Implementing Contextual Teaching and Learning: Case Study of Lynn, a High School Mathematics Novice Teacher

Heide G. Wiegel
University of Georgia

Final Report
March 30, 2003

The work reported herein was prepared in association with the *contextual teaching and learning in preservice teacher education* and *studies of novice teachers' implementation of CTL approaches in the classroom* projects at the University of Georgia, with funding support from the U.S. Department of Education, Office of Vocational and Adult Education, Contract # ED-98-CO-0085, 1998 – 2003.

Implementing Contextual Teaching and Learning:
Case Study of Lynn, a High School Mathematics Novice Teacher

Heide G. Wiegel
The University of Georgia

Abstract

This is a case study of Lynn's student teaching experience and one semester of her first year of teaching. Lynn identified her experience with contextual teaching and learning before becoming involved with the CTL project as limited, including a high school geometry class and activities in a few college math classes. Lynn completed the entire UGA course sequence designed with a contextual teaching and learning focus. Her experience with InterMath, a service learning project that included working with classroom teachers, was a very influential component of her teacher preparation and shaped Lynn's perception of teaching that includes extensive use of technology.

Lynn's student teaching experience can be characterized as predominantly conventional with CTL elements interspersed. CTL elements included writing assignments, portfolios, small-group work with presentations, and hands-on activities. Several of the factors that seemed to hinder CLT implementation for Lynn during student teaching were the use of a very traditional algebra textbook, lack of time for adequate planning, and problems with class management. Lynn, however, was generous in sharing her time with her students by being available for tutoring and by attending students' extra-curricular activities. Factors fostering CTL implementation during student teaching included the statistics textbook used because Lynn saw it as promoting problem- and activity-oriented teaching, Lynn's past experiences in mathematics, and her ability to reflect on her actions and to evaluate them in light of her goals.

Lynn was similar to many student teachers who are overwhelmed by the complexity of the daily teaching demands. What sets her apart is that she kept her goals alive, despite the difficulties she encountered. As a first year teacher, within the first month, Lynn started CTL student projects with three of her five classes and established a class website that includes, among other information, examples of the use of mathematics in the "real" world.

Background

Lynn entered the University of Georgia in fall 1998; she was admitted to the College of Education as "unspecified." Early on she worked toward becoming a teacher of mathematics taking calculus and physics in her first semester at the university. Lynn was admitted to Mathematics Education in fall 1999. In Summer 2001, after an undergraduate research experience in the mathematics department, Lynn added mathematics as a second major. She graduated May 2002 with a B.S. Ed. in mathematics education and in December 2002 with a B.S. in mathematics.

Because Lynn did not start her first teaching job until January 2003, all but one observation took place during her student teaching in Spring 2002. Lynn's student teaching assignment took place in a local high school that, because of the large minority population, is considered to be an inner city school. Lynn felt comfortable in this environment because her own high school had been a racially mixed school. Lynn knew a lot about African-American culture that, in turn, helped her understand some of her students' difficulties in school in relation to their life situations.

Methods

Data Collection

I collected the main part of the data during Lynn's student teaching experience. Lynn fulfilled her student teaching in an inner city school that was racially mixed, very much like her own high school. The school was on block schedule, that is, each course was taught daily for 90 minutes and completed in one semester. During the height of her student teaching experience, Lynn taught three classes: Statistics/Probability (seniors),

Beginning Algebra (Seniors), and Algebra 2 (mostly sophomores); the fourth period was her planning period.

I observed Lynn four times during February and March of 2002, and once in January 2003. During each visit, I took field notes that I expanded on the day of the visit. After the observations (in 2002 only), we sat down for interviews. During the interviews Lynn had the opportunity to comment on all aspects of her student teaching experience, including class management issues, parent meetings, extra-curricular activities Lynn shared with her students, and general issues of teaching and learning mathematics. I did not use a specific interview schedule because I wanted Lynn to highlight what was important to her. In April of 2002, Lynn came back to campus for an extended background interview. This interview was more structured, in that it specifically asked for CTL-related experiences in her high school and college mathematics and mathematics education courses, as well as for Lynn's view on implementing the different CTL principles during student teaching.

All interviews were audiotaped. At first I transcribed verbatim only the segments directly relating to CTL. I paraphrased general comments about school, college, teachers, teaching, the classes, etc. and expanded those segments as needed.

In May 2002 Lynn graduated with a B.S. Ed. in mathematics education but did not enter the teaching profession in the fall of that year. She was still working on her second major, mathematics, which she completed in December 2002. For the spring semester 2003, Lynn was hired by a neighboring county to teach mathematics in one of the middle schools.

Analysis

I analyzed the field notes and interview protocols using analytic induction. Analytic induction involves scanning the data, developing initial categories, and looking for relationships among those categories. Working typologies and hypotheses are developed by examining initial cases and modified on the basis of subsequent cases (Goetz & LeCompte, 1984).

