Listening: Questions, ideas, reflections, and mistakes from a pre-student teacher

Grace-Ann Astrid Manes

Eastern Michigan University

Follow this and additional works at: https://commons.emich.edu/honors

Recommended Citation
https://commons.emich.edu/honors/257

This Open Access Senior Honors Thesis is brought to you for free and open access by the Honors College at DigitalCommons@EMU. It has been accepted for inclusion in Senior Honors Theses & Projects by an authorized administrator of DigitalCommons@EMU. For more information, please contact lib-ir@emich.edu.
Listening: Questions, ideas, reflections, and mistakes from a pre-student teacher

Abstract
This autobiographical self-study thesis explores the growth of the pre-student teacher within the context of an exploration of differentiation. It is an in-depth, reflective study of the development of a curriculum unit based in environmental mathematics education, the teaching of that unit in three contrasting school systems, and the results of that teaching for the student and teacher. The importance of listening in differentiation is emphasized as the questions, ideas, reflections, and mistakes of a pre-service teacher are discussed. In order to maintain validity and perspective, the thesis is written in narrative style with particular attention to author context, chronological insight, and future implications.

Degree Type
Open Access Senior Honors Thesis

Department
Teacher Education
LISTENING: QUESTIONS, IDEAS, REFLECTIONS, AND MISTAKES FROM A PRE-STUDENT TEACHER

By

Grace-Ann Astrid Manes

A Senior Thesis Submitted to the

Eastern Michigan University

Honors College

in Partial Fulfillment of the Requirements for Graduation

with Honors in Education

Approved at Ypsilanti, Michigan, on April 12, 2011

Supervising Instructor (Print name and have signed)

Honors Advisor (Print name and have signed)

Department Head (Print name and have signed)

Honors Director (Print name and have signed)
LISTENING: QUESTIONS, IDEAS, REFLECTION,
AND MISTAKES FROM A PRE-STUDENT TEACHER

An Honor’s Thesis presented in partial fulfillment of
requirements for graduation with

Departmental Honors in

EDUCATION

Eastern Michigan University
College of Education

April 16, 2011

GRACE-ANN ASTRID MANES
Table of Contents

Abstract ...................................................................................................................... 1

Introduction .............................................................................................................. 2

Defining Differentiation ........................................................................................... 4

Methods .................................................................................................................... 6

The Schools: An Overview ....................................................................................... 8

Alternative School A—Trial and Error ................................................................. 11

Grand—Doing it by the Book ................................................................................. 15

Bluefield—An Experiment in Listening .................................................................. 19

Looking Forward to Student Teaching and Beyond .............................................. 25

Post-Student Teaching Reflections and Recommendations ............................. 27

Appendices

Bibliograph ............................................................................................................... 32

Curriculum Unit

Timeline ..................................................................................................................... 34

Don’t You Forget About Me Lesson ....................................................................... 35

Our House Lesson ................................................................................................... 39

Challenge Project ................................................................................................... 41

Final Evaluations ..................................................................................................... 44

Final Project Pictures ............................................................................................... 50
Abstract:

This autobiographical self-study thesis explores the growth of the pre-student teacher within the context of an exploration of differentiation. It is an in-depth, reflective study of the development of a curriculum unit based in environmental mathematics education, the teaching of that unit in three contrasting school systems, and the results of that teaching for the student and teacher. The importance of listening in differentiation is emphasized as the questions, ideas, reflections, and mistakes of a pre-service teacher are discussed. In order to maintain validity and perspective, the thesis is written in narrative style with particular attention to author context, chronological insight, and future implications.
Introduction:

Four years ago, I enrolled in Eastern Michigan University as an education major. Though at the time I knew little more than the fact that I wanted to teach something to someone, I have since developed into a reflective practitioner and educator. At Eastern, I have earned 126 credit hours with a 3.91 Grade Point Average and will graduate with University and Departmental Honors in April of 2011. I have studied at three universities, observed in seven schools, and worked as a tutor for four separate organizations. My experiences include field placements in diverse and varied school districts, serving as the event coordinator for the Math Club, and working as a teaching assistant and counselor at a summer camp for gifted mathematics students in Seattle. Soon, I will begin student teaching in a Michigan public high school; thus beginning the final step towards concluding my degree. In many ways, my curriculum vitae would seem to declare that I am an exemplary education student. The result of this exploration in differentiation, however, has left me with one clear result: I still have a lot to learn.

When I first approached my thesis adviser, Dr. Ethan Lowenstein, in February of 2010, I had a clear idea of what I wanted to explore. Having recently completed the triumvirate of Curriculum, Assessment, and Social Foundations, I was passionately in love with the idea of differentiation. I wanted to help every student—regardless of gender, economic status, and race—to achieve all of the dreams that had ever floated in the corners of their mind. I wanted to ask “What is right for this place?,” just like William McDonough and Michael Braungart did for the environment in their book Cradle to Cradle, by differentiating the same unit in three contrasting school environments. I knew that students in the Metro Detroit area would share some needs because of geographical location and
social similarity, but I was also quite positive that different school districts had very individualized challenges and questions. I sought to compare and contrast these needs while discovering how one could differentiate the curriculum to fit a certain community of students. What was the most important factor in differentiation, I wondered? Grade level? Diversity? Classroom size? In addition, I wanted to focus on real-life environmental issues, asking questions like: “How can mathematics and environmental issues be properly integrated, especially in a limited time span? How does learning style affect the presentation and product of a lesson? What can the teacher do to accommodate for these differences, and how are those accommodations similar in varying school districts?” I would, I decided, create a three day unit before moving off to conquer these classrooms armed with fresh textbooks, reams of notes, and a boundless enthusiasm.

In some ways, nothing has changed. I did indeed create a three- to four- day curriculum unit that tied together the concepts of mathematics and the environment. It was taught in three very different schools over the course of six months and for each school my lesson plans changed dramatically. In conclusion, as expected, I firmly believe that differentiating your curricula is absolutely essential to reaching your students. Yet I’ve made several mistakes, and the questions I am leaving with are not the ones with which I began. Now, I am instead looking not just to find those factors which cause the most need for differentiation, but to address them. I am questioning how environmental and social issues can be incorporated into the curriculum while remaining developmentally appropriate. Most importantly, I have seen the value of student ownership and what the responsibilities of that ownership truly are for both the teacher and student.
In my haste to be the best teacher possible, I forgot one very important little fact: in order to be a truly good educator, you must not only be prepared to instruct your students, but to listen to what they are saying to you. The students are the ultimate factor in differentiation, and until you know them your efforts in differentiation will ultimately fall apart. It is not a lesson I will forget again.

**Defining Differentiation:**

If, like me, you are an education student who began your program of study within the last twenty years, chances are you’ve heard the word “differentiation” used frequently. While a core aspect of the teacher education program, it is perhaps overused to the point where much of its meaning is lost. To the modern undergraduate, differentiation is not something new or in development. Having not been a part of the gradual evolution of educational models that made differentiation what it is today, we use it in casual terms to describe everything from an alteration for grade level to the use of calculators in the classroom. Instead of seeing it as a teaching theory, a “complex mix of beliefs and instructional approaches,” we often see it as a checkbox in the lesson plan (Bratten 2). Did we do a pair-and-share? Is there something relevant to real life? What about our ADHD students, are they accommodated for? And what does that mean, anyway?

I admit to being one of these undergraduates. Even midway through this project, I still cannot claim that I truly understand the concept of differentiation. To me, differentiation was just change. If I altered the technology, adapted for class size, or modified for grade level, I considered this differentiation. It is necessary to go back to the root of this concept in order to truly define it.
Carol Tomlinson, the creator of the foundation of modern differentiation theory, claims that differentiation is “active planning for and attention to student differences in classrooms” (Tomlinson). It is important to note that it is the students we are differentiating for, not the classroom layout or technological advances. Even more importantly, we must remember that differentiation is not just about how “difficult” a concept is. Joseph Renzulli, a profound contributor to the theory of gifted education, explains that “true differentiation requires that we look at all the characteristics of the learner in addition to achievement level” (Renzulli). Specifically, as outlined by Tomlinson and then expanded upon by Renzulli, we alter our practices in five principle areas: content (what is taught), process (how it is taught), product (how students relay learning), classroom environment (the setting), and the teacher (who is doing the teaching).

