICULUM AND TECHNOLOGY TO INCREASE COMPREHENSION AND MOTIVATION IN A MIDDLE SCHOOL CLASSROOM

By

Amy Lynn Maurer

A THESIS

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTERS OF SCIENCE

Interdepartmental Physical Sciences

2009

ABSTRACT

EVALUATING THE USE OF LAYERED CURRICULUM AND TECHNOLOGY TO INCREASE COMPREHENSION AND MOTIVATION IN A MIDDLE SCHOOL CLASSROOM

By

Amy Lynn Maurer

This study was designed to use differentiated instruction and technology to increase motivation and comprehension in the middle school classroom. Whereas, engaging students through choice and learning style preference will translate into measurable comprehension and motivation. Layered Curriculum^{tm} is centered on the theory of differentiated instruction and was the foundation for the two units taught in this study. The study was conducted with 115 seventh grade science students in four different sections of seventh grade general science. Of the115 students, 45 agreed to participate in this study. The study was incorporated into two different science units; groundwater and atmosphere. Two different units were assessed to determine the effect of technology, more precisely Moodle, on comprehension and motivation. Data was collected in the form of pre and post unit surveys and assessments. Significant evidence from this study suggests that the implementation of layered curriculum and Moodle was effective in increasing comprehension. However, there was no significant correlation between Layered curriculum and Moodle to motivation.

TABLE OF CONTENTS

LIST OF TABLES v

LIST OF FIGURES vi

INTRODUCTION 1
- Layered Curriculum™ 5
- Blended Instruction 7
- Comprehension 8
- Motivation 12
- Assessment 16
- Demographics 19

IMPLEMENTATION 22
- Groundwater Topics and Activities 23
- Atmosphere Topics and Activities 34

RESULTS AND EVALUATION 45
- Surveys 45
- Assessments 47
  - Groundwater Unit 47
  - Atmosphere Unit 49
- Missing Assignments 50
- Use of Moodle 52

CONCLUSION 54

APPENDICES 59
- Appendix I 59
- Appendix II 64
- Appendix III 70
- Appendix IV 76
- Appendix V 106
- Appendix VI 121

REFERENCES 124

LIST OF TABLES

TABLE 1: Correlation of Groundwater Topics to Michigan Content Expectations.....24

TABLE 2: Outline of Groundwater Unit.....25

TABLE 3: Correlation of Atmosphere Topics to Michigan Content Expectations.....35

TABLE 4: Outline of Atmosphere Unit.....37

TABLE 5: Summary of Missing Assignments.....52

LIST OF FIGURES

FIGURE 1: Model Aquifer Project.....33

FIGURE 2: Water Filter Project.....33

FIGURE 3: Moodle Course Page.....37

FIGURE 4: Summary of Assignment Type Chosen during Groundwater Unit....46

FIGURE 5: Average Pre/Post Assessment Scores.....47

FIGURE 6: Groundwater unit average pre/post assessment scores arranged by topic.....49

FIGURE 7: Atmosphere Unit Average Pre/Post Assessment Arranged by Topic.....50

FIGURE 8: Summary of Moodle Use.....53

Images in this thesis are presented in color

Introduction

The goal of this study is to use differentiated instruction and technology to increase motivation and comprehension in the middle school classroom. The hypothesis is that engaging students through choice and learning style preference will translate into measurable comprehension and motivation. The rationale for this study was influenced by both internal and external factors. Those in the field of education understand it's in constant change. "Adaptive" and "flexible" are two qualities that are essential in effective teaching. Some of those changes are brought about internally, such as an attempt to further reach students because they care about their success; and others are external national and state expectations that drive change in schools and the classroom. Since standardized assessments such as the Michigan Educational Assessment Program (MEAP) are based on these expectations; the curriculum must be aligned with those expectations as well. In doing research, you will find a variety of opinions on the effectiveness of standardized tests (Goodman) (Muijs, 2001) (Stiggins R. J., 2005). However, the purpose of this project is not to contest the validity or reliability of those tests; regardless of the opinion, the fact remains that results of those tests affect adequate yearly progress (AYP), school of choice, funding, among others. Adequate Yearly Progress is part of the federal *No Child Left Behind Act* requiring schools to continually improve each year so that 100% of the students in the state are proficient on state assessments by the 2013-14 school year. In Michigan, AYP is a measure of year-to-year student achievement on the MEAP test. Failure to make AYP for two or more consecutive years can result in loss of funds. Furthermore, science grade level content expectations for

the state of Michigan were adopted in early 2008. To avoid any content gaps, these new expectations would be implemented in our school over a three year period with seventh grade, the grade level of this study, implementing those expectations in the fall of 2009. Currently, the seventh grade is in the process of realigning the curriculum. Content expectations from the groundwater and atmosphere units were the only ones carrying over from the previous expectations making them the logical choice for this study. In addition, integration of technology has been reinforced through national and state standards.

Furthermore, several internal factors influenced the pedagogical approach and direction of this study. In the past, units were taught in a traditional style of teaching where content information was presented with a reading selection from the textbook or through lectures or demonstrations. Basic knowledge was practiced through worksheets and applied with several laboratory investigations. Students were formally assessed with quizzes and an end of the unit test. Even though this style of teaching works very well for some students, the goal of this study was to help all students become successful in the classroom. The idea that most classrooms consist of students with a wide range of abilities became the driving force in developing a curriculum that utilizes the strength of all students. Classrooms, including the ones in this study, contain gifted, learning disabled, Aspergers syndrome, autistic, cognitively and emotionally impaired students. Even if a student doesn't come with a label, they all enter the classroom with unique life experiences that affect the way they learn. However, with external pressure of the *No Child Left Behind Act,* it is no longer acceptable

for most students to comprehend the material because schools are required to make every child successful in the classroom. Teaching lessons with the same approach wouldn't be effective in increasing comprehension within a diverse classroom. In addition, research has shown that teacher-centered classrooms where textbooks, videos, and lectures are the basis of teaching are not conductive to long-term learning. Also, this style of teaching has proved to be ineffective in increasing students' ability to apply the knowledge they've learn to other aspect of life and learning (Nunley, Differentiating the High School Classroom, 2006). Some students learn best by seeing or visualizing; whereas others learn best by hearing having an auditory preference. Still others learn best by doing or taking a physically active approach called a kinesthetic preference. This Visual, Auditory or kinesthetic (VAK) learning preference was developed from Richard Bandler and John Grinder's work on Neuro-linguistic programming (Gilbert, 2002). Since students enter our classrooms as individuals with different learning styles, it is unfair and ineffective to expect all students to learn the same content the same way in the same amount of time. Students can learn using all three learning styles; however, most have a preference. Learning through their preference should help students learn more effectively and increase their time on task. As a result, *differentiated instruction* was incorporated into the development of the groundwater and atmosphere units with the goal of providing an effective approach to increasing motivation and comprehension for all students.

Students enter our classroom with different learning styles but also different ways to communicate. Technology has changed the way we communicate. Cell phones, emails, text messaging, and social networks allow us to communicate with people at any given time and in most cases with an immediate response. What movie grossed the most amount of money in 1978? What team won the Super Bowl in 1991? Easy, "Google it" and within seconds an answer to those questions are given. Our students are coming to us from a society where information and answers can be searched and downloaded in a matter of seconds and they are accustomed to instant feedback. As a result, teachers are challenged with maintaining students' attention, communicating and motivating students in the classroom.

Students in today's secondary classrooms often enter the classroom with technology skills that exceed the ability of most of their teachers. The things students are able to do at home with technology are on a completely different level of what they are able to do at school. Even the technology that is utilized in school, such as PowerPoint ® and Excel ® is often very basic in comparison. Therefore, one goal of this thesis is to utilize the experience and enthusiasm students have for technology to act as a catalyst for formal learning. The idea was that if students are more motivated to learn then they will become more engaged and complete more assignments translating into measurable comprehension. Also, technology in the classroom can provide another avenue for students to acquire information contributing to comprehension. These concepts were tested by incorporating blended instruction into a unit on

atmosphere. Blended instruction uses a combination of direct lessons and concepts taught face to face and online.

The basic goal of this study is to increase student achievement of all students through engagement and motivation. Since all students do not learn the same, it is ineffective to teach them all the same. Differentiated instruction provides multiple options for taking in information, making sense of ideas and expressing what they have learned (Tomlinson, 2001). Layered Curriculum™ is centered on the theory of differentiated instruction and was the foundation for the two units taught in this study. Layered Curriculum™ is a method of instruction developed by Kathie F. Nunley, EdD focused on the three essential components of providing choice, encouraging higher level thinking and increasing accountability (Nunley, Layered Curriculum, 2004). However, it is necessary to understand how Layered Curriculum works before the rationale can be understood.

LAYERED CURRICULUM ™

Layered curriculum consists of three layers: C, B and A. The first layer introduced to students is the C layer and named so because it is the highest grade that the student should receive through the completion of the layer. The C layer is where basic knowledge is constructed and consists mostly of vocabulary and facts. The C layer is broken into four or five big ideas of the unit and each idea or topic begins with a direct lesson given to all students. Independent practice followed the direct lesson. The independent practice is very conducive

to differentiated instruction because it contains three to five choices for students with each choice differentiated by learning style. The choices vary in points earned based on their complexity. Each topic has a set amount of points the student needs to complete. Overall, the unit contains three to four times as many assignment choices as you expect the student to complete. In differentiating the instruction, the activities should accommodate different learning styles. According to the neuro-linguistic programming mentioned previously learners can be classified as Auditory, Visual or Kinesthetic or tactile learners (Nunley, Layered Curriculum, 2004).

The B layer asks students to apply, manipulate, demonstrate or problem solve. In this layer student extend the basic knowledge acquired in the C layer. The goal of this layer is to increase the complexity of the students' thinking with idea of making connections to previous knowledge. In science, this can be done through laboratory investigation. Again, choice can also be incorporated in the B layer, and students can be assessed written or orally depending on preference of the teacher. In addition, with the completion of the C and B layer, students should be able to achieve a B grade.

The A layer is referred to as the top layer because it relies on critical thinking and analysis of real world issues. The A layer requires students to analyze a current issue and give students an opportunity to express their opinion. Brain research has indicated that students learn best when they connect concepts to real-life (Caskey, December 2003). The A layer should involve some formal research to provide background and support of the issue; however, the

issue may not have a definite answer. The goal is to encourage students to think critically about research and current issues through the incorporation of personal beliefs, morals and ethics.

BLENDED INSTRUCTION

In addition to layered curriculum, this study focused the effect of technology as a tool to increase motivation and comprehension in the classroom. As mentioned previously, blended instruction uses a combination of lessons and concepts taught face to face and online. Blended instruction was implemented using the free open source software, Moodle ®. Moodle® is an open source course management system (CMS) or Virtual Learning Environment (VLE), meaning that the user can use, modify and redistribute as long as sources are provided to others and the original copyrights and license are not removed or modified (Rice, 2007). Moodle® is utilized by a small percentage of teachers at Fowlerville Junior High School. Many teachers at the school are unaware of the potential and benefits of the software. In addition, Moodle® does require a significant amount of time initially creating an online course deterring some teachers. Moodle® provides a platform for an online curriculum and offers many activity platforms such as, wikis, databases, and forums allowing the formation of learning communities extending outside the classroom. In addition, Moodle ® can be used to deliver content through lessons, PowerPoint ®, videos and other resources compiled by the course designer. Moodle ® also has the capabilities to assess student as well. Furthermore, "instructional technologies are powerful tools to achieve successful implementation of curriculum-based learning

objectives to foster learning in regards to student engagement, collaboration, and active learning" (Palak, 2006).

COMPREHENSION

Research indicates that classroom instruction that includes a variety of approaches addressing the diverse needs and interest of students directly correlates to the success of those students (Mastropiero, Fall 2006). Howard Gardner research also supports diversifying instruction. Howard Gardner's theory on Multiple Intelligence classified seven types of intelligence (Gardner, 1999):

1. Linguistic – capacity to use language
2. Logical – mathematical – ability to analyze problem logically, mathematical operations and conduct scientific investigations
3. Musical – skilled in the performance, composition and appreciation of music
4. Bodily-kinesthetic- the skilled use of one's body
5. Spatial – ability to recognize and manipulate patterns
6. Interpersonal – ability to understand intentions, motivations and desires of others
7. Intrapersonal- capacity to understand one's self

Even though Gardner expresses the importance of recognizing these types of intelligence, he explains that an intelligence is not the same as a learning style. Learning style is an approach that can be applied to a wide range of content whereas an intelligence is specific in content (Gardner, 1999). In addition, "at the practical level, it [multiple intelligence theory] suggests that any uniform educational approach is likely to serve only a small percentage of children optimally." Incorporating different pedagogical approaches, effectively reaches more students (Gardner, 1999). These ideas correlate with the philosophy of layered curriculum. However, layered curriculum incorporates the intelligences

into three different learning styles: visual, tactile or bodily-kinesthetic and auditory (Nunley, Layered Curriculum, 2004). The different learning styles provide different avenues for students to construct and demonstrate understanding.

In most classrooms, textbooks are the primary resource of information. However, textbooks can be considered inaccessible for many special education students because of the discrepancy of reading levels between the book and the student. Since most textbooks in secondary education are written above grade level, special education students fall behind their peers when they transition from elementary to secondary schools (Mastropiero, Fall 2006). With Moodle, a variety of resources and lessons can be easily adapted to different reading levels. For example, the lessons and resources can be auditory to accommodate students that are deficient in reading. Also, since they are web-based, the activities can be completed anywhere in any amount of time.

Accommodations to the curriculum are important because research from the 2000 National Assessment of Educational Progress Science Assessment determined students with learning disabilities scored nearly one standard deviation lower than general education students on science achievement tests. One reason they are thought to be underachieving in science is the complexity of the textbook (Mastropiero, Fall 2006). Making accommodations is important considering nearly 20% of the student population in this study receive special education services. Furthermore, students often view textbook and teacher as the experts in the classroom. However, Moodle enables the compilation of resources providing a variety of "experts." Since the majority of the students in

this study have internet access at home, Moodle provides a platform to increase accessibility of all assignments, which benefits all students. In addition to home computers, eight computers were available in the classroom and the school contains two computer labs of approximately thirty computers in each lab.

A layered curriculum also accommodates special education students. Layered curriculum is designed around differentiated instruction which provides instruction using a variety of approaches to meet the needs of different learners. Furthermore, using layered curriculum to address different learning styles, such as auditory, tactile and visual capitalizes on the strength of students. This is especially important with special education students because they are more successful when given a choice of how to demonstrate their learning (Tomlinson, 2001). Layered curriculum also provides students an opportunity to work at their own pace. As a result, special education students can utilize extra time without being pressured.

The strategies implemented in this study focus on big ideas of the unit. Big ideas enable students to make connections and generalizations about facts and provide them a framework to incorporate new knowledge (Rice, 2007). According to Conderman and Bresnahan (2008), teaching big ideas is one of the effective methods that produce significant academic gains for all students (2008). Moodle can be used to incorporate big ideas using Wikis and lessons. Wikis are web pages that a group of individuals can edit together from anywhere. In this study, a Wiki was developed by the teacher centered on the big ideas of the lesson. Students collaborate to add information, resources, and examples to the big

ideas. This enables students to connect details and previous knowledge to the big idea. Connecting ideas to prior knowledge is one of the most powerful strategies to build interest and enhance learning (Goodman, 2008). Moodle lessons also focus on the big ideas of the unit. Lessons begin with an outline that enables students to jump to a particular topic. Most lesson pages contain reading information, graphics, and examples focused on a big idea.

Layered curriculum is also designed centered on big ideas. The big ideas of the unit are called topics. Each topic contains differentiated assignments providing practice. The assignments and the assessments are aligned to demonstrate mastery of the big ideas. However, according to the research of Conderman, "only the high performing students or those with considerable subject background knowledge learn, understand, and apply material just from exposure" (2008). As a result, the B and A layer require the application and critical analysis of the big ideas. Deeper understanding requires students to apply basic knowledge otherwise they are more likely to revert back to their preconceptions. In order to apply information, they must first organize the ideas into a conceptual framework (Bransford, 2000). Furthermore, as schools become more accountable, it is important the big ideas align with state content expectation and incorporate classroom instruction that promotes mastery through understanding. Merely covering the topics doesn't promote understanding.

MOTIVATION

Reports from Wiseman and Hunt 2001 indicate that student motivation ranks first among the top ten common problems faced by first year teachers. However, from personal experience, the problems with student motivation extend far beyond the first year. Motivation is a challenge faced by novice and experienced teachers alike. Before analyzing how layered curriculum and Moodle increase motivation, it is necessary to have a deeper understanding of motivation.

Motivation can be classified from three different perspectives: behaviorist, cognitive or humanistic. The behaviorist perspective focuses on providing reinforcement or reinforcers to increase the likelihood of certain behavior (Wiseman, 2001). The cognitive perspective focuses on self efficacy. Self efficacy is the belief that one is capable of performing at a certain level or achieving certain goals. Students have a higher self efficacy when they experience success, and a higher self efficacy increases motivation. The humanistic perspective focuses on Maslow's Hierarchy of Needs developed in the 1970's. Maslow's classified two basic categories of needs: deficiency and growth. Deficiency needs are the basic needs required for survival, such as food, water, shelter, safety and self esteem. However, growth needs are higher level needs that can only be met once the lower level needed are fulfilled. Growth needs are intellectual achievement, aesthetic appreciation and self actualization. Self actualization is considered the highest level of needs and is fulfilled when someone reaches their full potential. However, growth needs are never fully

satisfied (Wiseman, 2001). In the classroom, the survival needs are not in our control, such as food, sleep, shelter. On the other hand, we can provide safe environment to learn and use learning communities to increase the feeling of belonging, acceptance and respect.

Both the layered curriculum and Moodle incorporate learning communities which are environments of diverse curriculum and learners that provide interaction and create a sense of common purpose (Kellogg, 1999). Wiki's enable students to work together to compose or edit a website promoting collaborative learning in and out of the classroom (Brandl, May 2005). When students feel they are contributing to the community, they become motivated to learn (Bransford, 2000). Features of Moodle support the social constructionist ideology that students learn best when they are able to construct knowledge from a social environment (Doolittle, 1999). Moodle extends beyond the classroom the construction of knowledge from a social environment. In addition, Moodle and layered curriculum are centered on diverse curriculum promoting more interaction. Since Moodle is web-based, it provides a platform where students can interact with each other or the teacher at anytime.