In a first step, I identified and coded segments of data by subject or issue discussed; e.g., prior experience, class management, ball activity, planning. I then examined how the labeled segments related to CTL principles and strategies, and their implementation.

Recollections of Lynn's CTL Experiences

Experiences in High School

Geometry was the only high school mathematics class that Lynn identified as providing contextual learning and teaching experiences. She remembered vividly the activity of a polygon scavenger hunt that brought them out of the classroom into the whole school building and onto the school grounds. This activity stuck in her mind because it made her see mathematics around her; e.g., "I started looking at water fountains and seeing parabolas" (Interview 4/3/02). Lynn also remembered that her geometry teacher used "Problems of the Week" that often were contextual, and that they did a lot of teamwork. In summary, Lynn said about her geometry teacher, "I think she was trying to do that without knowing it [CTL]. … I think she had an intuition about how she wanted her class to be and that she wanted it to be untraditional, but she, she wasn't

saying, 'Okay I'm gonna make this contextual teaching and learning'." (Interview 4/3/02).

In general, Lynn experienced her physics classes and science academic team providing more contextual experiences than the mathematics courses and team. "Even on the math team we were so focused on doing the problems, getting the right answer" (Interview 4/3/02). About the physics classes she said, "They brought mathematics to life, even though it was a lot harder to see because everybody is intimidated by/of …word problems" (4/3/02)

Experiences in College Math Courses

Initially, Lynn could think of no college mathematics courses that she saw highlighting any of the contextual teaching and learning principles. She emphatically stated, "No math classes. None." Lynn finally mentioned word problems.

> *Maybe—the word problems. There is one thing I am struggling with as far as going past word problems and seeing them as contextual. You can't just make a word problem up and say, Oh I made this cultural—a different name that my students might relate to, instead of saying Billy Joe, if I was in an urban city I would use something like Derek or a different, maybe an African name and would be more conscious of cultures*. (Interview 4/3/02).

She wondered, "But as far as the mathematics involved, what makes a conceptualized [contextualized] word problem different from a word problem that kids are seeing from a day-today basis" (Interview 4/3/02).

Lynn identified one specific activity as being contextual. In her calculus class, she had to write Maple[1] programs that would simulate slicing a pizza in parallel cuts so that all slices had equal area, and cutting a watermelon horizontally so that all pieces had equal volume.

Experiences in Professional Mathematics Education Courses

Lynn identified several mathematics education courses that she thought had contextual elements. She mentioned that, in one of her curriculum classes, they did "a lot of self-discovery and open mathematics" (Interview 4/3/02). She characterized the activities in that course as being authentic learning because "we were discovering things for ourselves in a different way. He wasn't giving us the formula, he was having us find the solution and go backwards and see how we got the solution" (Interview 4/3/02).

Hands-on experiences seemed to be the key for Lynn to characterize an activity as contextual. She mentioned an activity in which they had measured the height and depth of stairs, and tested whether the staircase was up to code.

> *One cool activity that we did, my favorite one the whole semester, was the stair activity where we went and measured the height and depth of each stairs, and talked about the angle—of inclination, and whether the school was up to code or not. I did the exact same thing with my statistics class and, the reason I did that because now, if I walk up the stairs in Aderhold*[2]*, I think, "These steps aren't up to code"* (laughs). (Interview 4/3/02)

---

[1] Maple is a programming language used in the labs of the first two calculus courses at the university.

[2] Aderhold Hall houses the Schools of Teacher Education and Professional Studies in the College of Education.

Another memorable activity came from her statistics class in which they had measured their body parts and investigated whether "they were square."

On the other hand, if an activity was too complex, Lynn tended to dismiss it. For example, she did not see the "Ant-on-the-Wheel" activity from her second curriculum class as a model for contextual learning. This activity was an in-depth investigation of the cycloid and its component functions and required the pre-service teachers to use their knowledge of trigonometry in a novel situation. The activity also combined mathematical and physical concepts as explanatory constructs.

Lynn also dismissed her work on a unit from the textbook series Interactive Mathematics Program (IMP). The highlight of the IMP series is that the mathematical topics, concepts, and procedures are embedded in unit-specific contexts. In Lynn's unit, the framing context was the Edgar Allen Poe's *The Pit and the Pendulum* with the overarching question of whether or not the prisoner had time to escape. In order to answer the unit question, students had to extract the mathematical information embedded in the provided excerpt of the story and make some assumptions about the pendulum and different pendulums. The mathematical topic embedded in the unit was that of data spread. Lynn commented about the unit,

> *I may think about it sometimes, but I think that the whole concept was so huge, some of the concepts that we tackled were so huge, it was hard to take in a simple thing that I can go and apply to my life on a daily basis.* (Interview 4/3/02)

But she also thought that the work on the unit opened a door for her because "see, I can make connections to literature now without having to use [this unit]" (Interview 4/3/02).