There are several factors that we must focus on in order to differentiate these areas. First, and perhaps the most obvious, is readiness level. All students enter a classroom with different prior knowledge, making them more or less ready to apply a concept (thought not, it should be noted, more or less able). For example, in a math class one student might recall the formula for area of a circle while the other needs to be refreshed on this concept. Both are capable of finding the area, they simply have different needs in order to be ready to do so. Another important factor to consider is the multiple intelligences of students. Currently, Howard Gardner (with Gary Harm’s adaptation) identifies eight major styles of learning. These include everything from interpersonal learners to spatial learners to naturalistic learners. Each has specific strengths and needs, but all must be accommodated for in order to create a learning environment in which all students can thrive. Finally, content must also be differentiated for student interest. Once a student is personally invested in an issue, their
chances of success increase dramatically. Student interest is perhaps one of the most important (and also one of the most overlooked) aspects of differentiation.

Though I did differentiate the content within this exploration, those changes were minimal. Since the idea was that I wanted to present the same material to various classrooms, curricula was changed mostly to adhere to grade level and not to actual individual students. I also differentiated the product similarly for all three school districts. However, I made several decisions in altering the process, classroom environment, and my own role during the course of this project. Some of these choices were active, while many others were subconscious instinct; but all contributed to the overall experience of differentiation. What is important to note, however, is that differentiation is not just change (like I might have originally claimed) but personalized change for real, individual students.

Methods:

The original foundation of this study was a common unit plan entitled “Green House.” It was necessary to choose a concept which multiple grade levels could explore, therefore the unit was founded in geometric principles and could be used as an introductory exploration, challenge project, or review assessment. It focused specifically on the Michigan State Standards for 8th grade and Geometry in volume and area while addressing additional objectives of group collaboration, critical thinking and problem solving, and environmental education. The unit was prepared as a three day lesson, though it could be extended for additional student support.

The first day of the lesson was designed to cover the topics of finding area and volume in rectangles and circles. As an anticipatory set, the teacher began with a discussion
on students’ favorite games and lead in to a brief explanation of the game Sardines. A news article on public Japanese trains which fit sixteen people into one square meter followed. Students were asked to create a one meter by one meter square on the floor using duct tape and attempt to fit sixteen people within it. This inquiry led to a discussion on area and volume by asking how one could accurately calculate the number of people that should be able to fit on a train (or in a room for Sardines). Students were then given a brief review of how to calculate area and volume using the “Geometry Cheat Sheet” and direct instruction which allowed them to recall and record visual depictions, variable descriptions, and equations of volume and area properties. Following this, students were broken into groups and asked to find how many people could potentially fit into the classroom. After giving time for this exploration, a discussion was held on the process and critical thinking used by different groups to answer this question. Before leaving the class, students were asked to record their favorite and least part of the lesson and one suggestion for the following day.

The second day, students were to begin the “Our House” challenge project. Images were shared of houses from the United States and around the world: Bedhouin huts, igloos, misshapen apartments in Japan, etc. Students were then shown images of eco-friendly houses and the techniques used to make them so. A discussion was led on the benefits of being eco-friendly, after which students were broken into groups of approximately five. (Groups were chosen differently in all three classrooms according to the needs of those individual schools.) These groups were asked to design their own eco-friendly house which met certain volume specifications. In order to make them ‘eco-friendly’, the houses were built out of cans, cups, and recycled boxes of varying size. During this lesson, students were to choose their materials and complete their blueprints for the house, including finding the
volume. While the final product was always a blueprint, calculations, and the house itself, the product was still differentiated. House designs were created on student choice and so students inadvertently differentiated for their own readiness level and interest. Also, limitations were placed on the project in order to create a challenge and tier learning.

On the final day, students were to physically construct the house. They were encouraged to add color, decoration, and personal touches to the home. Whereas more mathematical-logical and spatial learners may have thrived during the early part of this project, these artistic skills relied on the strengths of visual and artistic learners. A discussion was then conducted on the differences in the houses, the importance of environmental awareness, and the highlights and challenges of the project. Again, this use of group discussion appealed to more interpersonal learners while intrapersonal learners could share their thoughts through the exit survey. Students were asked to fill out a final survey evaluating their experience during the “Green House” project.

The exit questions, including the survey, were then collected as data for the experiment. All blueprints and Geometry Cheat Sheets were collected to assess student understanding of volume and area. In addition, photos of the houses were taken in order to evaluate their relevance, creativity, and visual display of concept comprehension.

The Schools: An Overview

The first school in which I taught this lesson was Alternative School A (a pseudonym) in Ypsilanti, Michigan. Alternative School A (ASA) is an alternative combined middle and high school which serves students from every district in Washtenaw County. Approximately 120 students attend ASA per year (though not usually for the full calendar year) and its focus
is on personalized education and choice. ASA originally began as a school for at-risk students and prides itself on being “a chance, not a punishment.” In addition to teaching core subjects and a few electives, ASA focused strongly on teaching respect and conflict resolution skills.

There are benefits and challenges to ASA that are very different from a traditional high school. First, the class size there tends to range between five and ten students, allowing more individualized attention. However, because ASA is noncompulsory, the actual attendance of a class tended to range between one and seven students. Also, since students were constantly coming in and out of different school districts, no set curriculum could be established. I spent my time at ASA in their sole mathematics class. There, a class period might hold six students: two working on a seventh grade level, one in Algebra I, two in Algebra II, and one in Precalculus. Classes varied strongly from period to period, and the constant changes in enrollment caused even more changes in the classroom curriculum content. Instruction therefore followed the student, not the class, and there was a heavy emphasis on personal in-class study. In the class that I worked with for this project I had three students, all of whom have been renamed for this study. Simon was studying Algebra I, John Algebra II, and Dan Precalculus (the most advanced mathematics course ASA offered). Such a small class size and varied knowledge level led to an immediate need for differentiation.

The second school I taught in is a public charter school in Inkster called Grand School (a pseudonym). Grand School is a Pre-Kindergarten through 8th grade school focused on “educating the whole child” through hands-on and experiential learning. With a population that is approximately 70% African American and 20% Caucasian, it posed its own
racial diversity challenges and questions. Originally a relatively elite elementary school, academics in the public Inkster school system had led many parents to look elsewhere for their students to attend—usually to Grand. Many of the students were of low socioeconomic status and were placed there in the hopes that its superior status would help alleviate some of the racial tensions of the area. With a strong focus on community and real-world exploration, Grand has showcased itself as a school diversity and learning.

In Inkster, I worked in a classroom of “mid-level” 5th and 6th grade students. It was a class of average size (approximately twenty-three students a day) and younger than I was accustomed to teaching. The difference between the 5th and 6th grade students was also prevalent, both socially and mathematically. At such a critical age, development of basics skills, such as following directions and thinking intuitively, vary greatly from student to student. Though their enthusiasm helped to deter many obstacles that may have lain in their way, the age and diverse population of the classroom caused the biggest differences in my differentiation.