Allowing student choice is one strategy that emotionally enhances learning. When students are more emotionally involved in the classroom, they will become more motivated to learn. Choice is one of the three key components of the layered curriculum. Choosing assignments provide students with ownership, in principle increasing motivation and retention (Nunley, Layered Curriculum, 2004). In addition, student-centered instruction where choices are

given are compatible with brain development (Caskey, December 2003). Motivation is important because it affects the amount of time that people are willing to devote to learning (Bransford, 2000). Choices give students control over the strategy in which they want to learn and support a metacognitive approach to learning. Giving students choices engages them in the learning process, making it less likely they will revert back to their preconceptions (Bransford, 2000). In addition, when students are able to choose the style of learning that best suits them, they "will learn more effectively, more quickly and more enjoyably than learning outside of [their] preference" (Gilbert, 2002). Layered curriculum and Moodle also incorporate differentiated instruction supporting the belief that effective teachers use a variety of instructional methods so that all students want to learn most of the time (Goodman, 2008). If students are motivated to learn, they will show enhanced cognitive processing which results in long term retention and critical understanding of the material they will make sense of the material rather than memorize (Goodman, 2008).

Learners are motivated when they see the usefulness or relevance of their learning, especially if it has an impact on others and themselves (Bransford, 2000). The A Layer requires critical analysis of a current issue in the real world. Making the connection between the big ideas in the classroom and the real world creates a sense of usefulness and relevance. All A layer choices consist of issues that have a direct impact on society. Students become engaged in the process because they connect and evaluate the issues with their own personal beliefs, morals and ethics. Not only is motivation enhanced but learning is

enhanced when teachers help students understand the importance or relevance of the material (Goodman, 2008).

Since Moodle is web-based, students can access it from anywhere. This extends the classroom to the home or virtually anywhere making learning no longer confined to a fifty-five minute class period. Research has indicated "information and communication technology was also found to be a good motivator, students working on the computer showing high levels of enthusiasm and on-task behavior, and often wanting to continue school work after the task had finished" (Muijs, 2001). In addition, the efficiency of computers can free up more time for more engaging and enriching activities helping students gain a deeper understanding of the concept or big idea. This efficiency, especially with editing, increases the risks taken by students (Muijs, 2001). Some students are learning motivated and like new challenges; however, others are performance motivated and are more concerned with making mistakes (Bransford, 2000). Technology promotes risk taking which can reduce the anxiety of performance motivated students. In addition, the anxiety of performance motivated student can be reduced with rubrics for self evaluation and frequent opportunity for self reflection (Bransford, 2000). Both the A and B layer are based on rubrics given to students in advance. Also, the C layer contains a student guide given to students at the start of the unit providing the expectations for each topic.

ASSESSMENT

Layered curriculum and Moodle lend quite nicely to assessment for learning, otherwise referred to as formative assessment. In research performed in over forty studies, Black concluded that teachers using formative assessment techniques "produced significant, and often substantial, learning gain" (Black, 2003). Formative assessment techniques include aligning and informing students of important goals and standards, providing multiple and varied ways students can demonstrate their knowledge, understanding students preconceptions and misconceptions, adjusting instructions based on assessments, and providing an opportunity for students to self assess and reflect and provide immediate feedback (Hammerman, 2009).

Layered curriculum is based on more frequent smaller assessments given in the form of topic quizzes. Topic quizzes are short quizzes given after the completion of a topic within the C layer. In addition, prior to topic quizzes students are informally assessed before acquiring a signature for completion of an assignment within the C layer. These informal assessments are centered around the big ideas of the unit and are consistent with the information being assessed on the quizzes. Informal assessments enable the students to discuss what they have learned, giving the teacher the opportunity to provide feedback. This aligns with the goal of increasing student achievement and success occurring when teachers aren't just checking for learning but increasing learning (Stiggins R. J., 2005).

Layered curriculum also includes the expectations of the unit on the guide given to the students. These expectations are discussed prior to the unit. In addition the pre-assessment gives students an indication of what they are expected to learn. Also, both the A and B layer provided the students with analytic rubrics. Analytic rubrics focus on specific learning goals and provide ongoing assessment integrated with instruction (Hammerman, 2009). Rubrics clarify the expectations of the student and provide feedback to the student relating to their progress. In addition, rubrics enable students to self assess their work. All of these are essential in formative assessment. In addition, if students understand the expectations of the unit in advance of the teaching, students will be more successful (Stiggins R. J., June 2002). Success also is a motivator. Furthermore, if students know what is expected of them, they feel more in control of their chances for success increasing their motivation to learn and perform at their best (Stiggins R. J., 2005). As mentioned before, success increases self efficacy and the student will be more apt to sustain progress towards a goal (Wiseman, 2001). With many of the informal assessments being oral, immediate feedback is given and misconceptions can be discussed and clarified between the student and teacher. This enables the student to be involved in the assessment and students that participate in the assessment process and analyze their thoughts and work become better performers (Stiggins R. J., 2005).

Moodle lessons are designed to combine information and assessments. The lesson begins with an outline that enables students to move to a particular topic. Most lesson pages contain reading information, graphics, and examples

focused on a big idea and end with an assessment question. Students must answer the question correctly to move to the next page; otherwise, they are sent to a remedial page to review the information. Combining the information with the assessments also enables the assessments to align with the big ideas. As a result, when a student completes a lesson, they have demonstrated a mastery of the big idea. Allowing the student to go back through the lesson places the goal on learning and not on performance.

Moodle incorporated quizzes within lessons and at the end of a topic. The quizzes enable the student and the teacher to monitor progress and assess information learned. This simply holds the student accountable for the information. Online quizzes provide the student with immediate feedback. Research has indicated interactivity and immediate feedback provided through the use of computers has been found to motivate and stimulate learning, even if the student's response is incorrect (Muijs, 2001). In addition, end of the topic quizzes could be taken twice with the official score given to highest grade. This again shifts the goals to be focused on learning and not performance. "Because learning goals focus on mastery of information without great concern for or overemphasis on mistakes, they contribute to increased levels of student motivation" (Wiseman, 2001).

Formative assessment where students are aware of their learning and teaching techniques, focus on self assessment, make connections to previous knowledge and have an understanding of personal growth supports metacognitive approach. This increases students' ability to apply knowledge to

different settings (Bransford, 2000). Use of Moodle supports the idea that students need to be formally assessed on a regular basis so they be accountable for their learning and educators can adjust lessons to accommodate the results of the assessment (Doolittle, 1999).

DEMOGRAPHICS

Fowlerville Community Schools is a rural school district located about thirty miles east of Lansing, Michigan in Livingston County. Livingston County is the fastest growing county in Michigan and one of the fastest in the United States. However, the residential growth in Fowlerville has slowed significantly over the past three years. Fowlerville School District covers 116 square miles with a population of 15,000. Fowlerville Schools consists of 3088 students and 60% of those students rely on bussing for transportation. The district employs 185 teachers with an average of 10.5 years of experience and 70% have an education at or above a Masters Degree. In addition, the district has a 96.04% graduation rate (09Ju)http://fowlerville.mi.schoolwebpages.com

Fowlerville Junior High School, the location of the study, consists of 698 sixth through eighth grade students. Fowlerville Junior High School received a "B" letter grade as measured by the Michigan Department of Education Report Card System. Of the eighth grade students taking the science MEAP test, 75% met or exceeded Michigan Standards which was slightly below the state average of 77% and the previous year of 86%. The student population is 96.5% white, about 1.3% American Indian, about 1% Asian, 1% Hispanic and about 0.5%

Black/African American. Of the 698 students, 18% receive special education services and 31% receive free and reduced lunch. This study was conducted with 115 seventh grade science students in four different sections. The average number of students in each section was about 29. Twenty-one of the 115 (18%) students receive special education services and two sections had a paraprofessional to assist with emotionally and cognitively impaired students. Of the115 students, 45 agreed to participate in this study. Participation required a completion of a parent and student consent form.

The seventh grade curriculum includes a year long general science course broken into two semesters: physical and earth science. Seventh grade science consists of 8 sections split between two teachers. The books are shared so the teachers are teaching opposite semesters. The four sections included in this study completed physical science first semester and earth science second semester. The Earth science unit began with topographic maps which led into earth materials such as minerals, rock types and formation, rock cycle and fossils. The groundwater unit followed the unit on earth materials. The year concluded with atmosphere and weather. The units used in this study were implemented during the fourth marking period. The unit on groundwater began April 13, 2009 and concluded on May 8, 2009. The Atmosphere unit started on May 11, 2009 and concluded June 5, 2009.

The study was incorporated into two different science units; groundwater and atmosphere. The goal of the groundwater unit was to analyze the flow of water between watershed, surface waters and groundwater. Also, students

analyzed how water from the Red Cedar River can get to the Atlantic Ocean. In addition, students analyzed how human interactions and pollution affects species, habitats and changes in the environment. The unit on weather focused on methods of heat transfer in the atmosphere, such as conduction, convection and radiation. The unit also analyzed the effects of ocean currents on climate, composition of the atmosphere and weather associated with air masses and fronts. Two different units were assessed to determine the effect of technology, more precisely Moodle, on comprehension and motivation.

Implementation:

Before the implementation of the unit, student and parent consent (Appendix I-a and I-b) forms were handed out to the students by Bobbiesue Adams, an eighth grade science and algebra teacher, on March 29th. The research was explained to the students and they completed and return the student consent forms in the same class period. The parent consent forms were taken home and returned on a later date. As an incentive, extra credit was rewarded to those that returned the consent form regardless of their willingness to participate. The consent forms were kept in a sealed envelope concealing involvement until after the units were completed and grades issued for these units. Of the 115 students, 45 and their parents agreed to be included in the study. Of the 45 students, three received special education services.

Prior to the unit, students also completed a pre-unit survey (Appendix II-a) administered by the classroom teacher. The survey asked students a variety of questions about how they learn best, the type of assignments they prefer, technology, and prior knowledge about the big ideas of the two units. In terms of the big ideas of the unit, they were given five different options to choose from ranging from *I could explain the topic in detail* to *I've never heard of this topic before*. From the survey, 81% of the participants in this study were A/B students that overwhelmingly preferred doing labs or projects and felt those assignments helped them learn best. Participants felt that quizzes and test were least helpful to them. In addition, they preferred to work with partners or in groups of threes because they enjoy working with friends. However, most of them felt they

learned best when taught directly by a teacher or other adult. Nearly all students felt they should choose how they learn because it is easier to learn when given choices. In addition, most (92%) of the respondents felt that assignments using technology should be included in to the classroom. When asked if they were good at setting goals and completing them on time, 74% agreed and 89% felt they can do well in science. Prior to the unit, these students were most comfortable with origins and human causes of air and water pollution. The results of the survey are shown in Appendix VI.

In addition to the survey, students completed a pre-unit assessment prior to each unit. The pre-unit assessments (Appendix II) assessed students' prior knowledge of the big ideas of the unit. The pre-unit assessment resembled a summative assessment answering direct questions relating to the big ideas. This assessment was necessary to accurately determine the effectiveness of the units on students' comprehension.

GROUNDWATER TOPICS AND ACTIVITIES

This study was broken into two different units. The first unit, groundwater, focused entirely on basic vocabulary and using the technique of layered curriculum, and was based on grade level content expectations. Since the seventh grade will be incorporating the new standards in the fall of 2009, the unit consisted of a combination of the previous and new content expectations. From those expectations the unit was broken down into five big ideas or topic, as they

are referred to in the unit plan. The topics and Michigan content expectations are correlated in table 1.

Table 1: Correlation of Groundwater Topic to Michigan Content Expectations (2008)

Topic	MI Content Expectation
Water Cycle	**E.ES.07.82** Analyze the flow of water between the components of a watershed, including surface features (lakes, streams, rivers, wetlands) and groundwater.
Watersheds	**E.ES.07.82** Analyze the flow of water between the components of a watershed, including surface features (lakes, streams, rivers, wetlands) and groundwater.
Surface Waters	**EH.V.2.ms.2** Describe how surface water in Michigan reaches the ocean and returns.
Groundwater	**EH.V.2.ms.3** Explain how water exists below the earth's surface and how it is replenished.
Human Influence on Pollution	**E.ES.07.41** Explain how human activities (surface mining, deforestation, overpopulation, construction and urban development, farming, dams, landfills, and restoring natural areas) change the surface of the Earth and affect the survival of organisms. **E.ES.07.42** Describe the origins of pollution in the atmosphere, geosphere, and hydrosphere, (car exhaust, industrial emissions, acid rain, and natural sources), and how pollution impacts habitats, climatic change, threatens or endangers species.

Each topic included a direct lesson that was required of all students and independent practice choices. The choices accommodated different types of learners, such as auditory, visual, and kinesthetic or tactile. Table 2 provides the direct and independent assignments for each topic, correlates them to the three different learning styles and includes point value. These collectively were known

as the C layer. Students were given a guide that contained all of the information in Table 1 and 2 (Appendix IV-a) at the beginning of the unit. The student guide provides an outline of the entire unit and explains point distribution (100) for the C layer. As students completed the independent choices, they obtain teacher signatures on the student guide. The guide keeps track of their assignments and points for the unit. As a result, students monitored their own performance on assignments. To obtain signatures, the students answered basic questions based on the assignment. This kept the students accountable and informally assessed the students' knowledge of that topic. In completion of the C layer, students demonstrated a basic understanding of the material. When students completed the C layer, they handed in the guide with signatures. There were several students that did lose their sheets throughout the unit. Those students were given new guides but were required to prove the completion of the assignments to regain signatures.

Table 2: Outline of Groundwater Unit [ ] = appendix number/designation

Topic 1: Water Cycle	**Learning Style**	**Point value**
Direct Lesson: Vocabulary terms [IV-b]	Visual	
Independent Choices:		
1. 1.1 Review and Reinforce/ Enrich Worksheet	Visual	10
2. Water Poster	Tactile	10
3. Water Cycle in a Bag [IV-c]	Tactile	10
4. Water Cycle Children's Book	Tactile	10
Points needed to complete topic		**20**
Topic 2: Watersheds	**Learning Style**	**Point value**
Direct Lesson: Read pg 368-371, Vocabulary	Visual	
Independent Choices:		
1. Guided Reading [IV -d]	Auditory	10

2. Red Cedar River Activity	Visual	10
3. Watershed Brochure	Tactile	10
4. Concept Map	Tactile	10
Points needed to complete topic		**20**
Topic 3: Surface Waters	**Learning Style**	**Point value**
Direct Lesson: Vocabulary terms	Visual	
Independent Choices:		
1. RAFT Story [IV-e]	Tactile	20
2. Draw a map of the Great Lakes to Atlantic Ocean and trace a path the water would flow	Tactile	10
3. 11.2 Review & Reinforce	Visual	10
4. Song about journey from Red Cedar River to Ocean	Auditory	10
5. PowerPoint of different surface waters	Tactile	10
Points needed to complete topic		**20**
Topic 4: Groundwater	**Learning Style**	**Point value**
Direct Lesson: Groundwater Demonstration, Vocabulary	Auditory/Tactile	
Independent Choices:		
1. Groundwater Demonstrations Notes and questions [IV-f]	Auditory	10
2. 11.3 Review & Reinforce/ Enrich Worksheet	Visual	10
3. Porosity and permeability Activity [IV-g]	Tactile	10
4. Michigan Aquifer Guide	Visual	10
5. Build a working well	Tactile	10
Points needed to complete topic		**20**
Topic 5: Human Influence and Pollution	**Learning Style**	**Point value**
Direct Lesson: Guided Reading, Vocabulary	Visual/Auditory	
Independent Choices:		
1. Case Study Analysis [IV-h]	Visual	10/ ea
2. Water pollution article summary	Visual	10/ ea
3. Fowlerville's Environmental Concerns [IV-i]	Visual	10
4. Non Native Species Activity [IV-j]	Tactile	20
5. 12.3 Review & Reinforcement/ Enrich	Visual	10
Points needed to complete topic		**20**

Table 2 Continued

An emphasis was placed on tactile learners because they make up the majority of the students in a typical classroom including the classroom in this study (Nunley, Layered Curriculum, 2004). After the completion of each topic students were required to take an exit quiz (Appendix IV-k and l) to assess their mastery of the big ideas of each topic. Topics 1, 3, 4, and 5 were written quizzes whereas topic 2 was assessed orally. Ideally, all topic quizzes would be oral; however, written quizzes were necessary because they were used as the post assessment for the unit.

The unit was broken up in terms of grading. Our school uses Zangle ®, a web-based grading program and grades were entered after the completion of topic 3. This was to break up the points so they were not all accumulated at the end of the unit. This helped keep the students on pace and kept the parents informed of their child's progress. However, the official due date for all assignments was not until the end of the unit. Since all assignments were due at the end of unit, it enabled students to work at their own pace.

All of the direct lessons for the groundwater unit contained basic vocabulary words. These were given to students at the start of topic 1. Prior to teaching this unit, students wrote the definition of important terms in the completion of their study guide prior to taking the test. However, after research, the importance of vocabulary became apparent. Mastropiero and Scruggs, reported that "more new vocabulary and terminology were introduced in a science unit than were introduced in a comparable unit in a foreign language course" (2006). Their reports suggest that strategies that enhance vocabulary

increase learning, particularly for special education students (Mastropiero, Fall 2006). It is reasonable to expect students will not understand the content if they are struggling with the vocabulary and completing vocabulary at the end of the unit seemed ineffective. As a result, new vocabulary terms for each topic were introduced first using a strategy called LINCing vocabulary. The goal of LINCing vocabulary was to help students make connections between the meaning of new terms and previous knowledge using both auditory and visual links to help make connections. Next, the student created a linking story, a mnemonic device making connections between the new term and background knowledge. Last, a visual link was made when students drew a picture or cartoon based on the term's definition. We often spent time sharing stories and pictures of the vocabulary terms. Next, the unit will be broken down and explained in terms of topics. However, all of the review & reinforcement activities were worksheets from the text not requiring an explanation.

C-Layer Groundwater Topics and Activities

Topic 1: Water Cycle

Students needed to complete two of the four assignments for C layer. Most students chose to make a water cycle poster or complete the "Water Cycle in a Bag" mini-lab. For the water cycle poster, students were required to draw and color a diagram of the water cycle. Their poster needed to include: title, energy source (sun), and all eight terms from the pre-unit assessment. After they were completed they were displayed around the classroom. The mini lab had students fill a Dixie cup with water and a drop of food coloring. The cup was

taped inside a Ziploc bag and taped to the window. The students made observations for four days and wrote a paragraph conclusion. I discussed their conclusions with each student that performed the lab. Several students wrote a children's book on the water cycle which included eight terms and illustration. The stories that were completed were very well done. However, completing the story was more time consuming than the other activities and most of those students fell behind the class. Falling behind the class caused some of those students to feel overwhelmed. In the future, I would adjust the points of the story to 20 making it the only assignment they needed to complete for topic 1.