Finally, I taught in the more traditional Bluefield High School (a pseudonym). Bluefield High School (BHS) supports approximately 1,875 students. Though racially and socioeconomically diverse (nearly 50% African American and 50% Caucasian, with most students receiving free or reduced lunch), administrative and structural guidelines create a strict policy with little room for movement. Most general courses (Algebra I and Algebra II, for instance) have a set curriculum that all teachers follow. For my purposes, this presented a problem in that my students were very accustomed to mathematics that was formulaic and focused on correct solutions. However, there was also little difference in the readiness level from one student to the next, making tiering an easy activity in this particular school.
During the fall semester of my fourth year at Eastern Michigan, I observed in several classes at BHS. After some deliberation, I chose to present my project in a “Senior Math” course. This was the first year that the semester long course had been offered, in response to Michigan’s decision to enforce a law requiring that students must complete four years of high school math. Senior Math was designed for those students seen as “unmotivated” or “low level.” There were no exams and homework was rarely assigned; instead, students were given ample time to complete their work (usually small math modeling projects) in class. Though there were approximately 26 students in the class, attendance was usually around 21. Despite the fact that the class was made up entirely of 12th grade students, their supposedly low retained knowledge and motivation made them a prime group to enact the project with. Furthermore, the fluidity of the schedule and the wide range of their interests made the classroom an intriguing challenge.

**Alternative School A—Trial and Error**

Due to my presence in the classroom, I was already acquainted with the students and resources at ASA by the time I began teaching my unit there. I was able to make several immediate changes to the curricula that centered primarily on the fact that my class at ASA contained only three students, all of whom were working at extremely different levels. I altered the content for their readiness levels, adapted my technological expectations, and tossed out the idea of group work—obviously, we would either be working as a whole class or individuals regardless of who was present.

I felt comfortable with them because I had already been working with these students for some time, observing and tutoring in their classroom. What I felt less comfortable with
was my role as a teacher. It was, after all, only the second classroom which I had spent a considerable amount of time in and the students at ASA can be an intimidating cohort to a beginning teacher. My insecurities undoubtedly became the focus of my desires, as what I subconsciously desired from ASA was very specific (and, in retrospect, very self-centered). I wanted my students to learn by doing, to enjoy a mathematics project, and to like me as a teacher.

My wishes were nearly as difficult to grant as they were to acknowledge. When I began teaching the unit, the introduction was fairly smooth. As I had planned, we created a one meter by one meter square and discussed the difficulty of trying to fill it with sixteen people. While my students were quick to bluntly reason that “Asians are smaller,” they still had difficulty imagining so many people in one place. We focused on the Geometry Cheat Sheet and briefly reviewed the concepts. Dan was eager to supply what he remembered of the formulas, while John and Simon simply followed along. This apathy concerned me and, worried about boring them, I moved on to having them try to calculate the volume of the room. In this case, we actually found the volume of the office attached to our classroom so that we did not spend an inordinate amount of time measuring the room when the focus was truly on the calculation process.

In the end, though our calculations were slightly skewed, we had a (mostly one-sided) discussion on why our expectation for the amount of people that could fit in the room was so large. While Dan supplied the idea that we had not accounted for the room around people or if they could be piled on top of one another, it was difficult to encourage John and Simon to participate. This was frustrating. I was enthusiastic and encouraging and truly loved my subject, but there was still a vast chasm of difference between my expectations and the
student's participation levels. Slightly downtrodden, I allowed them to return to other classes early and began reflecting on what had gone—if not wrong—then not-quite-right.

On the second and third day, Simon did not attend school. I continued on regardless, and John, Dan, and I went through the slides briefly. I pointed out that people in other locations often had different needs and thus, different houses. While I found this concept both interesting and also relevant to my differentiation project, John announced several times that other people were "stupid" for living without our technology. Despite my attempts to curtail this opinion, he remained disagreeable. Unenthused to argue the point, I moved on to the project explanation. Though I offered the pair the option of working together, they declined due to their differing ideas and goals. I wanted them to make this choice independently in order to encourage ownership of choices, and therefore accepted their decision.

Dan immediately set off to create a house made entirely of cylinders, spending most of the period calculating their volume and choosing to focus on building the next day (as I had intended). The individual choice involved in the product allowed Dan to challenge himself. Using only cylinders made both the mathematical and architectural aspect of the project more complex, which effectively tiered his learning. John, however, was more standoffish. He worked slowly, taping things together before measuring them and leaving the classroom to wander down the hall on several occasions. At the end of the class, still unsure of myself and what direction to take with the project, I asked both students to leave me with suggestions for the followed day. Though John instead asked to be excused to another room, Dan stated, "I loved instruction + project explanation. Didn't like failure to be more stern & assertive."
When I began working at ASA, I had three goals. First, I wanted to differentiate my curricula to the point where all of my students learned something new about mathematics or problem solving. Second, I wanted to show them that mathematics could be fun and relevant to their real world. But third—and this goal was more subconscious than acknowledged—I wanted the students at ASA to like me. I wanted them to like my lesson and my unit.

This is not an unexpected goal. In fact, most pre-service teachers would love to be liked by their students. After all, this is why we begin this job: we truly love working with adolescents. It is not an impossible goal either, since thousands of teachers around world are liked by their students. But the relationship between teacher and student is not about being best friends; instead, it is about respecting each other and utilizing that respect in order to foster education and growth in both parties. I had been told this before, of course, but it was not until confronted by a student about this point that I truly began to realize it. To John, I was a hopeful college student with a project and not a lot of credibility. On the final day, however, I took my first step as an educator who listens and came in prepared to be a Teacher, not just a girl in front of a chalkboard.

Miracles did not happen instantaneously, but I did not expect them to. Instead, I discussed Dan’s project with him briefly, reassuring him that was all well, before sitting down with John. Despite his initial reluctance, I pushed gently, guiding him slowly through the steps of finding the volume of one shape before having him do the next. I did not let him refuse and I did not do his calculations. Together, we worked out how to measure his house without dismantling what he had already begun. I encouraged his artistic skills, as his model was distinctly unique, but I also asked him indirectly to show me his mathematical comprehension. Their final evaluations reflected our experience. Dan liked “the fact that it
was hands-on and it was a creative way of learning” and found nothing frustrating. John’s responses were succinct, stating that he liked “learning about volume” but that he did not do his best. While, at the end of the day, all I really had were two completed projects and a few comments on a survey, I was also satisfied. Unlike the first two days of class, John did not ask to leave early. Instead, he stayed to add a few finishing touches on his house and, when the bell rang, left me with just a short nod. It was all the affirmation that I needed.

Grand—Doing it by the Book

At Grand School, where I taught in May of 2010, I was less comfortable. The teacher I visited I knew through my thesis advisor and, because of time conditions, I was not able to visit her class until the day I presented my material. I’m a relatively quick study, however; and I assumed that having already taught the lesson once at ASA, 5th and 6th graders couldn’t be so difficult. I had made several changes for them as well by cutting out any discussion on surface area, adapting to their limited technology, and simplifying the language on anything I was presenting to them. I arrived before the class began, briefly discussing its dynamics, “problem students,” and what to expect in general from middle school adolescents with the teacher. Though I was warned that there was one definite problem student (referred to here as Damien) and that the students were often extremely boisterous and talkative, I was confident. After all, I had “differentiated” by the book and learned the importance of being respected—surely there couldn’t be too many problems.

I could not have been more wrong.

That day, I learned exactly three things. First, 5th and 6th graders, while very enthusiastic participators, are also extremely loud. And emotional. Second, they do not
really know what volume is (in fact, they had only just finished learning long multiplication when I entered their class). Finally, like secondary students, they struggle working in groups; not, however, because of an imbalance of workload, but simply because they are so young. Their collaborative social skills are still in development and not nearly as stationary and practiced as those of secondary students. This made it far more difficult to differentiate for them.

The lesson did not go horribly awry. I had plenty of willing volunteers to help me create and fill our square. Several students had played Sardines and were eager to share the experience with their friends. They had even heard of area and volume before, and were able to follow along as we covered the Geometry Review Sheet. It was when we began trying to calculate how many people would fit in the room that chaos ensued. I grouped them with those they were sitting with, assuming that this would be tolerable to everyone. I quickly learned, however, exactly who did and did not like their seatmates. Furthermore, I learned that meter sticks make great swords or walking canes and that trying to figure out what to measure when finding length, width, and volume is inexplicably more difficult for a 5th grader than a 6th. I wound up allowing the students to work with whom they wanted for the day and made a short announcement explaining exactly how to measure the room before going to each group individually to assist them. Cylinders were also a challenge, so we simply made people into rectangular prisms. I was unable to assign groups that mixed readiness levels to balance this issue because I was not familiar with my students. In the end, we worked with one group’s data and I chose volunteers to carefully go through the long multiplication necessary to calculate volume. We ran out of time before we could find a
proper estimate for the people that would fit in the room and I went home sure of one thing: Grand was not what I had expected in the slightest.

I made changes again. I came back armed a new sheet for them, outlining exactly what they had to hand in to me: the calculations for the volume of five boxes, multiplied and totaled by hand. My directions were incredibly specific and focused primarily on process while glossing over the final product. With assistance from their teacher, I created groups made mostly of tablemates (with a few small changes to accommodate some of the problems I had learned of the day before). Most importantly, I arrived with boatloads of energy, now aware that it was necessary in such a boisterous classroom.

Again, however, there were issues. First, running even a simplistic discussion is infinitely more difficult with those who wish to share all of their opinions, all of the time. I handled this with a few reminders to raise your hand and several rounds of “If you can hear me, clap once.” I thought, as we moved into group work, that all seemed to be improving. Yet as I made my rounds, I quickly had to (re)enforce the fact that we were using centimeters, not inches. And that the group roles were helpful so that you stayed on track, and did not necessarily indicate that you were born to be a drummer/singer/manager in real life. And that when we measure a cereal box, chances are none of our measurements are going to be the same—if they are, we probably have remeasured a side instead of finding the third. Many of these issues could be explained with a brief tutorial, but the one thing I struggled most with was the social dynamic. In particular, Damien’s group had difficulties working together, ending with one girl nearly in tears before I was able to sit down with her and encourage her through the rest of the day.
On Day 3, I admit, I gave in. I allowed them calculators to check their work and to speed up the process, glossed over inconsistencies in the mathematics, and allowed one student to switch groups. They presented their houses with lopsided enthusiasm and I had them fill out a simplified version of the Final Evaluation. I learned from the evaluations essentially what I expected: that they liked the project (73% “Strongly Agreed” that they would recommend doing the project again), but that their main focus for the time had been the fact that they did not like the group work. Nine of my fifteen students either reported that some aspect of group work was the “most frustrating” part of the project or that it was “something they would change.” For instance, one student told me that “working together” was the most frustrating part of the project, and another shared that they would change “the people.”

There was an important lesson to be learned here. At Grand, I changed things. I did exactly what my Assessment class instructed by adjusting the curriculum standards for their grade level, developing a pre-activity that allowed everyone to be on the same page, and constantly re-teaching difficult concepts. I also acted as a teacher, not a college student. The age gap assisted me with this immediately, but I adapted my authority to fit the enthusiasm and energy of the class. What I did not prepare for was the fact that I did not know who my students were.

If you do not know the people you are teaching then you can make as many changes as you want, but you cannot truly differentiate. I could not assign them proper groups, challenge students who already had a firm understanding, or reassure those who struggled with their partner or the math. I made the incorrect assumption all students were of the same readiness, had an interest in the environmental big picture, and were capable of identifying
their own strengths (and thus learning profile). I did not even know their names, much less how best to support and encourage them in their educational growth. Luckily, their eagerness saved the unit and it finished with several complete (if hastily taped together) environmentally friendly houses. I doubt, however, that they truly learned much of anything from the experience. These students most definitely liked me—I was new, and fresh, and let them color and do math at the same time. They respected me as well, mostly because our age difference was vast enough that they never recognized the fact that I was barely an adult and hardly a capable teacher. But they didn’t know me, and I most certainly didn’t know them, and what kind of relationship—or education—can be built on that? You can make dozens of book-perfect alterations, but differentiation can only happen when you truly know your students.

Bluefield—An Experiment in Listening

It was some time after teaching at Grand School before I worked with Bluefield High School. Communication difficulties and the summer break meant that it wasn’t until early October that I taught at BHS, and already I had grown as both an academic and educator. I had spent the summer working as a teaching assistant and counselor at the Summer Institute of Mathematics at the University of Washington, a camp for mathematically gifted high school students, where I had rediscovered that the most fascinating and relevant aspect of math is not its application, but the act of solving problems. In addition to this, I was in the process of taking Reading 311 (Teaching Reading in Secondary School), which had taught me (amongst other things) that pictures really do say more than words.
Before teaching the unit in the Senior Math class, I visited BHS at least twice a week for six weeks. I knew my student’s names, but more than that, I knew their personalities. While many of them did possess an attitude that bespoke of their growing apathy and arrogance towards school (a constant in any class full of high school seniors) they possessed a degree of depth that few seemed to recognize. My initial differentiation for this class was unique. I immediately chose to let them pick their own groups, scrapped the idea of roles, altered my method for reviewing volume and area, and set a new goal for the project. I decided that correct calculations and math technique was definitely important but that, particularly for this class of seniors who thought math was useless to real life and always had only one right answer, our focus would be on problem solving. This time, I had only one goal: to let them create their own answers.

The first day, I lived by the rule, “Keep your energy one step higher than you want theirs to be.” I asked for volunteers to create our square, step in to it, explain Sardines, and offer formulas. More importantly, however, was that I was careful that my volunteers all came from different cliques in the class. I knew exactly who was friends with whom—and I knew that if I could get just one of them talking, I could get a few more as well. When one student, Mandy (a pseudonym), commented that my volume formulas seemed “like magic,” I made a split-second decision to explore this avenue of thought and explain our “Magical Math Formula.” I based their understanding off of visuals that they could see and understand, offering a description for volume formulas that required nothing but pictures. Though many caught on quickly, her best friend did not. I was excited to see Mandy explaining the concept later in a manner that was correct, confident, and clear. When we asked why instead of
merely looking at what, utilizing a variety of learning styles to do so, we created understanding where before there had been only memorization.

When I had them break into pairs to calculate how many people could fit into the room, I was immediately plagued with students asking me, “Is this right? Are we doing this okay? What do we do next?” I was careful to never answer with either a yes or a no. Instead, I asked my students questions in return: “Why were they doing it that way? Did that make sense? How did they get there? What if this happened?” Every single group went about things differently. One explained to me that they had decided that the height of the room should really only be considered as about 6 feet, since it wasn’t like people were going to standing on each others’ shoulders. Another told me that they were thinking about it liking piling bodies on top of one another. A third calculated the volume of a person and then added on a little extra to give them a “personal bubble.”

At the conclusion of the hour, we gathered back for a large group discussion where they shared both their different answers their reasons for them. A heated discussion on the best methods and solutions grew and, in the end, they turned to me for the “right answer.” I explained to them that they were all viable, as long as you had a process and a reason for it. Mathematics is all about critical thinking, not solutions, and every student had impressed me that day in class with their unique approach to the exploration. Some protested (“But what did you get, Ms. Manes?”), but many seemed to mull this idea over. As a final gesture, I asked for suggestions for the next class, intent on learning from my experiences at ASA and Grand. This time, I would listen to my students.