Topic 2: Watersheds

Most students chose to complete the guided reading as one of their choices. The guided reading was basic note taking from the book. Once they completed the notes, I asked them several questions before they could obtain a signature on their student guide. Students could answer all questions fairly easily. The few that couldn't were sent back to review the section until they could answer the questions. In addition, the Red Cedar River activity had students identify characteristics of the Red Cedar River watershed. They successfully traced the river and its tributaries on a topographic map and determined the boundaries of the watershed, flow direction and stream order. Other students produced brochures and concept map based on watersheds. Most brochures were produced using Microsoft publisher and students used the software Inspiration ® to complete the concept map.

Topic 3 Surface Waters

The first three choices were the most common assignments completed. RAFT is a creative writing assignment which stands for role, audience, format and topic. Students needed to describe their journey from the Red Cedar River to the Ocean. They chose their role which was the perspective, audience and format. For example, students could write a letter from a ship captain to their family back home or write a diary from the perspective of a trout. I was impressed with the number of students that chose to complete the story. Providing an option for students to write creatively and the number of points were determining factors for choosing that assignment.

Topic 4: Groundwater

The direct lesson for this topic was a demonstration using a groundwater simulator. Students could complete the notes and questions as we went through the demonstration as one of their assignments for the topic, and most chose this option. Students were required to draw and label the different components, such as the confining and unconfining layers, saturation zone, wells, aquifers, lake, stream, and recharge zone. These concepts are relevant to the students because the majority of them rely on water from aquifers. We analyze the flow of water through the aquifer with and without contaminants. Furthermore, many other students designed a working well in beakers or cups. From this activity, most students understood the importance of having a filter on the well and also the effect the permeability of material has on water flow. Many of them had to

adjust their materials or thickness of their model aquifer. This assignment was designed as a precursor to the B layer project. Several students also chose to complete the porosity/permeability mini-lab in which they determined the volume and percent of water each material could hold. The lab worked well but did take longer than expected to complete. Overall, students really enjoyed the hand-on activities; however, things did get a little messy. A few clogged sinks later, we were ready for topic five.

Topic 5: Human Influence and Pollution

Students began the unit with guided reading and vocabulary as the direct lesson. Most students chose to write an article summary on the restoration efforts at Lake Apopka in Florida and Saginaw River in Michigan. The students were given guideline questions to help focus their summary. In the past, I have found seventh grade students have difficulties identifying the main idea of articles. As a result, I provided the guidelines to help students be successful in their first writing attempt. However, many students did have to revise their summary. Based on observation, many others completed the Non-native species activity. In this activity, students made flashcards of eight different invasive species in the Great Lakes and then designed a wanted poster for one of the species. This activity also provided some background knowledge for one of the A layer choices. Furthermore, Fowlerville's Environmental Concern activity looked at sites of environmental contamination in the Village of Fowlerville. Students determined the types and researched the health effects of the

contaminants. As students completed topic five, they handed in their student guide with the signatures.

B Layer

The B layer requires students to apply the basic knowledge they learned in the C layer. Students could design and build a model aquifer, design filtering device used to treat polluted water, design a lab determining the best method to clean an oil spill or build a watershed. Initially the students were supposed to design and write a formal lab report for the B layer. However, due to time restraints, students designed, built and presented their projects. Students were assessed based on the presentation of their project. For example, students that built aquifers had to demonstrate their working well and identify the different parts of the aquifer. Furthermore, many students designed a filtration device for treating polluted water. They were shown a two liter bottle containing various thing such as grape Kool-Aid, coffee grounds, soil, grass, etc. and needed to design a device that would filter and purify the water using at least three materials and two of them being natural. Most students were amazed how much filtering fine grained sand can provide. Students experimented with the thickness and arrangements of certain layers and utilized trial and error to adjust their design. They explained their rationale for the design and tested it using the sample of polluted water. The B layer utilized formative assessment to increase student knowledge. With the water treatment choice, most students did not accomplish their goal on their first try. However, they were able test their device and communicate issues and concerns without their grade being compromised.

This allowed them to reevaluate their thinking and gain a deeper understanding of the objective. Another goal of the B layer was to enable the students to incorporate the learning objectives into everyday life. Figure 1-2 shows examples of different B layer choices. The rubric for this activity is included in Appendix IV-m.

Figure 1: Model Aquifer Project

Figure 2: Water Filter Project

A Layer

The A layer was a research based project that focused on current water issues. The students discussed the issue or problem, problem solved and gave their opinion of they would do to alleviate the problem. Following the theme of the other layers, students were given a choice of four different water issues to choose from: damming the Columbia River, restoring the Everglades, selling water from the Great Lakes, and preventing the spread of non-native species. The non-native species issue was part of a C-layer assignment and the other issues were part of *The Power of Water* video. As a result, students had some

basic knowledge on the issues. They were given two days of research time in the computer lab and three additional days to finish the project. The projects were presented in the form of a research poster or paper. The A layer took several days longer than expected. During the A layer, our high school was closed for two days due to a probable case of the swine flu. Even though our school remained opened, the attendance fell to around 50%. As a result, the deadline of the project was extended. Furthermore, the A layer was also used as an end of the unit formal assessment. The rubric is included in Appendix IV-n. Next, students began the atmosphere unit.

ATMOSPHERE TOPICS AND ACTIVITIES

The atmosphere unit was originally intended to be a two week unit on just heating of the atmosphere. However, with just over three weeks of school left, it was necessary to adjust the last unit to include all of the weather objectives. Table 3 correlates the topics of the weather unit with the Michigan content expectations. It has more objectives than ideal leaving the question of covering some in depth or covering all. The choice was made to cover all objectives addressing some more extensively than others using layered curriculum. Moodle was incorporated into this unit to assess the effects of technology on motivation and comprehension.

Table 3: Correlation of Atmosphere Topics to Michigan Content Expectations

Topic	MI Content Expectation
Composition of the Atmosphere	**E.FE.07.11** Describe the atmosphere as a mixture of gases. **E.FE.07.12** Compare and contrast the atmosphere at different elevations.
Heating of the Atmosphere	**E.ST.07.72** Describe how different weather occurs due to the constant motion of the atmosphere from the energy of the sun reaching the surface of the Earth. **E.ES.07.73** Explain how the temperature of the oceans affects the different climates on Earth because water in the oceans holds a large amount of heat.
Wind and Ocean currents	**E.ES.07.12** Describe the relationship between the warming of the atmosphere of the Earth by the sun and convection within the atmosphere and oceans. **E.ES.07.13** Describe how the warming of the Earth by the sun produces winds and ocean currents. **E.ES.07.73** Explain how the temperature of the oceans affects the different climates on Earth because water in the oceans holds a large amount of heat.
Water in the Atmosphere	**E.ES.07.73** Explain how the temperature of the oceans affects the different climates on Earth because water in the oceans holds a large amount of heat.
Air Masses and Fronts	**E.ES.07.74** Describe weather conditions associated with frontal boundaries (cold, warm, stationary, and occluded) and the movement of major air masses and the jet stream across North America using a weather map.

Prior to the unit, students completed a pre-unit assessment on atmosphere (Appendix III-b). Almost all students had the preconception that oxygen is the most abundant gas in the atmosphere. However, students could describe the human causes and health effects of air pollution. This correlates with students positive comfort level on the pre-unit survey.

As for the Atmosphere unit, each topic contained a direct lesson that was required for all students and independent practice choices. This unit worked much like the previous unit with the exception that some of the instruction, assignment choices and quizzes required the use of Moodle. After students made their Moodle account, they could edit their profile by adding a picture, interests, email, etc. Most students were very excited about having a profile helping to create a sense of online community. The expectation was this excitement would translate into completing assignments on Moodle. Moodle provided the students with an outline of the unit, deadlines, resources, lessons and assignments that could be completed and/or submitted online. An example of what a student would see when they log into Moodle is shown in Figure 3. Students would have access to the assignments and resources outside of the classroom, providing them more opportunity to complete work. Table 4 provides the direct and independent assignments for each topic and correlates them to the three different learning styles and point value. Also, the assignments that were exclusive to Moodle are indicated with the word *Moodle* italicized and in parentheses. At the end of each unit, students were required to take the exit quiz on Moodle. The quizzes were timed and the answers were scrambled with each attempt to help prevent cheating. As in the previous unit, students were given a guide that contained all of the information in Table 3 and 4 [Appendix V-a]. The students were responsible for obtaining signatures as they completed assignments and handing in the guide at the end of the unit.

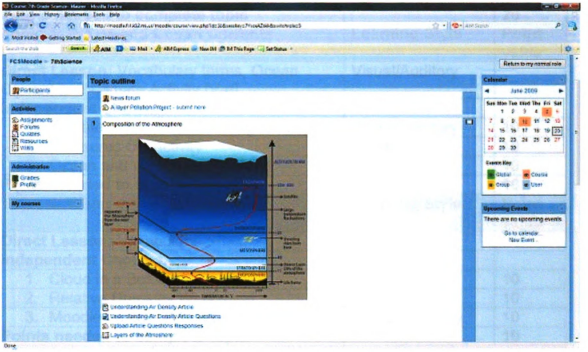


Figure 3: Moodle Course Page

Table 4: Outline of Atmosphere Unit [ ]= appendix number/designation

Topic 1: Composition of the Atmosphere	**Learning Style**	**Point value**
Direct Lesson: Vocabulary terms	Visual	
Independent Choices:		
1. Understanding Air Density Article and Questions [V-b]	Visual	10
2. Layers of Atmosphere Wiki *(Moodle)*		10
3. Atmosphere Video and Questions *(Moodle)*	Visual/Auditory	10
4. Layers of Atmosphere Poster	Tactile	20
Points needed to complete topic		**20**
Topic 2: Heating of the Atmosphere	**Learning Style**	**Point value**
Direct Lesson: Vocabulary, Heating Earth Materials Lab [V-c]	Visual	
Independent Choices:		
1. PowerPoint Lecture Notes	Auditory	10
2. Wiki *(Moodle)*	Visual	10
3. Energy in the Atmosphere Video and Questions	Visual/ Auditory	10
4. Greenhouse effect summary [V-d]	Visual	10

Points needed to complete topic		**20**
Topic 3: Winds and Ocean Currents	**Learning Style**	**Point value**
Direct Lesson: Vocabulary terms, Ocean Current and Climate Activity [V-e]	Visual/Auditory	
Independent Choices:		
1. Climate Video & Questions *(Moodle)*	Visual/Auditory	10
2. Pressures On Activity	Tactile	10
3. Ocean and Wind Activity	Visual	10
Points needed to complete topic		**10**
Topic 4: Water in the Atmosphere	**Learning Style**	**Point value**
Direct Lesson: Vocabulary	Visual	
Independent Choices:		
1. Cloud in a Bottle	Tactile	10
2. Relative Humidity Worksheet	Visual	10
3. Moodle Lesson *(Moodle)*	Visual/ Auditory	10
Points needed to complete topic		**10**
Topic 5: Air Masses and Fronts	**Learning Style**	**Point value**
Direct Lesson: Vocabulary, Types of Air Masses Notes	Visual/Auditory	
Independent Choices:		
1. Moodle Lesson *(Moodle)*	Visual	10
2. Frontal Boundaries Activity [V-f]	Visual	10
3. Air Masses and Fronts Video and Questions *(Moodle)*	Visual/Auditory	10
4. Air Masses and Fronts Mini Lab [V-g]	Tactile	10
Points needed to complete topic		**20**

Table 4 Continued

C-Layer Atmosphere Topics and Activities

Topic 1: Composition of the Atmosphere

As in the previous unit, new vocabulary terms were introduced at the beginning of the topic using the LINCing strategy. Since this was the students' first exposure of Moodle, not all of its features were utilized so as not to overwhelm the students. The Moodle assignments were kept to Wikis, Lessons and quizzes. All of the topic 1 assignments were available on Moodle except for *layers of the atmosphere poster.* The *Understanding Air Density* article and

questions required students to read an article on air density and humidity and answer questions. Students could complete this assignment on or off line. If completed online, students could submit the assignment as well. Being able to submit the assignments online directly after completion is beneficial to those students that have a tendency to complete work but forget to turn it in or lose it somewhere in the transition from home to class. The Wiki was a Moodle exclusive activity. The Wiki was designed using an outline of the layers of the atmosphere and students were required to add two facts about each layer. However, those facts had to be different than those submitted by other students. The students in the class were assigned to groups on Moodle according to their hour. As a result, each hour had a different Wiki page. Also on Moodle, students could choose to watch video segment on the atmosphere and complete a Moodle video quiz. Many students took the quiz while watching the video. In addition, students chose to complete the atmosphere poster. For the poster, students were required to draw and label the layer of the atmosphere to scale using 1 cm =10km and illustrate two facts about each layer.

Topic 2: Heating of the Atmosphere

The direct lesson for topic 2 was vocabulary using LINCing strategies and a PowerPoint presentation on heat transfer in the atmosphere. Almost every student chose to complete the skeleton notes while listening to the presentation. The Wiki for topic 2 contained the words: convection, conduction and radiation. The students were required to provide an example, link a resource or insert a picture for each of type of heat transfer. Another option was to watch a video

segment on energy in the atmosphere and answer questions on Moodle. Furthermore, student could write a summary on the greenhouse effect. Several resources were on Moodle, but students were not limited to Moodle to complete the assignment.

Topic 3: Winds and Ocean Currents

The direct lesson for topic 3 was vocabulary and an ocean current and wind activity. The ocean current and wind activity had students compare the average temperatures of inland and coastal cities at the same latitude. This correlated with the *Heating and Cooling of Earth Materials* lab that was done previously and further discussed in the B layer section. The idea was to relate heat capacity of water to climate. They also compared the average temperatures of Battle Harbour in Canada and London in the United Kingdom and correlated them to ocean currents. For the independent choices, a student could choose to watch a video segment on climate and complete the quiz on Moodle or complete a worksheet from the book. In addition, student could complete the *Pressures On* mini lab. For the mini lab, students filled a cup with water, placed an index card over the top and flipped the cup upside down. They were surprised to find the index card stayed on the cup. Then they poked a hole in the bottom of the cup and observed the water coming out of the cup. The goal of the activity was to reinforce the concept air pressure.

Topic 4: Water in the Atmosphere

The direct lesson for topic 4 was again vocabulary. Additionally, the *Cloud in a Bottle* mini lab received a very positive response from the students. In fact, many saw others doing the lab and changed their activity to participate. The lab had students filled the bottom of the 2 liter bottle with water, drop a lit match in and use a pump on the end to increase pressure in the bottle. Then students released the pressure and observed a cloud forming in the bottle. Furthermore, many students also chose to complete the Moodle lesson on humidity, dew point and cloud formation.

Topic 5: Air Masses and Fronts

The direct lesson for topic 5 was vocabulary and weather front notes. The notes had students draw different types of air masses on a map and describe their characteristics. Since the end of the school year was fast approaching and I could sense the students were feeling overwhelmed, the notes also counted as one of their choices. The Moodle lessons and video followed the same format as previous topics. The air masses and fronts mini lab became an at-home assignment. Even with it being a homework assignment, there was high participation. In the lab, students dropped a blue ice cube in room temperature water with red dye. Through conversations with those that completed the lab, students could explain the how density affects the formation of fronts. Furthermore, the frontal boundaries activity focused on predicting the movements of fronts and weather based on the movement of the fronts. Since the

presentation of the topic was rushed, students struggled with the frontal boundaries activities. The activity required more background information for student to be successful with the assignment.

Atmosphere B Layer

To save time, the B layer was incorporated into the C layer. Students completed two laboratory activities applying concepts learned. The intention was to complete an additional lab but time was again an issue. Therefore, the lab for topic 4 on dew point was not performed. The first lab was an inquiry based lab performed as an introduction to the first topic on the composition of the atmosphere. In the lab, the students determined the percentage of oxygen in the atmosphere. Prior to the lab, an informal assessment determined that almost every student had the preconceived idea that Oxygen was the most abundant gas in the atmosphere. This lab challenged those preconceived ideas. The students used a test tube, water and a candle to determine the percent of oxygen in the atmosphere. As the oxygen was consumed during combustion, the water is drawn into the test tube to replace the oxygen. They can then use a ratio to determine the percent oxygen in the test tube. Students consistently determined the percent of oxygen in the air to be between 18-25%. This lab led into a discussion about the other gases in the atmosphere. The other laboratory activity completing the B layer was a focused on heating of the atmosphere.

The heating and cooling of earth's atmosphere lab focused on the big idea that weather is driven by the unequal heating of the earth's surface. Students

constantly found that sand or soil heated the fastest and sand cooled the fastest. This led to the discussion about the extreme night and day time temperatures in the desert. Students also determined that water heated and cooled the slowest making coastal cities warmer in the winter than inland cities of similar altitude and latitude. This concept was discussed again in topic 3 during the *Ocean Current and Climate* activity when students observed the average temperatures of several coastal and inland cities at similar elevation and latitudes.

Atmosphere A Layer

The *A* layer for the atmosphere unit focused on sources of air pollution and the health effects that result. The *A* layer project was again a research based project (Appendix V-h). Students were given a subject and format choice. They could present the project as a PowerPoint ®, research paper or poster. Students could choose to research a historical case such as the London fog of 1952 or Los Angeles 1943 and determine the cause of the air pollution, the effects it had on human health and their recommendations to improve air quality as mayor of the city. Another choice was to determine the type of air pollution released during attack and collapse of the twin tower in New York City on September 11, 2001. In addition, students described the definition of short and long term health effects and explained of the health effects of ground zero rescue workers, employees and residents due to the pollution resulting from September 11th. Students also discussed their opinion of whether or not they feel the government should compensate the people who have suffered from the health effects resulting from September 11th. Students could also choose to study the relationship between

air pollution and asthma and determine if there is a relationship between the air quality index of cities and asthma. The remaining option focused on benefits and drawbacks of ozone. Students discussed the idea that the ozone in the stratosphere which is used to block ultraviolet radiation is a necessity for life; however, ozone in the troposphere is harmful to human health. Hopefully, a clear picture of the implementation of the two units has been established so their effectiveness can be discussed.