I mixed things up on Day Two. Borrowing an idea from Reading 311, I began by having each student draw a quick picture of a house before showing it to their neighbor.
They were all nearly identical: a square with windows, a door, and maybe a chimney, bushes, or curtains. I then asked them if anyone had drawn a house that looked “like this” and promptly displayed my first image (an igloo) using the document camera. It made the impact I was hoping, as my students were now invested—both by their participation and by their surprise. We held a discussion on why it was necessary for some houses to look different before launching into a talk on how amazing the technology and innovation involved in an eco-friendly house was. By the time I presented the project to them, they already cared about it. Student interest had been created through the use of drawings, visuals, questions, and discussion, pulling on nearly everyone’s learning style. Furthermore, following their suggestions from the day before, I proposed that if everyone had their calculations mostly complete by the end of the period I would bring music and candy on Day Three. This gave me their cooperation as well as their attention. In addition, I allowed them to choose their own groups, showing my trust in their ability to act as the responsible adults they claimed to be. Finally, I offered them my example and its volume before allowing them to choose the range they wanted their houses to fit into (initially 11,000-13,000 cm cubed). This allowed them to challenge themselves, since nearly the entire class decided that my house was far too small and that they could do much better.

They worked beautifully, experience causing them to automatically assume roles in their groups and comfort with the material after having reviewed it allowing them to solve and calculate quickly. When the problem arose that reaching 11,000 cm cubed was difficult with the materials provided, we grouped back together for a discussion and chose instead to set our boundaries at 9,000-11,000 cm cubed. I also accepted flexibility. One group set up a design but protested that they wanted to bring their own supplies and therefore did not
actually start their blueprint or calculations that day. I allowed it, but only because I knew these students and that they were trustworthy. Their design, after all, was complex and required a series of shapes that I had not provided. Later, my favorite moment came when I praised a young woman named Tammy for taking a leadership role in her group and creating an elegant mathematical solution. Grinning, she announced that she “had almost felt smart for a minute.” While that may sound like a small thing, this comment came from a girl who had reassured me on multiple occasions that she was terrible at math and would never be able to do it. Even that simple statement meant a great deal. For the first time, I left Day Two feeling confident; not in myself, but in my students.

The final day, I brought in a Jack-o-Lantern full of candy and my Ipod player, set up, and let the students begin. Very shortly after, I stood in the center of the room, radio playing, and looked around at a classroom of supposedly unmotivated high school seniors who were all working. Not just working, either, but engaged: collaborating, questioning, and joking while they created mini masterpieces of mathematics and art. It was the first time in my life where I felt like a teacher, and I wasn’t doing a thing. Instead, my students were the owners of their learning.

What they presented to me was amazing. All of their constructions were mathematically sound and yet completely unique. As they held a “Show-and-Tell”, they pointed out solar panels, mills, walls of ivy, and personal additions. They had not just created boxes with a volume, but eco-friendly houses, and they were prepared to defend and explain their creations. Tammy’s group won their impromptu “Most Creative” contest and earned the rest of the candy as reward. Everyone wanted their picture taken and everyone
participated in the discussion. This was not just a math project—this was something that they were proud of, and I was proud of them in return.

Their Final Evaluations (edited yet again) were equally as rewarding. When asked whether they would recommend doing the project again, 70% selected “Strongly Agree” and 26% selected “Agree.” Nobody disagreed with the statement that the project was fun, and all but two agreed on some level that they had learned something new. When asked to freely respond with three words that described the project, the most frequent responses were “Fun” (15), “Exciting” (6), and “Interesting” (6). The students also shared that it was “informative,” “cool,” “different,” and even “work-full.” Though more than half the class told me not to change a thing, several also gave me ideas to extend the lesson. They suggested challenging students to “make the tallest tower they can without falling and calculate it,” to “make sure houses don’t just sound creative, but look creative,” and to “make them BIGGER.” Overall, this data was extremely positive. Perhaps this should not be so surprising, but in my class of “unmotivated” high school seniors it was certainly a rare and exciting occurrence.

At Bluefield High School, I was faced with another class of “challenging” students and yet wound up impressed beyond all measure. What was the difference? I did less explaining, less work, and less encouraging. In fact, apart from asking good questions and posing good problems, I did very little at all. This was key. Instead of forcing student participation, I differentiated concepts to various learning styles, acted on a spontaneous learning activity, asked students to challenge themselves, and created an environment that encouraged critical thinking above all else. In order to become a good teacher, I had to
become a good listener. In order to become a good teacher, I had to make my students the true owners of their learning.

**Looking Forward to Student Teaching and Beyond**

As an education major, you hear again and again about the importance of student ownership and differentiation. Often, however, it is lost in a cornucopia of other terms: ethnographic analysis, transformative knowledge, classroom management, prior knowledge, etc. Even when we do remember it, we see it as something we will do for the students. *We* will differentiate our curriculum for them. *We* will tier the standards, *we* will add a kinesthetic component, and *we* will bring it into the real world. *We* will give the students ownership.

But this isn’t really how it works. Imagine yourself in your college curriculum course. The professor is educating you about how to create a collaborative lesson. Which is more beneficial? The professor explains what a collaborative lesson is, the steps on creating a lesson plan for it (with verbal and visual directions), and then places you in groups to create your own collaborative lesson plans on a topic of your choice (supposedly giving you ownership and adding an interpersonal aspect) OR you are given a piece of reading material, bring it to class and do a jigsaw on collaborative lessons, and afterwards group together and discuss as a class what *you* have just learned about collaborative lessons? Oh, in the second scenario you didn’t pick the topic and you didn’t have to have a visual component, but just think about it… *You* read the material, *you* put it all together with your group, *you* discussed it afterwards. In fact, you learned how to create a collaborative lesson while participating in a collaborative lesson. *That* is student ownership. Everything you get out of that lesson is
yours. Why? Not because the professor handed ownership over to you like a glass tiara, but because you built it from the ground up.

When I began this thesis, I thought I would learn things about my students. In many respects, I have. It is certainly true that, despite geographic and socioeconomic similarities, all three schools I visited required specialized differentiation. Though I taught the same unit every time, I never taught the same lesson twice. Each required different changes, focuses, and explanations. It was possible to address environmental and social issues even in a short amount of time; but it took a combination of images, student drawings, and discussion in order to fully convey that message (and much like any other content, it must be scaled to the academic level of the students). Finally, I did learn quite a bit about how to attune a lesson to a place. I differentiated for grade level, classroom size, available technology, and learning styles. Much of what I did was make changes, however, not differentiation. In fact, it took more than six months and a classroom full of unmotivated seniors to teach me that differentiation was not about me altering the curriculum, but about giving my students the opportunity to make their own choices.

What I learned just as much about was myself. I learned that my differentiation should not come only from a textbook example, but from my students’ suggestions. I learned that I have patience and enthusiasm in spades, but that my standing as a figure of respect and authority could use some work. Most importantly, I learned that ownership is not something I can give to my students, but that it is something we gain together when I take the time to know them. As I look towards student teaching next semester, this is a concept that I will most definitely keep in focus. Eastern Michigan University has prepared me for a great deal,
but with every class full of new students it is absolutely vital that I focus on one skill: listening.

Addendum – Post-Student Teaching Reflections and Recommendations:

There is a Latin proverb that states, “By learning you will teach, by teaching you will learn.” This is certainly a concept that has been true for me. This semester, I began my student teaching in a large public high school in Metro Detroit. I was given the unique opportunity to work with two cooperating teachers, both in mathematics. The first taught Algebraic Foundations (a supplementary course for “at-risk” Algebra I students) and Pre-Calculus while the second taught Geometry. Both teachers helped me learn a great deal, but one class in particular taught me more than I ever could have imagined.