Results and Evaluation:

SURVEYS

From the post survey results [Appendix II-b], 58% of the participants enjoyed engaging in layered curriculum. They felt being able to choose assignments and work at their own pace were the best things about layered curriculum. They also indicated that they enjoyed the increased number of labs and projects. However, many expressed that there was too much work in the time given to complete each topic. In addition, they felt they learned most from laboratory investigations and Moodle. After the unit, 80% of the students agreed that technology should be included into the classroom. This was a slight increase from prior to the unit. Furthermore, when asked if "layered curriculum made me learn information better than the way classes are usually taught" 18% felt it did all the time, 25% most of the time, 43% some of the time and 14% none of the time. The one change students would like to see with layered curriculum is more time.

There were several interesting findings analyzing the pre/post surveys [Appendix VI]. One interesting observation was that prior to the unit, the majority (58.5%) indicated they learned best when taught by teacher or other adult and after the unit the opinion shifted so that the majority (60%) felt they learned best on their own. Also, the post survey indicated a 21% increase in the idea that students should be able to choose how they learn. However, after the unit the "no opinions" dropped to zero from 29% most likely accounting for that difference. A

similar trend was observed with the question "It is easier to learn when given several choices." Other questions did not produce much of a change, comparing pre and post surveys.

Even though laboratory investigation was the preferred method of learning indicated by students in the survey, I found in surprising that the majority of the students opted not to do the lab when it was given as a choice (Figure 4). On the other hand, book work was reported as one of the least helpful assignments; however, the majority of the students chose book work when it was given as an option. Book work was most likely a popular choice because it can be completed faster. Book work usually focuses on recalling information and less on critical thinking making it an easier option to complete.

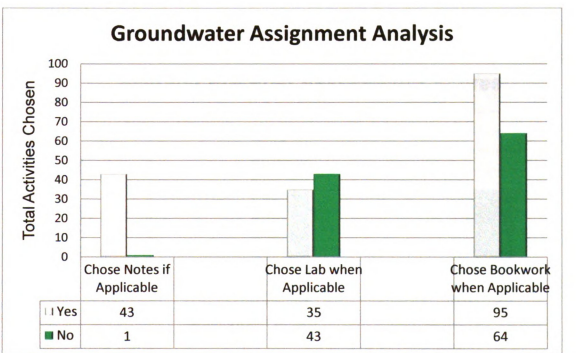


Figure 4: Summary of Assignment Type Chosen during Groundwater Unit (n=45)

ASSESSMENTS

Groundwater Unit:

One of the primary goals of implementing a layered curriculum into the groundwater unit was to increase knowledge comprehension. Comprehension was measured using a pre and post unit assessment. A student's paired t-test was conducted to compare the effects of the pre and post assessments on comprehension. There was a significant difference in the scores for the pre-assessment (M=7.09, SD=2.85) and the post assessment (M=18, SD=3.97); t(44)=-18.2, p=0.00. These results suggest that layered curriculum did have an effect on comprehension. The implementation of the layered curriculum resulted in an increase in comprehension. The difference in the average scores can be seen in figure 5. The assessments contained a maximum of 22 points.

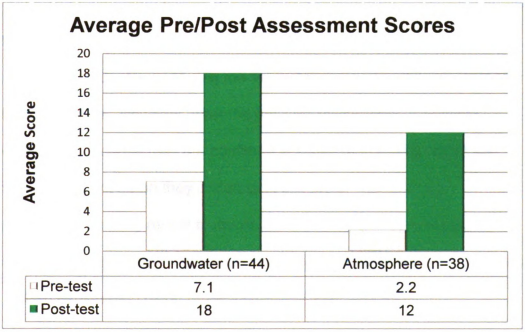


Figure 5: Average Pre/Post Assessment Scores

The water cycle produced one of the largest gains in comprehension (Figure 6). Again a student's paired t-test was conducted to determine the significance of the difference between the pre-assessment (M=0.96, SD=1.31) and the post assessment (M=6.71, SD=1.95); t(44)=-18.4, p=0.00. Figure 6 summarizes difference in average scores. On the pre-unit assessment, the water cycle results were most surprising. The students were given a diagram and a list of eight water cycle terms and asked to describe the cycle using the terms. Each term described correctly was given one point. The average score on the water cycle question prior to the unit was 0.98 out of 8. The water cycle is a concept that, in the past, I briefly covered and sometimes skipped if we were running short on time. My thinking was the water cycle is often covered in elementary grades because it is a concept of science that teachers with minimal science backgrounds were comfortable teaching. This assumption is backed by my mother being elementary school teacher in the district, and in previous years students always felt confident about the water cycle. In fact, with mention of the water cycle most students would sing me the water cycle song they've learned in second or third grade. However, after the pre-unit assessment, it became apparent that just because they are confident and can sing a song about the water cycle it does not mean they understand the cycle. The pre-unit assessment results clearly reveal students are not coming to seventh grade understanding the water cycle. Students are familiar with the terms but could not write a written explanation using those terms until after the unit.

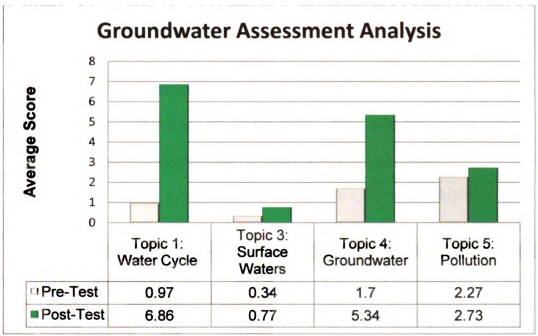


Figure 6: Groundwater unit average pre/post assessment scores arranged by topic (n=44)

Atmosphere Unit:

The primary goal of the unit was to increase comprehension; therefore another student's paired t-test was conducted. The results (Figures 5, 7) indicate a significant gain in comprehension between the pre-assessment (M=2.33, SD=1.64) and post assessment (M=12.0, SD=2.81); t(38)=-22.7,p=0.00. A summary of the average pre and post assessment scores are shown in figure 5. Figure 7 breaks down the average pre and post assessment scores for each topic. Topic 4 is missing because it was not assessed on the pre-unit assessment. This is due to the fact that this unit was originally intended to be just heat transfer in the atmosphere (topic 2). The other topics were added as result of time restraints. This also explains the disproportionate amount of points between the topics.

Since the unit focused heavily on topic two, another paired t-test was performed to test the unit's effectiveness on comprehension. The results indicated a significant gain between the pre-assessment (M=0.821, SD=1.14) and the post assessment (M=7.36, SD=2.18); t(38)=-17.7, p=0.00. These results suggest layered curriculum and Moodle did have a positive effect on comprehension.

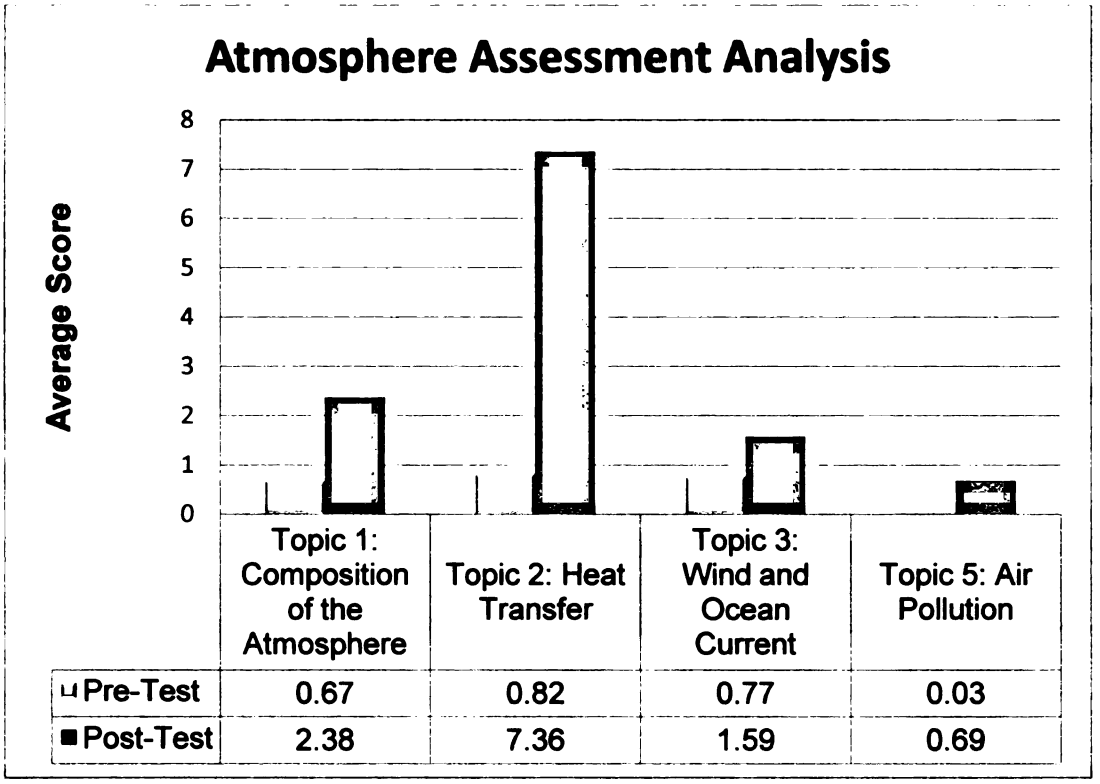


Figure 7: Atmosphere unit average pre/post assessment scores arranged by topic (n=38)

MISSING ASSIGNMENTS

Another goal of this study was to increase motivation. Missing assignments were analyzed to measure motivation with the idea that students would complete more assignments if they were motivated to learn (table 5) and having choices. Unfortunately, the implementation of layered curriculum and

Moodle did not decrease the amount assignments missing. In fact, the average number of missing assignments increased in comparison with the two units previously taught to this group of students. Several factors could be responsible for this increase. First, this study was implemented after spring break during the fourth marking period. From my experience, decreased motivation and increased missing assignment is common as the fourth marking period progresses.

Surprisingly, two participating students accounted for 48% and 30% of the missing work during the groundwater and atmosphere unit respectively. Student 25 and 10 didn't do work in prior units and continued those habits in this study. Even though the overall number of missing assignments increased with the implementation of Moodle, a reduction in missing assignments occurred for some students. For example, Student 28 had eleven (61%) missing assignments for the groundwater unit but only one (6%) for the atmosphere unit using Moodle. Similarly, student 11 decreased from 6 (33%) assignments missing to 0 when comparing the two units. Student 11 is one of the three students in the study receiving special education services. Furthermore, those two students accounted for 26% of the total missing assignments during the groundwater unit, but only 1% during the atmosphere unit.

Table 5: Summary of Missing Assignments (n=45)

	Weathering (Previous Unit)	Earth Materials (Previous Unit)	Groundwater	Atmosphere
Total Assignments in unit	7	14	18	16
Average missing/Student	.8	1.8	2.8	3.6
Average/Student (%)	11.8	12.6	15.5	22.3

USE OF MOODLE

The goal of Blended instruction through the use of Moodle was to translate students' motivation for technology into increased learning. When Moodle was given as an option, it was chosen 50% of the time (figure 8). Students tended to really like Moodle and complete all their assignments with Moodle or didn't use it at all. However, the post survey indicated the 80% of the students wanted assignments using technology, such as Moodle, as part of the course. In addition, as noted in the previous section, some students did turn in more assignments with the introduction of Moodle. In addition, teachers indicated that many students requested to work on Moodle with their free time in other classes.

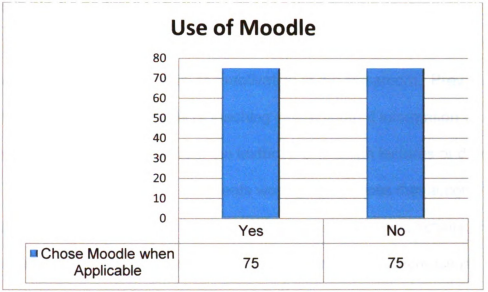


Figure 8: Summary of Moodle Use (n=45)

Conclusion

Layered curriculum and Moodle were implemented with the purpose of increasing comprehension and motivation in the classroom. Previous units were taught in a traditional style of teaching where content information was presented with a reading selection from the textbook or through lectures or demonstrations. The hypothesis was that if students were given choices that accommodated their learning style they would be more engaged in the learning activity. Furthermore, research indicates that engaging students correlates to increase in comprehension, retention and motivation. Overall, significant evidence from this study suggests that the implementation of layered curriculum and Moodle was effective in increasing comprehension. However, there was no significant correlation between Layered curriculum and Moodle to motivation.

Motivation was measured with the number of missing assignments throughout the unit, and missing assignments actually increased during the two units in comparison to the two previous units. However, the overall increase may be the results of several other factors. First, too much material was covered in too short of time. The unit did go at a faster pace than I would have liked but the end of the school year was fast approaching. The fast pace of the unit was also noted on many post unit surveys as a negative. In addition, as the end of the school year approached, many students became overwhelmed with end of the year projects in other classes and final exams.

Consequently, even though the units in this study did not produce a reduction in missing assignment in comparison to previous unit, they did produce

a change within the units in this study when comparing the two units. As discussed in the results section, several students had a significant decrease in missing assignments during the atmosphere unit. One possible cause for the reduction of missing assignments was introduction of Moodle. Even if Moodle positively affects a small number of students, it should remain as part of the curriculum. Furthermore, students chose Moodle 50% of the time when it was given as an option.

On the other hand, the strategies introduced did increase students' responsibility and confidence to learn. Based on the pre/post survey results, a shift in students' opinion occurred in how they learn best. Prior to the survey, 58.5% felt the learned best when taught by a teacher and after the survey that percentage shifted to students feeling they learn best on their own. I think layered curriculum's student-centered approach and focus on making students responsible for their learning gave them more confidence to figure things out on their own. Since layered curriculum integrates a variety of resources, students learn how to utilize those resources and rely less on the teacher. In addition, the use of formative assessments helps guide students learning and increasing their confidence.

In addition, LINCing vocabulary proved to be a very effective tool. I felt the students preferred this strategy over the previous method, and the strategy proved to be effective. For example, the topic 1 water cycle exit quiz focused on using vocabulary terms to explain the water cycle. Prior to the unit the average score was 0.97 out of 9 whereas after implementing the LINCing strategy and

topic 1 lessons the scores increased to 6.86. Since the assessment focused on vocabulary, I think the increase correlates to the LINCing strategy.

One problem faced during this study was the requirement of the consent form. The participants in this study were not a true sample of those taking the course. Participation in the study required signed consent from both the student and parent. Despite the incentive of extra credit and daily reminders, the majority of the students did not return the parent consent and were unable to participate. Those that did return both forms tended to be the more responsible students. The goal was to help the less motivated become engaged; however, if they don't turn in work it is unlikely to expect them to turn in a consent form with no relevance to them. In fact 80% of the participants were A/B students. Unfortunately, many special education students did not agree to be in the study. Unwillingness to participate may be the result of low self image regarding education. Despite the fact it was explained they would be anonymous, many feared the analysis of their work. As a result only 3 of the 45 (6%) participants were special education students, about a third of the of the percentage of special education students in the course. Furthermore, of the three students one didn't contribute much work to analyze. Low special education participation was unfortunate because I was hoping to analyze the effect of the accommodations provided by Moodle and layered curriculum. As discussed earlier, layered curriculum and Moodle are accommodating because students can chose their preference of learning focusing on their strengths, utilize many resources

adapting to different reading levels and allows students to work at their own pace.

Another problem was the length of the units. I think layered curriculum would be much more effective in middle school as a two or three week unit or about two or three days per topic. Adding too much information into the unit caused many students to become overwhelmed decreasing the effectiveness of the unit. In addition, incorporating the B layer into the C layer in the atmosphere unit was less overwhelming for the students. Incorporating the B layer throughout the C layer prevented students from having two projects due one after another. In future layered curriculum units, I will incorporate the B layer into the C layer through the use of laboratory investigations or formal reports. Also, I plan to adjust some of the point values of certain C layer assignments. For example, the water cycle children book took students significantly more time than other assignments to complete and should be worth 20 points instead of 10. Furthermore, the atmosphere unit would benefit from being divided into two separate units. Topics 1, 2 and 4 of the atmosphere unit could combine as one unit and topics 3 and 5 could be another unit. In addition, the swine flu epidemic also caused a distraction in the school and unit possibly affecting the unit.

Overall, I expect to continue to utilize layered curriculum and Moodle in the classroom. This study provided a solid foundation. With a few changes, such as shortening the unit, utilizing more of Moodle's features and incorporating the B layer into the C layer they will become even more effective. Furthermore, I was very impressed with Moodle. The Moodle features introduced in this study only

skim the surface. There are many more features of Moodle, such as forums, chat rooms, flashcard glossaries, etc. that I would like to introduce to the course. I feel that chat rooms that are monitored will extend the learning community outside of the classroom. Setting up a chat room will give students a chance to communicate about assignments or projects among themselves. Even though some students did not like Moodle, it definitely motivated others making it a valuable tool to the classroom. In addition, I received many compliments from parents regarding Moodle. It was another avenue to extend learning outside of the classroom.

APPENDIX I

APPENDIX I-a

Using Layered Curriculum and Technology to Increase Comprehension and Motivation in a Middle School Classroom
Parent Consent Form

I am currently enrolled as a graduate student in Michigan State University's Department of Science and Mathematics Education (DSME). My thesis research is on improving student comprehension and increasing motivation in a middle school classroom. Some of the components of the unit are laboratory investigations involving watersheds and energy in the atmosphere. The unit will also focus on giving students choices incorporating different learning styles and making connections to real life.

Data for the research study will be collected from standard student work generated in the course of teaching this unit, such as pre and post tests, lab activities, quizzes, and surveys. I am asking for your permission to include your child's data in my thesis. Your child's privacy is a foremost concern. During the study, I will collect and copy student work. These assignments will have the student's name removed prior to use in the study. All of the work being collected will be de-indentified and stored in a locked cabinet for three years. I am also requesting permission to take and use digital images of your child for use in my thesis presentation. The purpose of the images is to provide visual reference to lessons and activities performed during the unit. In addition, your child's identity will not be attached to any data in my thesis paper or in any images used in the thesis presentation. Your child's identity will be protected to the maximum extent allowable by law.

Participation in this research study is completely voluntary. Students who do not participate in the study will not be penalized in any way. Students who do not participate in the study will still be expected to participate in class and complete assignments. Students who participate in the study will not be given extra work to complete. You may request that your child's information not be included in this study at any time and your request will be honored. There are no known risks associated with participating in this study. Participation in this study may contribute to determining the more effective teaching methods in the middle school classroom.

If you are willing to allow your child to participate in the study, please complete the attached form and return it to Mrs. Adams, 8th grade science and math teacher. The form will be stored in a sealed envelope in a locked cabinet concealing involvement until after the unit is completed and grades have been assigned. Any work from a student who is not to be included in the study will be shredded.

If you have any questions about the study, please contact me by e-mail at maurera@fvl.k12.mi.us or by phone at (517) 223-6214. Questions about the study may also be directed to Dr. Merle Heidemann at The DSME by e-mail at heidema2@msu.edu, by phone at (517) 432-2152, or by mail at 118 North Kedzie, East Lansing, Michigan 48824. If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb@msu.edu or regular mail at 202 Olds Hall, MSU, East Lansing, MI 48824.

Thank you,

Ms. Amy Maurer
Fowlerville Junior High School

This consent form was approved by the Social Science/Behavioral/Education Institutional Review Board (SIRB) at Michigan State University. Approved 03/24/09 – valid through 03/23/10. This version supersedes all previous versions. IRB# 09-077.

I voluntarily agree to allow _____ participate in this study.

(print student name)

Please check all that apply.

_____I give Ms. Amy Maurer permission to use data generated from my child's work in Earth Science to be used in the thesis project. All data from my child will remain confidential.

_____I do not wish to have my child's work used in this thesis project. I acknowledge that my child's work will be graded in the same manner regardless of participation in the study.

_____I give Ms. Amy Maurer permission to use pictures of my child during her work on this thesis project. My child will not be identified in these pictures.

_____I do not wish to have my child's picture used at any time during this thesis project.

_____ _____

(Parent/Guardian signature) (Date)

This consent form was approved by the Social Science/Behavioral/Education Institutional Review Board (SIRB) at Michigan State University. Approved 03/24/09 – valid through 03/23/10. This version supersedes all previous versions. IRB# 09-077.

APPENDIX I-b

Student Consent Form

I am currently enrolled as a graduate student in Michigan State University's Department of Science and Mathematics Education (DSME). My thesis research is on improving student comprehension and increasing motivation in a middle school classroom. Some of the components of the unit are laboratory investigations involving watersheds and energy in the atmosphere. The unit will also focus on giving students choices incorporating different learning styles and making connections to real life.

Data for the research study will be collected from standard student work generated in the course of teaching this unit, such as pre and post tests, lab activities, quizzes, and surveys. I am asking for your permission to include your data in my thesis. Your privacy is a foremost concern. During the study, I will collect and copy student work. These assignments will have the student's name removed prior to use in the study. All of the work being collected will be de-indentified and stored in a locked cabinet for three years. I am also requesting permission to take and use digital images of you for use in my thesis presentation. The purpose of the images is to provide visual reference to lessons and activities performed during the unit. In addition, your identity will not be attached to any data in my thesis paper of in any images used in the thesis presentation. Your identity will be protected to the maximum extent allowable by law.

Participation in this research study is completely voluntary. Students who do not participate in the study will not be penalized in any way. Students who do not participate in the study will still be expected to participate in class and complete assignments. Students who participate in the study will not be given extra work to complete. You may request that your information not be included in this study at any time and your request will be honored. There are no known risks associated with participating in this study. Participation in this study may contribute to determining the more effective teaching methods in the middle school classroom.

If you are willing to participate in the study, please complete the attached form and return it to Mrs. Adams. The form will be stored in a sealed envelope in a locked cabinet concealing involvement until after the unit is completed and grades have been assigned. Any work from a student who is not to be included in the study will be shredded.

If you have any questions about the study, please contact me by e-mail at maurera@fvl.k12.mi.us or by phone at (517) 223-6214. Questions about the study may also be directed to Dr. Merle Heidemann at The DSME by e-mail at heidema2@msu.edu, by phone at (517) 432-2152, or by mail at 118 North Kedzie, East Lansing, Michigan 48824. If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb@msu.edu or regular mail at 202 Olds Hall, MSU, East Lansing, MI 48824.

Thank you,
Ms. Amy Maurer
Fowlerville Junior High School

This consent form was approved by the Social Science/Behavioral/Education Institutional Review Board (SIRB) at Michigan State University. Approved 03/24/09 – valid through 03/23/10. This version supersedes all previous versions. IRB# 09-077.

Please print Student Name: _____

_____I voluntarily agree to participate in this thesis project.

_____I give Ms Maurer permission to use pictures of me during her work on this thesis project. I understand I will not be identified in these pictures.

_____I do not wish to have my picture used at any time during this thesis project.

_____ _____

(Student signature) (Date)

This consent form was approved by the Social Science/Behavioral/Education Institutional Review Board (SIRB) at Michigan State University. Approved 03/24/09 – valid through 03/23/10. This version supersedes all previous versions. IRB# 09-077.

APPENDIX II

APPENDIX II-a

Pre-Unit Survey

1. My usual grade in science class is

   A B C D E

2. My Favorite class is

   Math Science English Social Studies Other:_____

   Because: _____

3. My least favorite class is

   Math Science English Social Studies Other: _____

   Because: _____

4. Which part of science helps you learn best?

   Demonstrations Notes

   Homework Labs/Projects

   Quizzes/ tests Bookwork

   Other: _____

5. Which part of science is least helpful to you?

   Demonstrations Notes

   Homework Labs/Projects

   Quizzes/ tests Bookwork

   Other: _____

6. Which kinds of assignments do you like the most?

   Bookwork Notes

   Daily work Labs/Projects

   Quizzes/ tests Other: _____

7. Do you prefer working alone or in groups?

   Alone Partners/group of three Big Groups 4-6

   Why?

8. I learn best:

   on my own being taught by a peer Being taught by a teacher or other adult

9. Students should be able to choose how they learn

   Agree Disagree No opinion

10. It is easier to learn when given several choices

    Agree Disagree No opinion

11. Assignments using technology(pod cast, Moodle, WebQuest, PowerPoint) should be included into the classroom

    Agree Disagree No opinion

12. I am good at setting my own goals and completing them on time

    Agree Disagree

13. I can do well in a science class

    Agree Disagree

On the following page, please circle or shade the box that best describes how you feel

Watersheds	I could explain the topic in detail	I can explain the main ideas correctly	Familiar with topic but could only explain a little about it	Heard of the topic but couldn't tell you anything about it	I've never heard of that topic before
Surface Waters	I could explain the topic in detail	I can explain the main ideas correctly	Familiar with topic but could only explain a little about it	Heard of the topic but couldn't tell you anything about it	I've never heard of that topic before
Groundwater and Aquifers	I could explain the topic in detail	I can explain the main ideas correctly	Familiar with topic but could only explain a little about it	Heard of the topic but couldn't tell you anything about it	I've never heard of that topic before
Human Causes of water pollution	I could explain the topic in detail	I can explain the main ideas correctly	Familiar with topic but could only explain a little about it	Heard of the topic but couldn't tell you anything about it	I've never heard of that topic before
The cause of wind and ocean currents	I could explain the topic in detail	I can explain the main ideas correctly	Familiar with topic but could only explain a little about it	Heard of the topic but couldn't tell you anything about it	I've never heard of that topic before
Heat Transfer in the Atmosphere	I could explain the topic in detail	I can explain the main ideas correctly	Familiar with topic but could only explain a little about it	Heard of the topic but couldn't tell you anything about it	I've never heard of that topic before
Temperature of Ocean and ocean currents affect on climate	I could explain the topic in detail	I can explain the main ideas correctly	Familiar with topic but could only explain a little about it	Heard of the topic but couldn't tell you anything about it	I've never heard of that topic before
Origin and human causes of air pollution	I could explain the topic in detail	I can explain the main ideas correctly	Familiar with topic but could only explain a little about it	Heard of the topic but couldn't tell you anything about it	I've never heard of that topic before

APPENDIX II-b

POST UNIT SURVEY

1. My grade during the Energy in the Atmosphere Layered curriculum unit was:

   A B C D E

2. I liked doing layered curriculum

   Agree Disagree

3. The best thing about layered curriculum was...

4. The worst thing about layered curriculum was...

5. I learned the most in this unit from...

6. My favorite part of the unit was...

7. My least favorite part of the unit was...

8. I learn best:

   On my own Being taught by a peer Being taught by a teacher or other adult

9. Students should be able to choose how they learn

   Agree Disagree

10. It is easier to learn when given several choices

    Agree Disagree

11. Assignments using technology(pod cast, Moodle, webquest, PowerPoint) should be included into the unit

    Agree Disagree

12. I am good at setting my own goals and completing them on time

    Agree Disagree

13. I can do well in a science class

    Agree Disagree

14. I felt layered curriculum made me learn information better than the way classes are usually taught.

    All of the time Most of the time Some of the time None of the time

15. I f I could change one thing about the layered curriculum unit, it would be...

Please circle or shade the box that best describes how you feel

Watersheds	I could explain the topic in detail	I can explain the main ideas correctly	Familiar with topic but could only explain a little about it	Heard of the topic but couldn't tell you anything about it	I've never heard of that topic before
Surface Waters	I could explain the topic in detail	I can explain the main ideas correctly	Familiar with topic but could only explain a little about it	Heard of the topic but couldn't tell you anything about it	I've never heard of that topic before
Groundwater and Aquifers	I could explain the topic in detail	I can explain the main ideas correctly	Familiar with topic but could only explain a little about it	Heard of the topic but couldn't tell you anything about it	I've never heard of that topic before
Human Causes of water pollution	I could explain the topic in detail	I can explain the main ideas correctly	Familiar with topic but could only explain a little about it	Heard of the topic but couldn't tell you anything about it	I've never heard of that topic before
The cause of wind and ocean currents	I could explain the topic in detail	I can explain the main ideas correctly	Familiar with topic but could only explain a little about it	Heard of the topic but couldn't tell you anything about it	I've never heard of that topic before
Heat Transfer in the Atmosphere	I could explain the topic in detail	I can explain the main ideas correctly	Familiar with topic but could only explain a little about it	Heard of the topic but couldn't tell you anything about it	I've never heard of that topic before
Temperature of Ocean and ocean currents affect on climate	I could explain the topic in detail	I can explain the main ideas correctly	Familiar with topic but could only explain a little about it	Heard of the topic but couldn't tell you anything about it	I've never heard of that topic before
Origin and human causes of air pollution	I could explain the topic in detail	I can explain the main ideas correctly	Familiar with topic but could only explain a little about it	Heard of the topic but couldn't tell you anything about it	I've never heard of that topic before

APPENDIX III

APPENDIX III-a

Pre-Unit Assessment

1. When the snow melts in Michigan, describe three things that can happen to this water.

2. Which is an example of a point source of water pollution?

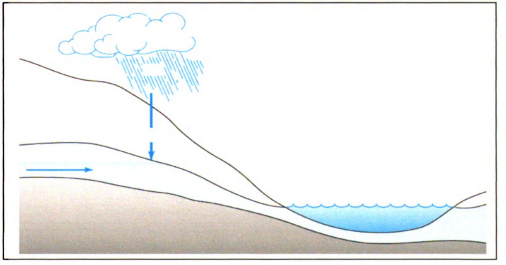
   A) Pesticides on farmland
   B) Exxon Valdez oil spill
   C) Salt spread on roadways
   D) Runoff of human and animal waste

3. A) Describe a way in which humans have been a source of water pollution.

   B) Describe a way we can improve water quality.

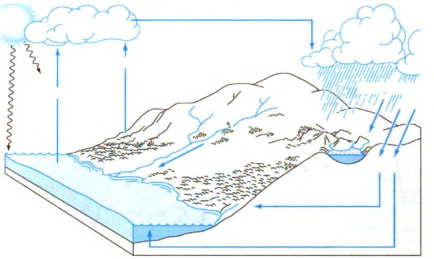
4. In the box below, label all of the following on the model aquifer: **Saturated zone, unsaturated zone, water table, impermeable layer, and permeable layer.**

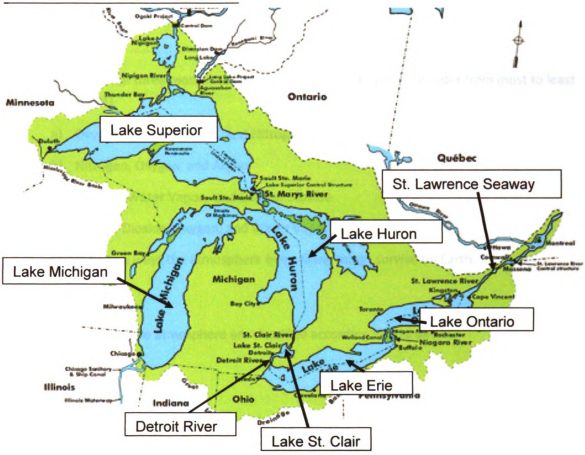
   Draw where you would dig a well. Make sure to include the depth of the well in your drawing.



Would the water collect where it is shown on the diagram? Explain.

5. **Use the diagram and the following terms to explain the water cycle. Use all of the following terms in your explanation: evaporation, transpiration, condensation, cloud** formation, precipitation, infiltration, surface runoff and groundwater.





6. Which of the following correctly describes the path water would take through the region covered on the map.

   a) St. Lawrence Seaway →Lake Ontario→ Lake Erie→ Detroit River →Lake St. Clair → Lake Huron →Lake Michigan

   b) Lake Superior → Lake Michigan →Mississippi River

   c) Lake Superior → Lake Huron →Lake St. Clair →Detroit River →Lake Erie → Lake Ontario → St. Lawrence Seaway

   d) Lake Huron → Lake Erie → Detroit River → Lake Ontario → St. Lawrence Seaway → Lake St. Clair

APPENDIX III-b

Pre-unit Assessment

1. What are the three most abundant gases in the atmosphere in order from most to least abundant)

   a) Oxygen, Carbon Dioxide, and Nitrogen

   b) Nitrogen, Oxygen, and Argon

   c) Oxygen, Water Vapor, and Carbon Dioxide

   d) Carbon Dioxide, Oxygen, and Water Vapor

2. Describe two ways the atmosphere helps living things survive on Earth.

3. The layers of the atmosphere are classified according to changes in:

   a) Altitude

   b) Density

   c) Pressure

   d) Temperature

4. Describe the three ways heat is transferred in the atmosphere. Give an example of each.

5. Three cities are at the same altitude and latitude:

   City A: Located in a sandy desert
   City B: Located in a dark colored rocky surface
   City C: Located along the coast of the Great Lakes

   During the winter the earth tends to lose heat which of the above cities would have the warmest average winter temperature? Why?

6. The sun is approximately 93 million miles from the earth and space has no temperature. How do we get heat from the sun?
7. Convection takes place because:

   a) Warm air is more dense than cold air

   b) Warm air and cold air have the same density

   c) Cold air is less dense than warm air

   d) Cold air is more dense than warm air

8. Winds are caused by differences in:

   a) Precipitation

   b) Humidity

   c) Air pressure

   d) Turbulence

9. Battle Harbour in Canada and London in the United Kingdom are both coastal cities at about the same latitude. Battle Harbour has an average temperature in January of -7°C whereas London has an average January of 7° C. Using your knowledge of ocean currents, explain why Battle Harbour has a cooler average temperature.

10. a) Describe two ways humans pollute the air.

    b) Describe two health effects caused by air pollution.

11. How do fronts form?

12. What type of weather is associated with a cold front?

    Summer:

    Winter:

APPENDIX IV

APPENDIX IV-a

Student Guide for Watersheds and Groundwater Unit

Essential Questions:

How does surface water in Michigan get to the Ocean?
How do human interactions effect the environment?

State Benchmarks:

E.ES.07.82 Analyze the flow of water between the components of a watershed, including surface features (lakes, streams, rivers, wetlands) and groundwater.

E.ES.07.41 Explain how human activities (surface mining, deforestation, overpopulation, construction and urban development, farming, dams, landfills, and restoring natural areas) change the surface of the Earth and affect the survival of organisms.

E.ES.07.42 Describe the origins of pollution in the atmosphere, geosphere, and hydrosphere, (car exhaust, industrial emissions, acid rain, and natural sources), and how pollution impacts habitats, climatic change, threatens or endangers species.

Previous Science Standards:

EH.V.2.ms.2 Describe how surface water in Michigan reaches the ocean and returns.
EH.V.2.ms.3 Explain how water exists below the earth's surface and how it is replenished.
EH.V.2.ms.4 Describe the origins of pollution in the hydrosphere.

C Layer

You must get your sheet initialed as you complete assignments. You will be quizzed on the information during a conference session. DO NOT LOSE THIS SHEET!!! Or you may lose points.