In my student teaching, I worked with two classes of Geometry. The first was a fairly typical classroom of thirty-seven in terms of race, gender, and readiness level. The second, however, was a co-lab Special Education course. Of my thirty-one students, twelve were specifically Special Education, identified as such for a various reasons (including but not limited to: ADD/ADHD, math learning disabilities, Oppositional Defiant Disorder, and Asperger Syndrome). I had little experience with Special Education and thus was at first concerned with my ability to act aptly as their teacher. In addition, most of the rest of the class was also considered “low level,” meaning that they were generally students who either received constant disciplinary action or who had finished the previous semester with a “C” or lower. Though I cannot be certain how much these students have learned from me, I am absolutely positive that they have taught me more than any other class.
I did my best to keep what I learned from this thesis in mind as I began teaching. During my original observations, I did not simply sit in the back and take notes. Instead, I circled the room, asking questions that related to math and questions that didn’t. By the time I took over the class entirely I was already familiar with both my students’ readiness level and their personalities. Most of the class transitioned easily into my enthusiastic, question-based style of teaching. I did my best to incorporate a great deal of kinesthetic and visual learning, shifting between direct, inquiry, and collaborative lessons. I also had four very advanced students in my class and often presented them with a choice of alternative assignments or placed them in a group together and gave them challenge questions. Most of these opportunities were optional, but my students rarely refused them. In fact, when I began giving these choices to the class as a whole, several unexpected students opted for more challenging problems, which both surprised and encouraged me.

There are two areas, however, where I struggled a great deal. The first lay in my expectations for the students. I do not believe that there is a wall to student potential. In specific, I do not believe that any student has a point in mathematics where they simply cannot learn anything else. My cooperating teacher would argue otherwise, which has been a point of frustration for me this semester. Yet she is not the one who ultimately needs to know that I believe these students are capable—they are. In the beginning of the semester, I heard the phrase, “I’m just not good at math” more times that I could count. I haven’t heard it recently. That is not to say that all of my students have suddenly become math prodigies, but rather that they have accepted that such a statement will always be followed by a series of questions from me. More importantly, they have begun to see that, when asked the right questions, they almost always reach a good conclusion. Verbal encouragement has been one
of my favorite tools this semester, as has a very Socratic method of teaching. Many students have found me at their desk because they have claimed they do not understand and are not participating, only to have their eyes light up in surprised understanding after a few minutes of individual questions. I know that many of my students are still struggling with mathematics. Yet, I have seen just as many raise a tentative hand in the air or explain something quietly to their group who, in the beginning of my student teaching, would have merely ignored the concept altogether.

My second biggest trial has been differentiating properly for this group of individuals. Most of this is simply because I am a student teacher, where the mountain of paperwork required for Eastern and the fact that it is not my own classroom has made it difficult to find time or ways to do what I think is best. Part of this, however, is due simply to the fact that this class is high-strung and very often I am not as much of the authority figure that I still need to become. I have had to take baby steps. This class is not used to being treated like they are actually in high school. They are unused to collaborative and inquiry lessons, as their “low level” and “disciplinary problems” usually result in an attempt to force feed them formulas and theorems instead of concepts and applications. When I first suggested doing collaborative work, my cooperating teacher outright told me that it would not work. Her assumption was correct in that the first time, it was chaotic. If it at first you don’t succeed, however, you try again, so I reorganized groups, specified directions, and placed the responsibility for the group on everyone. The next time it went better. The third time, it was almost productive. Now, I have a young woman who has a math learning disability performing better than most of the class because her group collaborates so well. They are a
delight to observe, since they balance each other’s strengths and weaknesses in a way that is helping all four of them to excel beyond anyone’s expectations.

I know that I have not been the perfect student teacher; but it is only my first semester, and I have many more to learn from. These students have taught me yet another lesson: slow and steady wins the race. Sometimes this has meant expecting something of them that someone else might not have recommended. Sometimes it has meant giving in to a mild amount of chaos for one lesson in order to actually see them think for themselves. Sometimes it has meant, five minutes into the class, changing everything about the next two weeks because a germ of an idea that will help these students has suddenly occurred to you. It is all about small changes. You might not be able to layer your curriculum from the first day, but you can give your students an option for the final project of a unit or the homework for the night. You might not have everyone raising their hand for every question, but you can make a deal with a student so that their calculator being turned upside down means that they are prepared to have you call on them. You might have to spend ten minutes asking questions in order to get students to reach their own conclusion instead of feeding them a formula that could be written in thirty seconds. Keep in mind, however, on those days when you come home from student teaching feeling like absolutely nothing has gone right, that teaching is a process, not a product.

Be honest with yourself for a moment. In ten years, do you really expect a student to remember theorem “x” or the main character in book “y” or the exact outcome of battle “z”? Did you remember it before you planned the unit? Teaching is about encouraging your students to become goal-oriented problem solvers with a respect for every person, including themselves. If one lesson or topic or even chapter goes poorly, then you learn from it. You
don’t make the same mistake twice (or at least, not three times). You listen and change, again and again and again, and you never stop because that is what a reflective practitioner does. A teacher once told me that, every year, their ultimate goal is do one thing better. I do not remember the teacher or the setting or the day, but I remember that idea. It is one I am determined to live by.
APPENDICES

Bibliography


<http://jte.sagepub.com/cgi/content/abstract/58/1/36>.
## Timeline

<table>
<thead>
<tr>
<th>Day 1</th>
<th>Lesson</th>
<th>Goal</th>
<th>End Product</th>
<th>Materials Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Don’t You Forget About Me: A Review of Perimeter and Volume</td>
<td>To ensure that all students have a working knowledge of how to calculate the perimeter and volume of rectangles and circles</td>
<td>Business card cube, Geometry Cheat Sheet</td>
<td>Business cards, toilet paper rolls, rulers</td>
<td></td>
</tr>
<tr>
<td>Day 2</td>
<td>Our House: Creating a Plan for the Recycled House</td>
<td>To create a plan for the construction of the house, including calculations</td>
<td>Blueprints, Calculations</td>
<td>Graph paper, calculators, rulers, materials, “My House”</td>
</tr>
<tr>
<td>Day 3</td>
<td>We Built this City: Construction and Evaluation of the Project</td>
<td>To build and decorate the house, and to discuss its significance in the bigger picture</td>
<td>Recycled House, Student Evaluation</td>
<td>Boxes, cans, toilet paper rolls, rulers, construction paper, markers</td>
</tr>
</tbody>
</table>
Don't You Forget About Me
A Review of Perimeter and Volume

I. Framing the Lesson

The purpose of this lesson is to review how to find volume and perimeter of two basic shapes: rectangles (cubes) and circles (spheres). This is an essential part of the geometry curriculum that is generally learned early on, and therefore it is expected that the students will already have some familiarity with the subject. However, it may have been weeks, months, or even years since students last dealt with perimeter and volume, and so it will be essentially to spend a day ensuring that every student understands the rules and formulas for volume and perimeter.

Lesson Objectives – Michigan Standards

Students will be able to:
1. Calculate the circumference volume of a given circle (G1.6.1)
2. Calculate the volume and perimeter of a given rectangle (G1.4.1)
3. Calculate the volume of a cylinder (G1.8.1)
4. Differentiate between rectangles (prisms) and squares (cubes)
5. Create a shape that meets a given volume requirement

Materials Needed

Business cards
Toilet paper rolls
Paper
Pencils
Calculators

II. Engage

The teacher will begin by telling the students “Have you ever played sardines? That game where you play hide and seek and all wind up in a tiny space? Well I was just thinking—how many people do you think we could fit in here? I mean, if we wanted to play sardines or something, how many people could we fit? 40? 60? 100?”

Students should then make a few guesses and the teacher will write them in the corner of the board. She will then say, “Well, I think I know a way for us to find out. Or at least for us to figure out a pretty good estimate, and then we can see whose guess is closest. Maybe they could even get a prize.”

The offer of some sort of prize should motivate the students, and the teacher will have candy or some other token on hand for the “winner” of the estimation competition.
"Well, I have an idea as to how I would figure out how many people could fit in here, but you all might have some good ones as well. Any suggestions? How do you think we could estimate how many people would fit in the room?"

The students should then make suggestions, which hopefully will lead to one of them pointing out that this is essentially a question on volume. If not, the teacher will have to bring it up herself, but the assumption is that the students will recognize this fact.