Topic 1: Water Cycle

☐ Completed assigned vocabulary terms

Independent Practice Choices: Need 20 Points — *Teacher Initials*

1. 11.1 Review & Reinforce/ Enrich WS (10 pts) _____
2. Design a poster of the water cycle (10 pts) _____
3. Water Cycle in a Bag (10 pts) _____
4. Water Cycle Children's Book (10 pts) _____

Topic 2: Watersheds

☐ **Read pages 368-371**

Independent Practice Choices: Need 20 points *Teacher Initials*

1. Guided Reading (10 points) _____
2. Red Cedar River Activity (10 points) _____
3. Make a watershed brochure (10 points) _____
4. Design a concept map (10 points) _____

Topic 3: Surface Waters

☐ Completed Skeleton Notes

Independent Practice Choices: Need 20 points *Teacher Initials*

1. RAFT Story (20 pts) _____
2. Draw a Map of the Great Lakes and Atlantic Ocean and trace a path for water from Red Cedar to Ocean (10 pts) _____
3. 11.2 Review & Reinforce (10 pts) _____
4. Write a song about journey from Red Cedar to Ocean (10 pts) _____
5. PowerPoint of different types of surface waters (10 points) _____

Topic 4: Groundwater

☐ Groundwater Demonstration

Independent Practice Choices: Need 20 points *Teacher Initials*

1. Demonstration Questions (10 points) _____
2. 11.3 Review & Reinforce/Enrich WS (10 points) _____
3. Porosity and permeability Activity (10 points) _____
4. Michigan Aquifer Guide (10 points) _____
5. Design a working well (10 points) _____

Topic 5: Human Influence and Pollution

☐ Completed and turned in "Power of Water" video questions

☐ Completed Guided Reading

Independent Practice Choices: 20 points *Teacher Initials*

1. Case Study Analysis (10 pts) _____
2. Find a current article about water pollution and write a summary (10 pts) _____
3. Trouble in Paradise (10 pts) _____
4. Non Native Species Activity (20 pts) _____
5. 12.3 Review & Reinforcement/Enrich (10 pts) _____

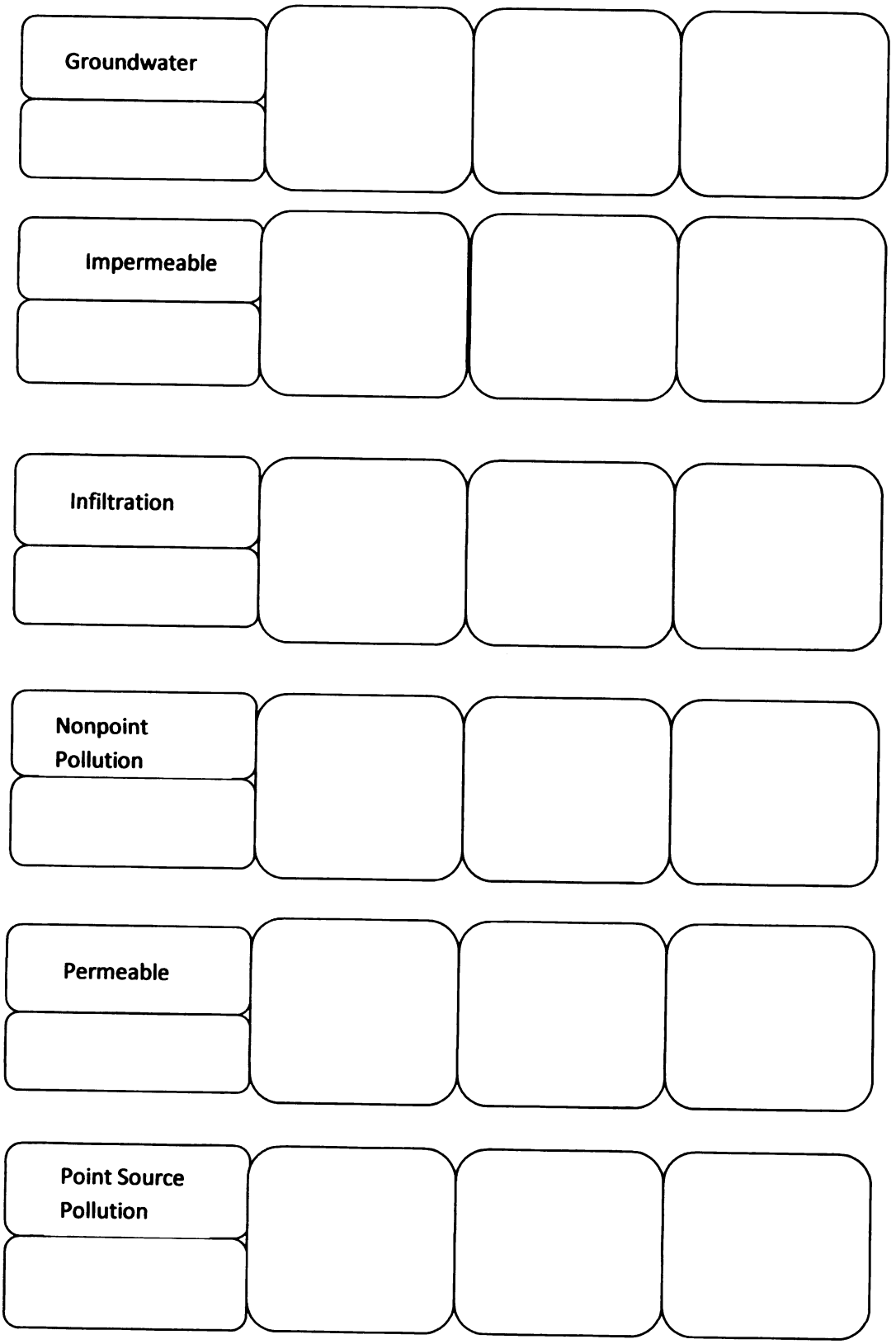
APPENDIX IV-b

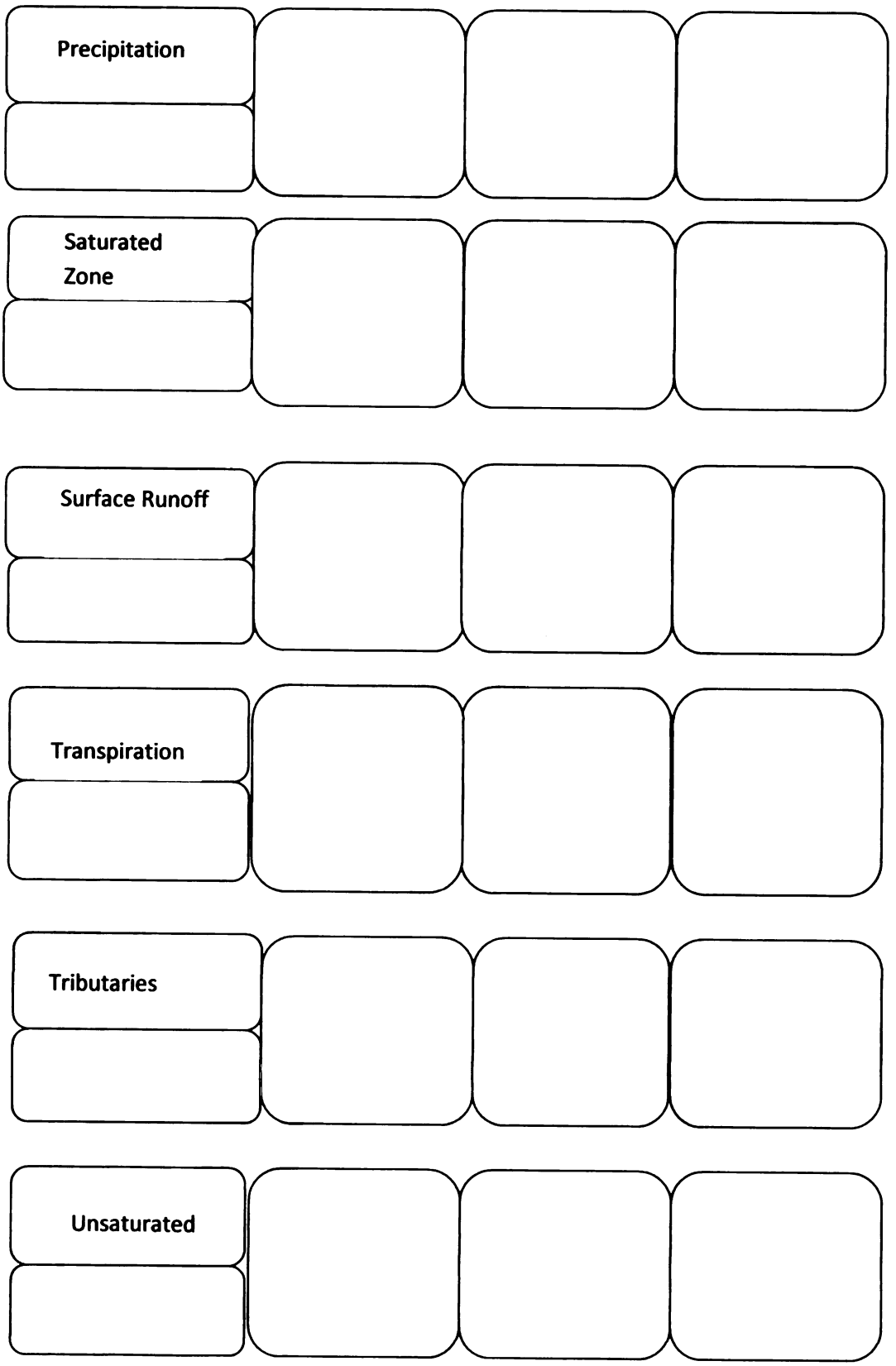
Groundwater Vocabulary

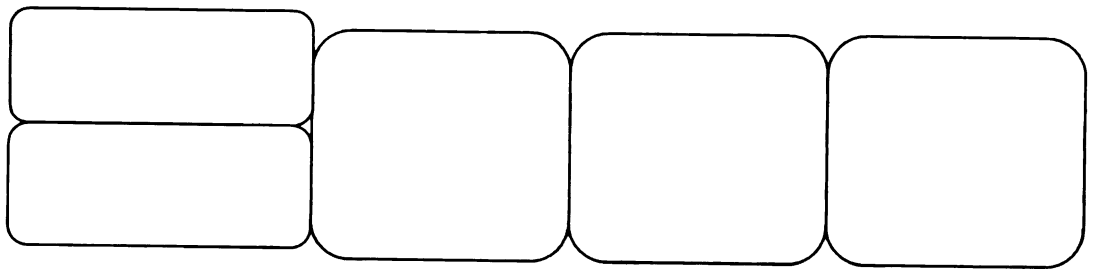
Directions: **The LINCing vocabulary is a useful strategy to help you remember vocabulary words and their definitions. Follow these steps to create a LINCing story:**

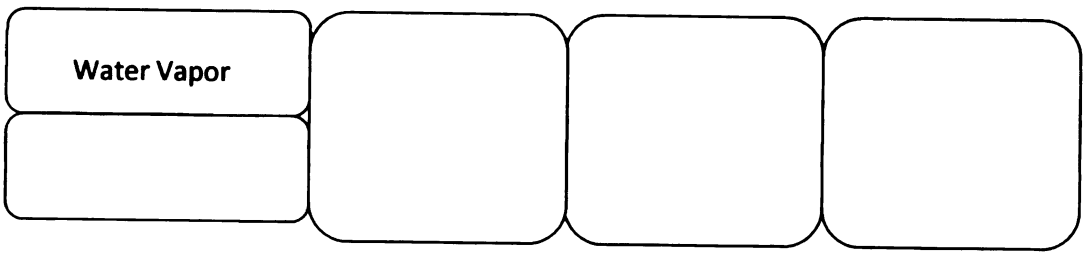
List the parts (vocabulary word and definition, Identify a reminding word, Note a LINCing story, Create a LINCing picture, and Self-test

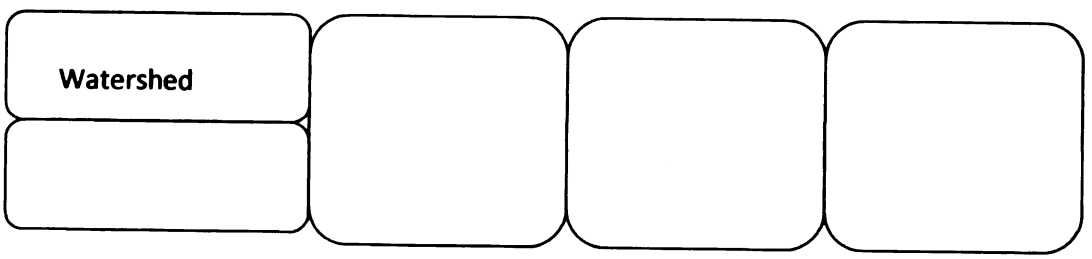
① Term Pollutant ③ Reminding Word	④ LINCing Story	⑤ LINCing Picture	② Definition
Aquifer			
Condensation			
Divide			
Evaporation			

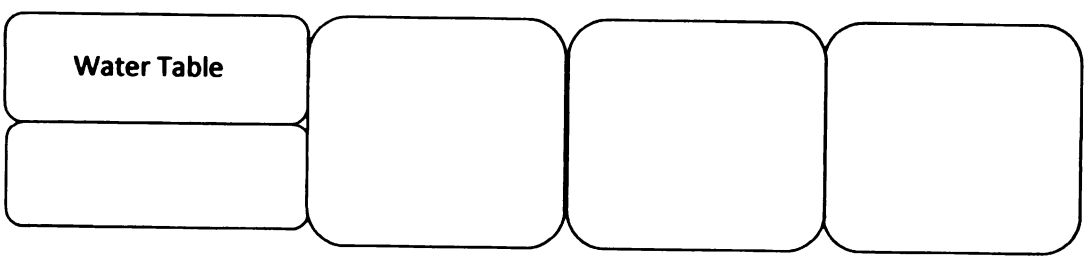

Groundwater
Impermeable
Infiltration
Nonpoint Pollution
Permeable
Point Source Pollution

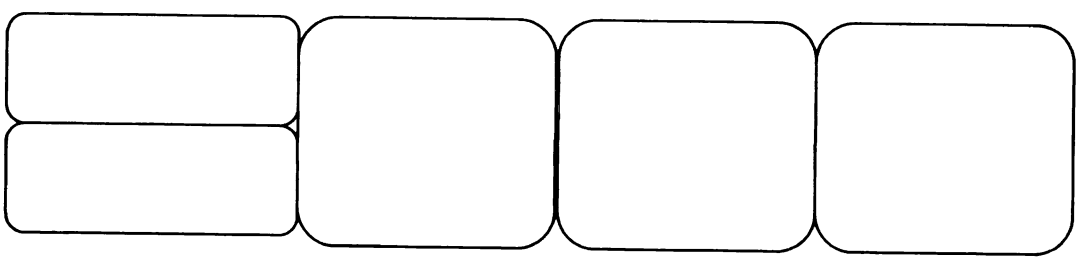

Precipitation
Saturated Zone
Surface Runoff
Transpiration
Tributaries
Unsaturated




Water Vapor


Watershed


Water Table



APPENDIX IV-c

Water Cycle in a Bag

Purpose: To demonstrate the continuous movement of **water** on, above, and below the surface of the Earth.

Materials: Small cup Masking Tape Ziploc sandwich bag water Food Coloring

Procedures:

1. Gather materials
2. Write your name on the Ziploc bag
3. Fill cup half way with water (do not fill over half)
4. Add a drop of food coloring to the water
5. Place the cup in the bottom of the Ziploc bag and tape the cup to the bag.
6. Seal the bag and tape it to the window

Data collection and Observations:

Day 1 (Initial Observations)	Day 2
Day 3	Day 4 (if necessary)

Conclusion:

Write a paragraph explaining how this activity models the water cycle. Be sure to include the terms evaporation, condensation, solar energy, water vapor and precipitation.

APPENDIX IV-d

Water on the Surface

***River Systems*:**

- _____
  _____
  _____

Tributaries

- _____
  _____
  _____

Watersheds

- _____
  _____
  _____

Divides

- _____
  _____

Rivers and floods

A flood occurs when

_____

_____

Can Floods be controlled?

A dam is

_____

_____

Levees are

_____

_____

How can building a levee backfire?

_____

_____

_____

Bodies of Fresh Water

Pond and lakes form

_____

_____

APPENDIX IV-e

Raft Guidelines

Role: The role the writer will "take on."

Audience: Who should the students consider as the audience for the product? Who will be reading the writing?

Format: What is the best product that will demonstrate the understanding of the interactions with the text?

Topic: This is the *when, who,* or *what* that will be the focus/subject of the final product.

Your assignment is to describe your journey from the Red Cedar River to the Ocean. You need to pick a role which will be the perspective you writing from. You may also choose a format for your writing.

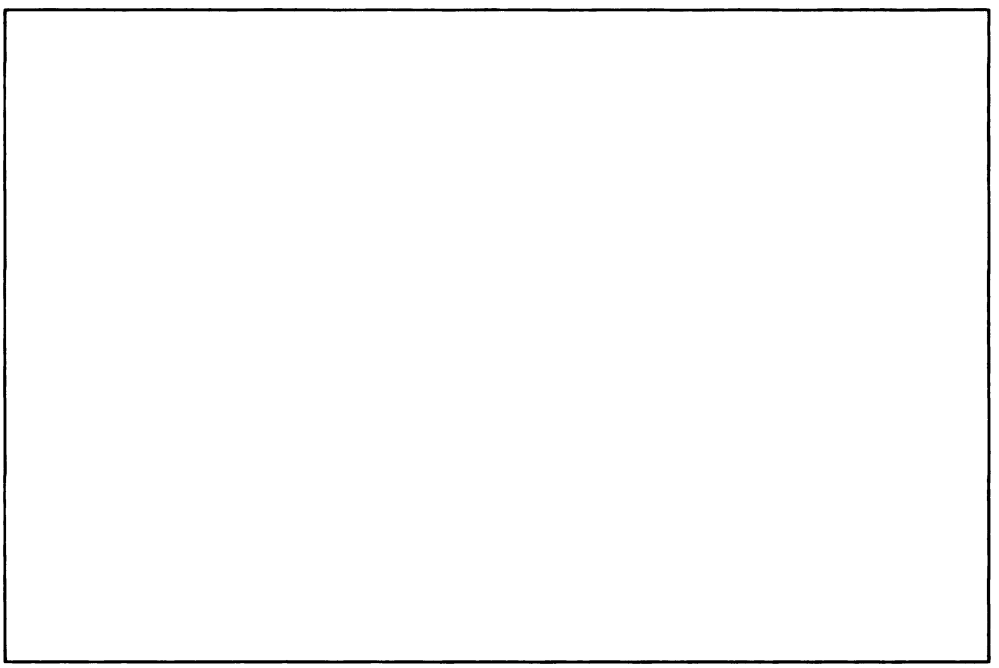
Role	Audience	Format	Topic
Water droplet	Other water droplets	Journal	Journey from the Red Cedar River to the Ocean
Ship Captain	Crew	Travel Guide	
Trout	Baby Trout (Fry)	Diary	
		Letter	

APPENDIX IV-f

Groundwater Simulator

The groundwater simulator represents a geologic cross section of the earth. Included in the simulator are the water table, aquiclude, artesian well, water wells. Disposal wells. Underground Storage Tanks (UST), septic tank, lake and a stream.

Draw and label a picture of the simulator. Note: The land surface is higher on the right side of the simulator than on the left side.



Label the following on your diagram: **water table, aquiclude, artesian wells, disposal wells, Underground Storage Tank, saturated zone, unsaturated zone, septic tank, lake, and a stream**

Water Cycle:

Closed systems - same water today as millions of years ago and millions of years into the future. Average time a water molecule spends in each form:

Atmosphere – 9 days

Lake – 10 Years

Oceans – 3-5,000 years

Ice/Groundwater – 10,000-100,000 yea

Groundwater Contamination Questions

Waste is injected into Well 2. Record your answers.

1. **Does the dye flow in the same direction as the water?**
2. **Which well does the dye (contaminates) impact?**
3. **Does the dye contaminate the lake or stream?**

Waste is injected into well 3, UST, and the Septic Tank. Record your answers.

1. **Which dye plumes contaminate the lake?**

   Why?

2. **Does the dye flow through the lake?**
3. **Where do all the dye plumes converge?**
4. **Can contaminated groundwater contaminate groundwater contaminate surface waters?**

   Under what conditions?

The effects of pumping wells on contaminate plumes. Answer the following questions.

1. **Does the pumping affect the flow of the dye plume?**
2. **What happens to the dye plume when the pumping stops?**
3. **Contaminates can flow above, into, or below wells down gradient from the contaminant source. What determines whether contaminates will contaminate a well?**

Appendix IV-g

Permeability Activity

Purpose: Determine the permeability of different substances

Background Information:

Permeability is determined by how easily water can pass through a material. Approximately 25% of rainwater permeates through the soil and become groundwater. The time it takes for the water to pass through the soil is an estimate of the permeability of the soil. The longer the time, the less permeable the soil.

Materials: Gravel, Sand, wood chips, Clay

Procedures:

1. Fill the bottle half way with gravel
2. Measure the height of the gravel in the bottle in centimeters
3. Set bottle over beaker (see figure)
4. Gently pour 200 ml of water over the gravel. Start timer when you begin to pour.
5. Stop timer when the water has passed through the material
6. Record data and repeat steps 1-5 with sand, wood chips and clay.

Quantitative Data:

Material	Time in seconds	Permeability (cm/sec.)

Construct a bar graph:

Conclusion:

Rank the materials from Most to Least permeable.

Porosity Activity

Background: Earth materials can hold water if they contain open spaces (pores). The open space is called porosity. Porosity is actually the percent of open space in the material and is expressed as a percent.

Porosity = Volume of water/ Volume of material

Materials: Gravel, sand, wood chips, clay

Procedures:

1. Fill one beaker, up to the 500 ml mark, with dry sand. Place it on a table or flat workspace. Record as soil volume.
2. Fill the other beaker, up to the 500 ml mark, with water.
3. Slowly pour the water from the second beaker into the sand sample. Stop pouring when the water level reaches the top of the sand. The soil has reached saturation and cannot hold any more water.
4. How much water is left in the second beaker?
5. How much water is now held in the pore spaces of the soil sample? Record as water volume.
6. Use your answer from question 5 to compute the porosity (the percentage of pore space) of the soil sample

Material	Rank	Soil Volume	Water Volume	Porosity

Problem: The average American uses 100 gallons of water each day (about a bathtub full). How many gallons of an aquifer with a porosity of 25% would be drained each day to provide this water?

How many gallons of the aquifer would be drained each day for the entire class (30 students)?

If so much groundwater is used, why are the aquifers not pumped dry?

APPENDIX IV-h

Case Study

Read the article on Lake Apopka or Saginaw River

Write a short summary of the article answering all of the following:

- **What is the water source and where is it located?**
- **What was polluting the river or lake?**
- **What was responsible for the pollution in the Lake or River?**
- **How did these changes negatively effect the ecosystem (plants, fish, people, etc)?**
- **What has been done to clean up the lake or river?**
- **What are the benefits that have been observed as a result of the restoration effects?**

You may write your summary below or on a separate sheet of paper

Article: _____

Summary:

APPENDIX IV-i

Fowlerville's Areas of Environmental Concerns

1. **What is the source of the environmental contamination at site S5 and S40?**

Contaminants from Stanley Tools

Chemical	Highest Conc. ug/L taken from monitoring wells	Maximum Concentration Level (MCL) ug/L (Safe Level)	
cis-1,2-dichloroethene (DCE)	600	70	
Trichloroethylene (TCE)	3400	5	
Vinyl Chloride	330	2	

- **Well samples taken November 2003 by EPA**

2. **The above table shows the main containments found at the Former Stanley Tool Site (now owned by Johnson Controls). What chemical is responsible for the most pollution?**

3. **Use the following websites to fill in the attached table:**

Trichloroethylene: http://www.atsdr.cdc.gov/tfacts19.html
cis-1,2-dichloroethene: http://www.atsdr.cdc.gov/tfacts87.html
Vinyl Chloride: http://www.atsdr.cdc.gov/tfacts20.html

4. **What direction is the known groundwater flow direction?**

5. Based on the locations of the site of environmental contamination and groundwater flow, which would have a higher risk of groundwater contamination: A house on Grand and Sharpe or a house on Grand and Van Buren?

6. Mark the map with a red "X" where you would place two monitoring wells.

   Explain why you chose those locations.

7. What are Wellhead Protection Areas?

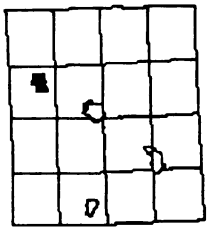
8. How many Leaking Underground Storage Tanks (USTs) are on the map?

9. What do USTs tanks have today to keep them from corroding? What helps notify the owner if the tank is leaking?

10. Leaking USTs account for what percentage of all groundwater contamination sites?

VILLAGE OF FOWLERVILLE

LIVINGSTON COUNTY, MICHIGAN



Sites of Environmental Contamination

S5 Boltec Industries INC.
S40 Stanley Tools

OPEN, Leaking Underground Storage Tanks

O6 Bob Smith Ford, Inc
O25 Freds Tire & Auto Service Inc
O68 Village of Fowlerville
O69 Waldecker Chevrolet

CLOSED, Leaking Underground Storage Tanks

C25 Fowlerville Fire Department
C26 Fowlerville Garage
C27 Fowlerville Mobil

Closed Dump/Landfill Sites

Location	Date of Closure
Garden Lane and Grand Avenue West End of Garden Lane	Early 1960's
Hogback Road near Railroad Tracks E1/2, SW1/4, Section 13	Mid 1970's

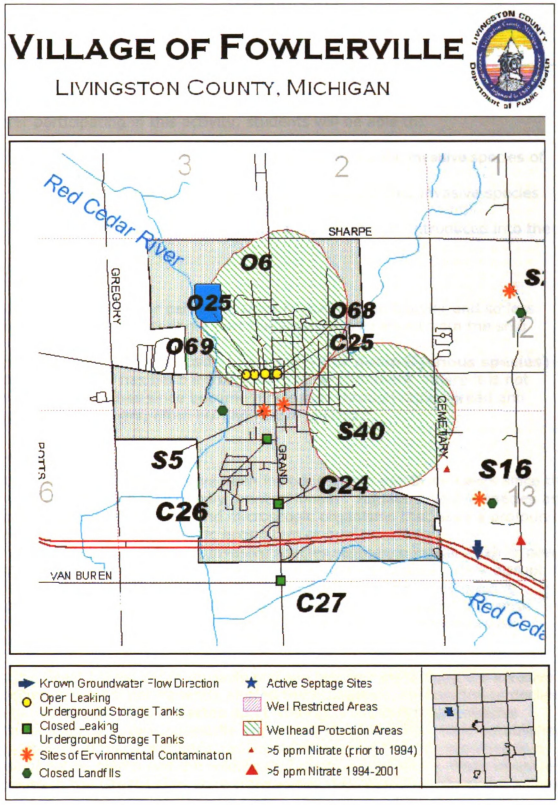
Licensed Septage Disposal Sites

No Known Sites In Fowlerville Village Limits

Water Supplies with Elevated Nitrates (5ppm or greater)

▲ Historical (prior to 1994)

▲ 1994-2001



http://co.livingston.mi.us/health/pdfs/EH/ehawarenesshandbook.pdf

APPENDIX IV-j

Non Native Species in the Great Lakes

Objectives:

After participating in this activity, students will be able to:

- Name and visually recognize the primary aquatic **invasive** species of the Great Lakes
- Understand and analyze the negative impacts that invasive species have on the Great Lakes ecosystem
- Explain the ways in which non-native species are introduced into the Great Lakes

Key Terms:

Ballast Water- Water carried in ships to make them heavier and so less likely to roll. Upon entering a port the water is discharged from the ship

Invasive Species (also called non-native or nonindigenous species)- Any species that has been introduced to an environment where it is not native, and that has since become a nuisance through rapid spread and increase in numbers, often hurting native species.

Background:

Many non-native species have been introduced into the Great Lakes since the early 1800s, either accidentally or intentionally. Aquatic invasive species are non-native plants, animals and microscopic organisms that have a profound negative impact on an aquatic ecosystem or human activity.
Free from natural predators, invasive species reproduce rapidly in their new homes and compete with native species for food and habitat. They disrupt the aquatic food web by reducing food for native species or by preying directly upon native species. Invasive species are often called "biological pollutants." They're costly to manage and have led to a severe loss of biodiversity throughout the world.

In the Great Lakes, zebra mussels and sea lamprey are among the invasive species that have permanently altered the ecosystem, contributed to declines in native species, and impacted sport and commercial fishing. Invasive plants, such as purple loosestrife and Eurasian watermilfoil, have established themselves in many wetlands and inland lakes, respectively, resulting in a loss of native plants and the wildlife that depend upon them. Many invasive species in the Great Lakes were transported from foreign ports in the ballast water of ocean going freighters. Today, the United States and Canada require that most ships entering the Great Lakes exchange their ballast water while still at sea to reduce transport and introduction of new species. Other

species like sea lamprey entered the Great Lakes on their own when shipping canals were modernized. Still other introductions are the result of accidental releases.

How You Can Help:

Prevent the transport of aquatic invasive species. Before leaving a body of water:

- Remove mud, plants, fish and animals from fishing gear, boats, motors, and trailers.
- Eliminate water from all equipment, including swimming floats, boat hulls, and bait buckets.
- Clean and dry anything that came in contact with the water—even boots, clothing, and pets.
- Do not release or put plants, fish or animals into a body of water unless they came out of it. Dispose of unused fishing bait in the trash.

Procedure:

1. Beginning with the photo cards, match each invader to its corresponding characteristics and impacts.
2. When you feel you have matched the cards to the best of your ability, you may review their answers on the answer sheets.
3. Brainstorm ways to prevent new species from entering the Great Lakes.
4. Make a either a wanted poster focusing on one of the invasive species or a cartoon depicting some of the impacts of the invasive species (Example: purple loosestrife chocking other plants

   A wanted poster should include:

   1. A large, bold font heading that says, "WANTED!"
   2. The photo imbedded in the document below the heading (needs to be colored)
   3. A brief description of the nonnative species and how it got into the Great Lakes
   4. A description of its crime(s) against the local environment
   5. A reward

   Cartoon should:

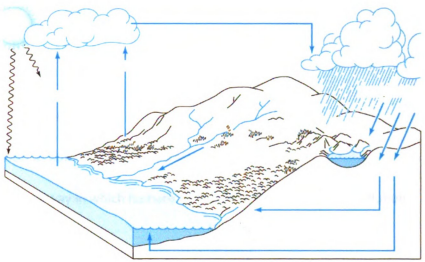
   1. Be colored
   2. Drawn on white construction paper (not lined paper)
   3. Contain the name of your invasive species
   4. Be Creative
   5. Neatly drawn and written

Brainstorm Ideas:

APPENDIX IV-k

TOPIC 1: Exit Quiz

1. **Use the diagram and the following terms to explain the water cycle. Use all of the following terms in your explanation: evaporation, transpiration, condensation, cloud formation, precipitation, infiltration, surface runoff and groundwater.**



APPENDIX IV-I

Topic 3-5 Exit Quiz

2. When the snow melts in Michigan, describe three things that can happen to this water.

3. Which is an example of a point source of water pollution?

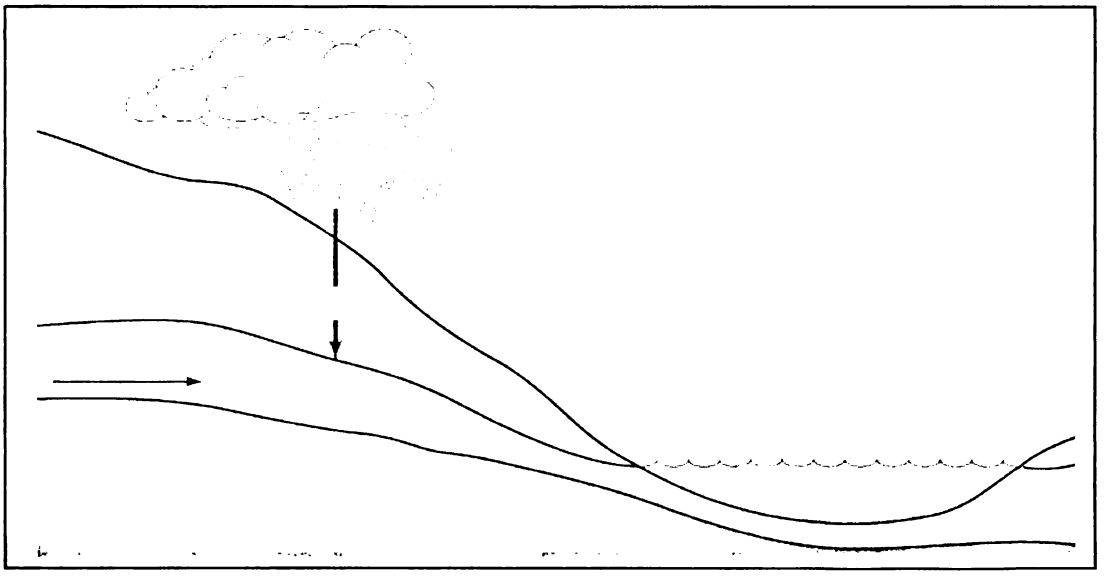
   E) Pesticides on farmland
   F) Exxon Valdez oil spill
   G) Salt spread on roadways
   H) Runoff of human and animal waste

4. A) Describe a way in which humans have been a source of water pollution.

   B) Describe a way we can improve water quality.

5. In the box below, label all of the following on the model aquifer: **Saturated zone, unsaturated zone, water table, impermeable layer, and permeable layer.**

   Draw where you would dig a well. Make sure to include the depth of the well in your drawing.



Would the water collect where it is shown on the diagram?

6. Which of the following correctly describes the path water would take through the region covered on the map.

   e) St. Lawrence Seaway →Lake Ontario→ Lake Erie→ Detroit River →Lake St. Clair → Lake Huron →Lake Michigan

   f) Lake Superior → Lake Michigan →Mississippi River

   g) Lake Superior → Lake Huron →Lake St. Clair →Detroit River →Lake Erie → Lake Ontario → St. Lawrence Seaway

   h) Lake Huron → Lake Erie → Detroit River → Lake Ontario → St. Lawrence Seaway → Lake St. Clair

APPENDIX IV-m

B Layer Checklist

- ✓ The project is neat, organized, labeled, and planned out thoroughly. (10 points)
- ✓ You have used proper spelling, grammar, and punctuation. (10 points)
- ✓ A title is at the top of your project indicating which B Layer option you chose. (5 points)
- ✓ You've included all requirements for your specific project. You've answered all of the questions if there were any. (25 points)

Look Fors	WOW! 5 points	4 points	3 points	2 points	0-1 point
Presentation x2	Project is neat, organized, and labeled.	1-2 minor mistake like something wasn't labeled, project was smudged, etc.	Project looks sloppy, isn't organized, or isn't labeled.	Project was attempted but sloppy and unorganized.	Project was barely attempted and very poorly done – 1 pt.
Convention x2	There are no spelling, grammar, or punctuation errors.	There are no more than 2 spelling, grammar, or punctuation errors.	There are no more than 5 spelling, grammar, or punctuation errors.	There are no more than 10 spelling, grammar, or punctuation errors.	There are more than 10 spelling, grammar, or punctuation errors.
Title x1	The title of your project clearly indicates which option you have chosen.		The title is included but doesn't clearly indicate which option you've chosen.		The title is missing or has no correlation to any of the options.
Requirement x5 (See below)	All requirements have been met.	4 requirements have been met.	3 requirements have been met.	2 requirements have been met.	1 or none of the requirements have been met.

Option	Requirement 1	Requirement 2	Requirement 3	Requirement 4	Requirement 5
Design & Build a model aquifer	Model contains surface water (lake, river, pond)	Contains a working well (artesian is extra credit)	Contains a confining layer	Contains a Saturated Layer	Contains an unsaturated layer
Design a Lab: What is the best method for treating polluted water?	Follow scientific method (all parts included)	Materials must be listed and procedure are clear, concise and repeatable	Data must be reported in graphs, tables, or diagram	Data must be used to support or reject hypothesis in the conclusion section	Critically review lab with places to improve and follow up questions.
Design a Lab: Determine the best method to clean up an oil spill?	Follow scientific method (all parts included)	Materials must be listed and procedure are clear, concise and repeatable	Data must be reported in graphs, tables, or diagram	Data must be used to support or reject hypothesis in the conclusion section	Critically review lab with places to improve and follow up questions.
Build a Watershed	Model contains a divide	Contains river w/ tributaries	Contains an water outlet	Model is 3 Dimensional	All parts are labeled
Choice	Activity focuses on a key topic in the chapter	*	*	*	*

* Write in requirements that are agreed upon with teacher

APPENDIX IV-n

A Layer Checklist

- **All projects must included** sources. 10 points will be deducted from projects without **sources.**
- **PLAGIARISM will result in** zero points

Look Fors	WOW! 5 points	4 points	3 points	2 points	0-1 point
Presentation x2	**Project is neat, organized, and labeled.**	1-2 minor mistake like something wasn't labeled, project was smudged, etc.	Project looks sloppy, isn't organized, or isn't labeled.	Project was attempted but sloppy and unorganized .	Project was barely attempted and very poorly done
Conventions x2	**There are no spelling, grammar, or punctuatio n errors.**	There are no more than 2 spelling, grammar, or punctuation errors.	There are no more than 5 spelling, grammar, or punctuati on errors.	There are no more than 10 spelling, grammar, or punctuation errors.	There are more than 10 spelling, grammar, or punctuation errors.
Title x1	**The title of your project clearly indicates which option you have chosen.**		The title is included but **doesn't clearly indicate which option you've chosen.**		The title is missing or has no **correlation** to any of the options.
Requirement x5 **(See below)**	**All requireme nts have been met.**	**4 requirements have been met.**	**3 requireme nts have been met.**	2 **requirement s have been met.**	1 or none of **the requirement s have been met.**

Option	Requirement 1	Requirement 2	Requirement 3	Requirement 4	Requirement 5
Columbia River: Dam it or not	Where it the river located? Describe some characteristics of the river.	List 5 pros and 5 cons of damming the Columbia River	How has the dams effected the salmon population?	What is barging and is it an effective way to help salmon bypass the dam?	Do you think we should eliminate some of the dams on the river? Explain.
Florida Everglades: Should they be restored?	Where are the Everglades located? Describe some characteristics of Everglades.	Why are they being destroyed and what species are endangered as a result?	Why are wetlands important to the ecosystem?	What has been done already to restore the Everglades?	If you were the Governor of Florida, would help restore the everglade or not. Explain.
Michigan: should we sell water from the Great Lakes to other states?	How big are the Great Lakes? What is the volume of water in the lakes?	List at least 5 pros and 5 cons of selling water from the Great Lakes	Who wants the water and how much do they need?	How would selling the water effect the lake levels?	If you were the Governor of Michigan, would you sell the water from the Great Lakes. Explain.
Non Native species: How can the spread be prevented?	What are non-native species? Provide examples.	Where did they come from? How did they get into the Great Lakes?	Why are they a problem in the Great Lakes?	Provide a list of things we can do to prevent the spread of invasive species. Provide at least 6 things	If you were the Governor of Michigan, what would you do to prevent the spread in the Great and in-land Lakes.