"Exactly! This is just a volume question. What do you remember about volume?"

The teacher will then lead a short discussion on volume, listing what the students remember on the board.

**III. Explore/Enable/Explain**

Once the discussion has concluded, the teacher will pass out the Geometry Cheat Sheet (attached) so as to help students cover the most important aspects of the lesson: the volume of rectangular prisms and cylinders. In doing so, the teacher should cover:

- What it means to be a rectangle
- How to find the perimeter and area of a rectangle
- How to find the volume of a rectangle
- The definition of the radius of a circle
- How to calculate circumference
- How to find the volume of a cylinder

This part of the lesson should take no more than fifteen minutes. The teacher should be sure to frequently ask questions for ideas on filling out the sheet and to ensure that all students are on track.

**IV. Enact/Evaluate**

Students will then be broken in to four small groups (based purely on location in the classroom). Each group will be given a stack of six business cards and a ruler and asked to create a cube and give both the perimeter and the volume of the cube. The students should be given approximately five to ten minutes to do so, and this should give them some hands on practice with rectangles. Once everyone is finished, the teacher will draw attention to the board and get student support in showing how to find the perimeter and area of the cubes. She will then pass out cans/toilet paper rolls and ask students to find the circumference and volume. Similarly, students will be given some time before coming together to give their solution.

Following this, the teacher will declare, "Okay, I think we're ready to figure out just how many people we can fit in this room. Now, we already discussed that this is both a perimeter and a volume question, so I thought we could solve it two ways."

The teacher will then ask each of the four groups to take on one of the following tasks:

1. Finding the perimeter of the room
2. Finding the volume of the room
3. Finding the "circumference" of a person
4. Finding the "volume" of a person

Note that more struggling groups could be given the task of finding perimeter, and students with stronger skills could be asked to find the volume of a person.

Once the four groups have established their data, they will be asked to write it on the board. The teacher will then ask, "Okay, so now that we have all of these values, what do they mean? How do we calculate how many people we can fit?"

She should then continue to ask questions until the students can lead her through the algebraic steps of using perimeter and circumference vs two volumes to determine how many people can fit in the room.

V. Extend

Once it has been established how many people can supposedly fit in the room, the teacher will ask, "Well what do you think? Which estimate is more reasonable? Why?"

She will then ask the students to return with their cheat sheet the next day, and also to respond on a piece of scrap paper to the following question:

• List one new thing you learned today
Geometry Cheat Sheet

Rectangles

<table>
<thead>
<tr>
<th></th>
<th>Area</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formula:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Picture:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Circles

<table>
<thead>
<tr>
<th></th>
<th>Area</th>
<th>Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formula:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Picture:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Our House
Creating a Mathematical Blueprint for Your Recycled House

I. Framing the Lesson

This cooperative project is designed to challenge students to utilize several basic geometry skills in order to create their own unique “house” which fits a certain set mathematical guidelines. This project will directly follow the lesson Don’t You Forget About Me: A Review of Perimeter and Volume, where students will have been given the chance to recall how to calculate the perimeter (or circumference) of rectangles and circles and the volume of rectangular prisms and cylinders. In other words, it is essentially Day 2 of a three day lesson. In this portion of the lesson, students will be designing their house from the provided materials and doing the necessary calculations to ensure that it meets the project requirements.

Lesson Objectives – Michigan Standards

Students will be able to:
6. Calculate the circumference volume of a given circle (G1.6.1)
7. Calculate the volume and perimeter of a given rectangle (G1.4.1)
8. Calculate the volume of a cylinder (G1.8.1)
9. Differentiate between rectangles (prisms) and squares (cubes)
10. Create a shape that meets a given volume requirement

Materials Needed

Graph paper
Calculators
Rulers
Sample House
Boxes
Cans
Pencils

II. Engage

The teacher will begin by displaying several pictures of houses in different areas of the world on an overhead projector/elmolco/etc. She will then say, “All over the world, people live in really different types of houses. You’ve seen igloos and teepees and Bedouin huts and castles. Why do you think people start building such different homes?”

The teacher will then lead a short discussion on how geography and culture can lead to vast differences in housing. After all, it’s a little difficult to build a castle in Northern Canada and it’s even more difficult to build an igloo in Africa.
The teacher will then ask, "What do your houses look like? People in America live in everything from apartments to ranch houses to mansions. I even have a professor who lives in a Geodesic dome house!" Then, the teacher will show pictures of a few eco-friendly houses. "These houses are all designed from materials that are eco-friendly or use natural resources in really interesting ways to help preserve the environment."

III. Explore/Enable

"For our project, we'll be making our own eco-friendly houses."

At this point, the teacher will reveal the Sample House, discussing how it has been made out of recycled (and thus eco friendly) materials to meet certain specifications just like the other houses.

The teacher will then pass out the project Description and Checklist, taking several minutes to go over them. Students will then be placed into groups based on a random color selection: each project Checklist will have a different color at the top, so students will then get in to their groups based on this color. This way, students will be broken up by random selection and so the assumption is that groups will be made up of students at a variety of readiness levels and with different ideas and opinions. However, since the lesson will take place well in to the year, most students should also already be familiar with their classmates and have some type of community bond.

Students will then be given the Role Sheet and asked to have every group member chose a role. They will also be given graph paper to be used for their house blueprint, and the available materials will be placed on a desk somewhere in the classroom. Students will then be given the majority of the class time to begin planning their houses. At this point in time, the teacher will circle around the room, answering questions and making suggestions.

IV. Evaluate/Enact

Students should be warned of the oncoming conclusion of the class about 10 minutes prior. They will be told that they will given the opportunity to finish their plans the next day if needed, but that as much as possible should be done today. They will also be asked to respond to at least two of the following three questions before leaving the class:

1. What do you see as the biggest challenge facing you in this project tomorrow?
2. How could this project help you in your everyday life?
3. Do you think students in a different geographic location would be designing a house similar to yours? Why or why not?
Our House
Challenge Project

Today, we've taken a look at some really crazy houses, from igloos to geodesic domes to underground hobbit houses. Now, you'll be given the chance to build your own eco friendly house! You and your band will be creating a unique building out of recycled boxes, cans, and other materials. However, like any house, there are a few design specifications you'll need to meet... and you'll want to put your own spin on things!

The Intro: Day 1
- Choose your materials.
- Make a blueprint. Check and make sure that your house is meeting all of the specifications!
- Do your calculations. Don't forget, you need both perimeter and volume. Show your work!

The Middle: Day 2
- Build that house!
- Make sure your house is stable (we wouldn't want the tornadoes to knock it over). Ie: Can you move it from one table to another?
- Add that personal touch to your house. Is your group name on it? Is it colorful? Does it feel like home?

The Finale: Day 2
- Show off! Let other people know what's so special about your place, and take a look at theirs too!
- Participate in the class discussion on the project. Make sure your voice and others' is heard.
- Evaluate your group members (including yourself). What roles did everyone take? Was there equal participation? How did you work within your group? (You can do this with the Group Eval Sheet)
- Reflect on what you've learned: the math, the issues, and how they all tie together.
- Make sure you answer all the questions on that Final Evaluation. Be open and be honest!
Group Role Sheet

Each member needs to choose their main role in the group and write their name next to their position.

Drummer: ________________________________

The role of the Drummer within the group is to keep the beat of the group moving well. That includes watching the time, keeping track of the work being done to look out for mistakes or problems, and making sure that everyone is on task.

Manager: ________________________________

Using their cool head and sensibility, the role of the Manager it to make sure that everyone is heard. They should be careful to make sure that every member of the group is given the chance to speak and defend their point of view, as well as to make sure that the conversation stays on track.

Singer: ________________________________

As a vocalist, the role of the Singer is to act as the speaker for the group. They will be the lead presenter of the group’s final solutions to the class, and should also be willing to bring up essential questions or challenges to the material being worked on.

Guitarist: ________________________________

With their quick fingers, the role of the Guitarist within the group is to be the notetaker. Their work will be the final work turned in for the group, and they should also be the person to write out any other necessary information for the lesson.

Remember, there are no Lady Gaga solo acts in this group: instead, make sure I’ll Be There for You!
(Additional Turn-In Sheet for Grand School)

Names:

Remember, we find volume by MULTIPLYING our THREE sides together… length x width x height

Box 1 =

Box 2 =

Box 3 =

Box 4 =

Box 5 =

TOTAL =
Final Evaluation (Alternative School A)

This project applies to my every day life.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

I have learned something new while completing this project.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

I would recommend doing this project again.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

I have done my best while working on this project.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

What did you enjoy most about this project?

What did you find most frustrating about this project?

Did you have enough materials to build your house as well as you wanted?

What would have been different if you had been given more materials? Less? How does this relate to our loss of resources in the world today?
Final Evaluation (Grand School)

This project applies to my every day life.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

I have learned something new.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

I would like to do this project again.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

I have done my best.

<table>
<thead>
<tr>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
</tr>
</thead>
</table>

What did you like most about this project?

What did you find most frustrating about this project?

What would you change if you were going to do this again?

How can this project relate to being ‘green’ or eco-friendly?
Evaluation Results: Alternative School A

Day Two:

What did you like most about today? What did you like least?
Student 1: I liked the assignment. I didn't like the fact that we're in cope.
Student 2: I loved instruction + project explanation. Didn't like failure to be more stern & assertive.
Student 3: I liked everything.

Day Three:

See above for evaluation

<table>
<thead>
<tr>
<th></th>
<th>SA</th>
<th>A</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relates to Everyday Life</td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Learned Something New</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Would do it Again</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did My Best</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>0</td>
</tr>
</tbody>
</table>

What did you enjoy most?
Student 1: The fact that it was hands on and it was a creative way of learning.
Student 2: Learning about volume.

What did you find most frustrating about this project?
Student 1: There was no frustration. It all went well.
Student 2: Building the house.

Did you have enough materials to build your house as well as you wanted?
Student 1: Yes I did and I am content with the architecture.
Student 2: yes

What would have been different if you had been given more materials? Less? How does this relate to our loss of resources in the world today?
Student 1: Yes it would have been different because we are losing trees, oil, and atmosphere which affect our planet jurassically.
Student 2: I really don't know I think my house would have been the same.
## Evaluation Results: Grand School

<table>
<thead>
<tr>
<th></th>
<th>SA</th>
<th>A</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relates to Everyday</td>
<td>4</td>
<td>8</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Learned Something New</td>
<td>7</td>
<td>8</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Would do it Again</td>
<td>11</td>
<td>4</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Did My Best</td>
<td>5</td>
<td>8</td>
<td>1</td>
<td>15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What did you like most about this project?</th>
<th>What did you find most frustrating about this project?</th>
<th>What would you change if you were going to do this again?</th>
<th>How can this project relate to being 'green' or eco-friendly?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decorating the house</td>
<td>Finding the value</td>
<td>Number of boxes</td>
<td>Building an eco friendly house</td>
</tr>
<tr>
<td></td>
<td>Not finishing</td>
<td>The house a lot</td>
<td>Cause you can make houses out of stuff you have already</td>
</tr>
<tr>
<td>Building</td>
<td>Complaining</td>
<td>The whole thing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Me being absent</td>
<td>Try to work together</td>
<td></td>
</tr>
<tr>
<td>Building</td>
<td>Nothing</td>
<td>I will be here</td>
<td>Don't know</td>
</tr>
<tr>
<td></td>
<td>The horseplay</td>
<td></td>
<td>Because we are using recyclable boxes</td>
</tr>
<tr>
<td>Building</td>
<td>Working together</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doing the math for volume</td>
<td>Finding the value</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building</td>
<td>Building</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building</td>
<td>Not finishing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building</td>
<td>Measuring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building</td>
<td>Nothing everything was easy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doing it</td>
<td>Work with friend</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>That you can make a house out of boxes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Putting it together</td>
<td>Building</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I finally got in a group and didn't fight</td>
<td>Measuring</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nothing everything was easy</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Work with friend</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Evaluation Results: Bluefield High School</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>This Project Was Fun</strong></td>
</tr>
<tr>
<td>SA</td>
</tr>
<tr>
<td>12</td>
</tr>
<tr>
<td><strong>Learned Something New</strong></td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td><strong>Would Do it Again</strong></td>
</tr>
<tr>
<td>16</td>
</tr>
<tr>
<td><strong>Did My Best</strong></td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

*Describe how you felt about the project in three words.*

<table>
<thead>
<tr>
<th>Descriptive Word</th>
<th># of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active</td>
<td>2</td>
</tr>
<tr>
<td>Awesome</td>
<td></td>
</tr>
<tr>
<td>Chill</td>
<td></td>
</tr>
<tr>
<td>Competitive</td>
<td></td>
</tr>
<tr>
<td>Cool</td>
<td>3</td>
</tr>
<tr>
<td>Creative</td>
<td></td>
</tr>
<tr>
<td>Different</td>
<td>2</td>
</tr>
<tr>
<td>Enjoyable</td>
<td>2</td>
</tr>
<tr>
<td>Entertaining</td>
<td></td>
</tr>
<tr>
<td>Excited</td>
<td>6</td>
</tr>
<tr>
<td>Exploring</td>
<td></td>
</tr>
<tr>
<td>Frustrated</td>
<td></td>
</tr>
<tr>
<td>Fun</td>
<td>15</td>
</tr>
<tr>
<td>Funny</td>
<td>2</td>
</tr>
<tr>
<td>Great</td>
<td></td>
</tr>
<tr>
<td>Happy</td>
<td>4</td>
</tr>
<tr>
<td>Hard-ish</td>
<td></td>
</tr>
<tr>
<td>Informative</td>
<td>3</td>
</tr>
<tr>
<td>Interested</td>
<td>6</td>
</tr>
<tr>
<td>Irritated</td>
<td></td>
</tr>
<tr>
<td>It. Was. Cool.</td>
<td></td>
</tr>
<tr>
<td>Laughter</td>
<td></td>
</tr>
<tr>
<td>Learning</td>
<td></td>
</tr>
<tr>
<td>New</td>
<td></td>
</tr>
<tr>
<td>Okay</td>
<td></td>
</tr>
<tr>
<td>Pickles!</td>
<td></td>
</tr>
<tr>
<td>Productive</td>
<td></td>
</tr>
<tr>
<td>Relaxed</td>
<td></td>
</tr>
<tr>
<td>Useful</td>
<td></td>
</tr>
<tr>
<td>Work-full</td>
<td></td>
</tr>
</tbody>
</table>
**Evaluation Results II: Bluefield High School**

*What is one thing you would do to improve this project?*

<table>
<thead>
<tr>
<th>Response</th>
<th># of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Don't change anything</td>
<td>14</td>
</tr>
<tr>
<td>Give a little more time</td>
<td>3</td>
</tr>
<tr>
<td>Give one more day to perfect them</td>
<td></td>
</tr>
<tr>
<td>Have them make the tallest tower they can without falling and calculate</td>
<td></td>
</tr>
<tr>
<td>everything after</td>
<td></td>
</tr>
<tr>
<td>Less time for work</td>
<td></td>
</tr>
<tr>
<td>Make sure houses don't just sound creative, but look creative</td>
<td></td>
</tr>
<tr>
<td>Make them make the houses bigger</td>
<td>2</td>
</tr>
<tr>
<td>Provide more resources</td>
<td></td>
</tr>
<tr>
<td>You did a great job</td>
<td></td>
</tr>
</tbody>
</table>
Alternative School A Projects
Grand School
Bluefield High School