APPENDIX V

APPENDIX V-a

Student Guide for Atmosphere and Weather Unit

Essential Questions:
How do changes in altitude affect pressure and density?
How is heat transferred in the Atmosphere?
How do ocean currents effect climate?

State Expectations:

E.ES.07.12 Describe the relationship between the warming of the atmosphere of the Earth by the sun and convection within the atmosphere and oceans.

E.ES.07.13 Describe how the warming of the Earth by the sun produces winds and ocean currents.

E.ES.07.42 Describe the origins of pollution in the atmosphere, geosphere, and hydrosphere, (car exhaust, industrial emissions, acid rain, and natural sources), and how pollution impacts habitats, climatic change, threatens or endangers species.

E.ES.M.7 Weather and Climate – Global patterns of atmospheric and oceanic movement influence weather and climate.

E.ES.07.71 Compare and contrast the difference and relationship between climate and weather.

E.ST.07.72 Describe how different weather occurs due to the constant motion of the atmosphere from the energy of the sun reaching the surface of the Earth.

E.ES.07.73 Explain how the temperature of the oceans affects the different climates on Earth because water in the oceans holds a large amount of heat.

E.ES.07.74 Describe weather conditions associated with frontal boundaries (cold, warm, stationary, and occluded) and the movement of major air masses and the jet stream across North America using a weather map.

E.FE.07.11 Describe the atmosphere as a mixture of gases.

E.FE.07.12 Compare and contrast the atmosphere at different elevations.

C Layer

You must get your sheet initialed as you complete assignments. You will be quizzed on the information during a conference session. DO NOT LOSE THIS SHEET!!! Or you may lose points.

Topic 1: Composition of the Atmosphere

- ☐ Completed assigned vocabulary terms
- ☐ % Oxygen Lab

Independent Practice Choices: Need 20 Points *Teacher Initials*

1. Understanding Air Density Article and Questions (10 Points) _____
2. Layers of atmosphere Wiki –Moodle (10 points) _____
3. Atmosphere Video and Questions - Moodle (10 points) _____
4. Layers of the Atmosphere Poster (20 points) _____

Moodle Exit Quiz Score _____ / 7

Topic 2: Heating of the Atmosphere

- ☐ Heating and Cooling of the Earth's Atmosphere Lab
- ☐ Completed assigned vocabulary terms

Independent Practice Choices: Need 20 points *Teacher Initials*

1. PowerPoint Notes (10 points) _____
2. Wiki (Moodle) (10 points) _____
3. Energy in the Atmosphere Video and Questions -Moodle (10 points) _____
4. Greenhouse Effect Summary (10 points) _____

Moodle Exit Quiz Score _____ / 5

Topic 3: Wind and Ocean Currents

- ☐ Ocean Current and Climate Activity
- ☐ Completed assigned vocabulary terms

Independent Practice Choices: Need 10 points *Teacher Initials*

1. Moodle Lesson (10 pts) _____
2. "Pressure On" Activity (10 points) _____
3. Ocean and wind Activity (10 points) _____

Moodle Exit Quiz Score _____ / 5

Topic 4: Water in the Atmosphere

- ☐ Just Dew It Lab
- ☐ Completed assigned vocabulary terms

Independent Practice Choices: Need 10 points *Teacher Initials*

1. Cloud in a Bottle (10 points) _____
2. Relative Humidity WS (10 points) _____
3. Moodle Lesson (10 points) _____

Topic 5: Air Masses and Fronts

- ☐ Air Masses and Density demonstration
- ☐ Types of Air Masses
- ☐ Completed assigned vocabulary terms

Independent Practice Choices: Need 20 points *Teacher Initials*

1. Moodle Lesson (10 points) _____
2. Frontal Boundaries activity (10 points) _____
3. Air Masses and Fronts Video and Questions –Moodle (10 points) _____
4. Air Masses and Fronts mini lab (10 points) _____

Moodle Exit Quiz Score _____ / 5

APPENDIX V-b

Understanding air density and its effects

1. Does air have mass? If air does have mass than what is the formula for finding the density of air?

2. What happens to the density of air in the atmosphere as air is heated? What happens do the density of air as the pressure is increased?

3. If you were to go hiking in the Rocky Mountains what would happen to the amount of oxygen your body has available to it as your rise in altitude? How is this different than what happens as you ride in an airplane?

4. Would you expect air to be more or less dense with increased humidity, or with more water vapor present?

5. Explain in terms of molecules how humid air is less dense than dry air, even though water weighs more than air.

6. If Bary Bonds were to play baseball in Colorado, would he have a greater or less chance of hitting a homerun than in San Francisco? Explain your answer in terms of density or air.

7. How can a racecar use dense air as an advantage in auto racing?

8. Pretend you are an aircraft pilot. Predict what will happen to the length of the runway you need to take off on a warm humid day. Why do you think this?

APPENDIX V-c

Heating and Cooling of Different Earth Materials

Purpose: To determine the rate of heating and cooling of different earth materials when exposed to a heat source.

Background Information: Weather is driven by the unequal heating of the earth's surface. Some earth materials absorb more heat than others. Specific heat is another physical property of matter. The specific heat is the amount of heat per unit mass required to raise the temperature by one degree Celsius. Some materials have a higher specific heat than others.

Materials:

4 containers

Water

4 thermometers

Soil

Heat Lamp

Sand

Procedures:

1. Put equal amounts of soil, sand and water in separate beakers.
2. Place a thermometer in each beaker so the bulb is buried beneath the surface (all three thermometer should be at about the same depth)
3. Place the heat source above the three beakers so that each is receiving what appears to be an equal amount of heat.
4. Before turning on the lamp, record the initial temperature
5. Then for the next ten minutes record the temperature of each substance every minute.
6. After ten minutes turn the lamp off and continue to record temperatures for the next ten minutes of cooling.

Data:

HEATING

Earth Material	Start Temp (°C)	1	2	3	4	5	6	7	8	9	10
Sand											
Water											
Soil											

COOLING

Earth Material	Start Temp (°C)	11	12	13	14	15	16	17	18	19	20
Sand											
Water											
Soil											

Analyze and Conclude:

1. Using the data table, plot each materials heating and cooling temperatures against time.

2. Which material had the largest increase of temperature during the heating stage?

3. Which materials cooled down the most over the 10 minutes cooling stage?

4. On a hot sunny day, which material would heat the fastest?

   Which would cool the fastest at night?

5. Three cities are at the same altitude and latitude:

   City A: Located in a sandy desert

   City B: Located in a dark colored rocky surface

   City C: Located along the coast of the Great Lakes

6. During the winter the earth tends to lose heat which of the above cities would have the warmest average winter temperature? Why?

7. The sun is apparently 93 million miles from the earth and space has no temperature. How do we get heat from the sun?

8. How would the uneven energy absorption by different surfaces on earth (water, soil, snow, sand) affect the atmosphere?

APPENDIX V-d

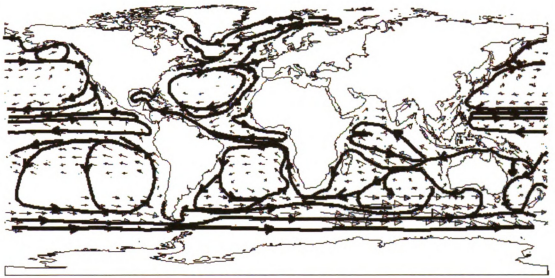
Greenhouse Effect Summary

Read the resources about the greenhouse effect and write a summary. In your summary make sure to answer the following questions:

- **What is the greenhouse effect?**
- **What are some examples of greenhouse gases?**
- **What would the earth be like without the green house effect?**
- **How do humans contribute to the greenhouse effect?**
- **How does the greenhouse effect relate to global warming?**
- **What is being done to reduce global warming?**

Wind and Ocean Currents

PART 1:



➢ The above maps shows the Global Wind Pattern and Surface Currents. Wind is indicated by small arrows and currents by large arrows.

1. What causes winds?

2. What is the Coriolis *Effect?*

3. Do surface currents appear to be related to wind directions? How do you know?

PART 2

4. Hypothesized: As the latitude increases, what happens to the average temperature?

_____

_____

City	Coast/Inland	Latitude	Average July Temp (F)	Average January Temp (F)	Difference in average Temp. (F)
San Francisco		38°	61°	48°	
Chicago		41°	75°	25°	
Irkutsk		52°	64°	-9°	
London		51°	63°	39°	

5. Complete the above table.

6. How does the difference in average temperature of coastal cities compare to that of inland cities at near the same latitudes?

   Provide an explanation:

However two coastal cities at about the same latitude can have very different average temperatures.

City	Latitude	Passing ocean current	Average July Temp (F)	Average January Temp (F)	Difference in average Temp. (F)
London	51°		63°	39°	
Battle Harbour	52°		50°	13°	

7. Use the ocean currents map to help answer the following questions.

The ocean current passing London is a _____ (warm or cold) current, and the current passing Battle Harbour is a _____ (warm or cold) current.

8. Use the ideas of ocean currents to explain why Battle Harbour in Canada has a much cooler temperatures than London even though they are around the same latitude.

APPENDIX V-f

Frontal Boundaries Activity

1. For days 1-3 label all fronts on the map.

2. Observe how the fronts have moved from day 1-3. Draw where you predict the front(s) will be on the map for day 4.

3. What do the shaded circular regions on the map represent?

4. The shaded areas are closest to which type of front?

5. The shaded areas are closest to which type of pressure?

6. On the day 4 map shade where you think there may be precipitation.

7. What are the lines on the map called?

8. What do the lines measure?

9. For days 1-3, indicate the area that would have strongest winds.

10. Where the winds are the strongest draw an arrow to indicate the direction of the wind

APPENDIX V-g

Air Masses and Fronts

Directions:

1. Fill the plastic container two-thirds full with lukewarm water.
2. Let the water sit for one minute.
3. Place a blue ice cube at one end of the plastic container.
4. Add three drops of red food coloring to the water at the other end of the plastic container.
5. Watch what happens.

Observations and Questions:

1. Draw a picture of what happens in this experiment, including color.

2. In terms of air masses what does the blue represent? What does the red represent? What evidence leads you to believe this?

3. In terms of density, why does this occur?

4. Which type of front does this most resemble to you? What type of weather is associated with this type of front?

APPENDIX V-h

A Layer Checklist

- ✓ The project is neat, organized, labeled, and planned out thoroughly. (10 points)
- ✓ You have used proper spelling, grammar, and punctuation. (10 points)
- ✓ A title is at the top of your project indicating which B Layer option you chose. (5 points)
- ✓ You've included all requirements for your specific project. You've answered all of the questions if there were any. (25 points)

Look Fors	WOW! 5 points	4 points	3 points	2 points	0-1 point
Presentation x2	Project is neat, organized, and labeled.	1-2 minor mistake like something wasn't labeled, project was smudged, etc.	Project looks sloppy, isn't organized, or isn't labeled.	Project was attempted but sloppy and unorganized.	Project was barely attempted and very poorly done – 1 pt.
Conventions x2	There are no spelling, grammar, or punctuation errors.	There are no more than 2 spelling, grammar, or punctuation errors.	There are no more than 5 spelling, grammar, or punctuation errors.	There are no more than 10 spelling, grammar, or punctuation errors.	There are more than 10 spelling, grammar, or punctuation errors.
Title x1	The title of your project clearly indicates which option you have chosen.		The title is included but doesn't clearly indicate which option you've chosen.		The title is missing or has no correlation to any of the options.
Requirement x5 (See below)	All requirements have been met.	4 requirements have been met.	3 requirements have been met.	2 requirements have been met.	1 or none of the requirements have been met.

Option	Requirement 1	Requirement 2	Requirement 3	Requirement 4	Requirement 5
Historical Case (London Fog 1952, Los Angeles 1943, Meuse Valley, Belgium 1930, Donora, PA 1948)	Describe the causes of air pollution	Describe temperature inversion	Described health effects and how many people were affected	As role of the mayor, your recommendations to improve air quality.	Information is accurate
New York City 9/11	Describe what type of air pollution was released	Information on long and short term health effects	What were the health affects due to pollution as a result of 9/11	Do you think the government should compensate?	Information is accurate
Air Pollution and Asthma	Present air Quality Index Chart	Information on long and short term health effects	Describe indoor sources of pollution. What should be done to improve pollution?	Two factors affecting air pollution	Determine whether there is a relationship between AQI in cities and asthma
Good Ozone vs. Bad Ozone	Why is ozone important?	Describe why too much ozone in the troposphere is harmful.	Health effects related to ozone. Present air quality index chart	How does ozone get into troposphere?	Your recommendations to lessen bad ozone

APPENDIX VI

Pre/Post Survey Results

Question/choices	Pre-unit Survey	Post-Unit Survey
I learn best:		
On my own	9 (22%)	27 (60%)
Taught by peers	8 (19.5%)	6 (13%)
Taught by teacher or other adult	24 (58.5%)	12 (26.7%)
Students should be able to choose how they learn:		
Agree	26 (63.4%)	38 (84.4%)
Disagree	3 (7.3%)	7 (15.6%)
No Opinion	12 (29.3%)	0 (0%)
It is easier to learn when given several choices:		
Agree	32 (78%)	40 (93%)
Disagree	3 (7.3%)	3 (7%)
No Opinion	6 (14.6%)	0 (0%)
Assignments using technology, such as Moodle should be included in the classroom		
Agree	30 (73%)	36 (92.3%)
Disagree	3 (7.3%)	3 (7.7%)
No Opinion	8 (19.5%)	0 (0%)
I am good at setting goals and completing them on time		
Agree	30 (75%)	34 (74%)
Disagree	10 (25%)	12 (26%)
I can do well in Science		
Agree	36 (95%)	40 (91%)
Disagree	2 (5%)	4 (9%)

	I could explain the topic in detail		I can explain the main ideas correctly		Familiar with topic bout could only explain a little about it		Heard of the topic but couldn't tell you anything about it		I've never heard of that topic before	
	Pre-Unit	Post Unit	Pre-Unit	Post Unit	Pre-Unit	Post Unit	Pre-Unit	Post Unit	Pre-Unit	Post Unit
Watersheds	0	17	2	15	2	11	11	0	25	0
Surface Waters	0	7	6	14	9	23	11	0	15	0
Groundwater & Aquifers	0	15	9	20	12	8	8	1	11	0
Human causes of water pollution	6	21	16	15	12	9	3	0	2	0
The cause of wind and ocean currents	2	7	5	21	15	16	15	0	3	1
Heat transfer in the Atmosphere	1	14	2	14	8	15	16	2	12	0
The effect of ocean currents on climate	3	10	5	17	12	14	12	3	8	0
Origin and human causes of air pollution	5	18	11	16	11	10	8	1	5	0

REFERENCES

REFERENCES

(n.d.). Retrieved June 2009, from http://fowlerville.mi.schoolwebpages.com/education/sctemp/8129945768f0396f79a166ca83af7987/1246289631/FCS_Annual_Report_2007-2008.pdf

Black, P. C. (2003). *Assessment for Learning: Putting it into Practice.* Maidenhead: Open University Press.

Brandl, K. (May 2005). Are You Ready to "Moodle"? *Language Learning & Technology* , 16-23.

Bransford, J. D. (2000). *How People Learn: Brain , Mind, Experience and School.* Washington D.C.: National Academy Press.

Caskey, M. M. (December 2003). Research for Awakening Adolescent Learning. *The Education Digest* , 36-8.

Conderman, G. a. (Summer 2008). Teaching Big Ideas in Diverse Middle School Classrooms. *Kappa Delta Pi Records* , 176-80.

Doolittle, P. E. (1999). *Constructivism and Online Education.* Retrieved June 20, 2009, from http://www.tandl.vt.edu/doolittle/tohe/tohe2.html/

Gardner, H. (1999). *Intelligence Reframed.* New York: Basic Books.

Gilbert, I. (2002). *Essential Motivation in the Classroom.* London & New York: Routledge Falmer.

Goodman, G. (2008). *Educational Psychology: An Application of Critical Constructivism.* New York: Peter Lang.

Hammerman, E. (2009). *Formative Assessment stategies for Enhanced Learning in Science, K-8.* Thousand Oaks: Corwin Press.

Kellogg, K. (1999). Learning Communities. *ERIC Digest* .

Mastropiero, M. T. (Fall 2006). Differentiated Curriculum Enhancement in Inclusive Middle School Science: Effects on Classroom and High-Stakes Tests. *The Journal of Special Education* , 130-7.

Muijs, D. a. (2001). *Effective Teaching: Evidence and Practice.* London: Paul Chapman Publishing.

Nunley, K. F. (2006). *Differentiating the High School Classroom.* Thousand Oaks: Corwin Press.

Nunley, K. F. (2004). *Layered Curriculum.* Amherst: Brains.org.

Palak, D. R. (2006). Integration of Instructional Technology: A device to Deliver Instruction or a Tool to Foster Learning. *International Journal of Instructional Media* , 355-65.

Rice, W. H. (2007). *Moodle Teaching Techniques.* Birmingham: Packt Publishing.

Stiggins, R. J. (June 2002). Assessment Crisis: The Absence of Assessment FOR Learning. *Phi Delta Kappen* .

Stiggins, R. J. (2005). *Student-Involved Assessment FOR Learning.* Upper Saddle River: Pearson Merrill Prentice Hall.

Tomlinson, C. A. (2001). *How to Differentiate Instruction in Mixed- Ability Classroom.* Alexandria: ASCD.

Wiseman, D. G. (2001). *Best Practices in Motivation and Management in the Classroom.* Springfield: Charles C Thomas Publisher, LTD.