Finally, Lynn never thought to mention a field trip to Washington DC the junior class had taken as part of a mathematics education CTL course[3]. On this trip the pre-service teachers' content study of transformational geometry was extended by visits to the Textile Museum with its collection of quilts and Arabic carpets, to a mosque, and to the Smithsonian collection of Arabic art. In all these exhibitions, pre-service teachers experienced mathematics in context of its use in different life situations. The trip was definitely memorable, but it did not enter Lynn's recollection of memorable experiences that were relevant to her immediate teaching situation.

CTL Courses

Lynn was one of four students who participated in and completed the entire CTL sequence and every course designed with a contextual teaching and learning focus. Upon my question of how these courses had shaped her image of teaching, Lynn responded with descriptions of the courses and the value they had for her development as a teacher. In particular, she highlighted three courses; a course on human growth and development, a sequence of seminars, and a class on academic community learning.

Human growth and development. Lynn voiced contradictory feelings toward this course. On the one hand, she enjoyed the set-up of the class because "it was like an open forum" (4/3/02). There were ample opportunities to talk, to interact with other students or the instructor, and to reflect on educational issues. In addition, the writing assignments gave her an outlet for "things that were on [her] mind a long time" (4/3/02). Although, as a mathematics person, she hated writing, she did like these writing assignments

[3] EMAT 3450: Practicum in Mathematics Education. The course was taught by a doctoral student in mathematics education who also organized the fieldtrip to Washington, D.C. A professor of mathematics, the students' geometry teacher, and I participated in the trip as faculty representatives.

because they valued what she wrote and did not criticize how she wrote. She was proud of her progress from the first to the last written reflection in the course.

One the other hand, Lynn described some of the group activity as useless; "Get into groups and talk, get into groups and talk, reflecting, reflecting" (4/3/02). She thought the group talks were not intellectually challenging enough to hold her attention. In addition, although Lynn valued the opportunity to observe instruction at a local high school, she did not always see the connection between her observations in the school and the instruction on campus.

> *Okay, we are going out into the school systems, which is great, but what are we doing in the classroom that is connecting my experiences here [the college class] into the classroom and how are we learning about all this educational psychology stuff? And I remember being very frustrated with that part of that class.* (4/3/02)

Seminars. The seminars included several fieldtrips that were memorable to Lynn. She made connections to teaching on some of the fieldtrips, but not on others. For example, Lynn reported from the visit to a children's hospital, how someone from the leadership team had highlighted how she had to develop different ways of talking, depending on the audience. If she was talking to a parent, she couldn't use technical terms, but had to communicate through pictures and everyday language. I did not see Lynn make the connection that as a teacher she would have to develop different ways of talking as well.

On the other hand, Lynn made a direct connection during a visit to a convention of technology during which one of the guest speakers highlighted the value of experience-based learning. He asked a science teacher to read a paragraph on snakes,

what a snake looks like, feels like, that it does not feel slimy but smooth. He then took a snake out of a bag, handed it to the teacher and asked, what was the better way to learn, from the reading or from holding the snake. Lynn concluded, "That's really what CTL is" (4/3/02).

Academic community learning. Lynn labeled this course as democratic because, as a class, the students decided the way they wanted to be graded and what they wanted to do. They decided to take on one large project for the semester, and the grade would come from a portfolio they would assemble from that project. Lynn thought her project was amazing because she had to write her first lesson plans, and she had the opportunity to practice networking. With two other CTL students, Lynn worked in the InterMath project[4]. Because the project is housed in the mathematics education department, Lynn got introduced to the mathematics education community before she officially started with the professional course sequence.

Lynn's service in InterMath was two-fold. First, she and her team members helped the InterMath group in that they tried out many of the items and problems written for InterMath. That is, they were guinea pigs. Second, her team was working with teachers who were learning to work with the InterMath items. Thus, the pre-service teachers were learning to introduce or explain an activity and to write lesson plans. In short, they were trying on their future roles as teachers. This service-learning project gave Lynn a lot of confidence, and it reassured her in her chosen career. It also extended her image of a teacher, in that this image now included extensive use of technology.

---

[4] http://www.intermath-uga.gatech.edu/homepg.htm

Results

Implementation of Contextual Teaching and Learning Principles

Lynn's student teaching, as revealed in the observations and interviews, can be characterized as predominantly conventional with CTL elements interspersed. In all three classes, Lynn followed the curriculum as laid out in the textbooks. Teacher presentation of new concepts and guided student input were her main teaching strategies. To this conventional framework, Lynn added tasks and activities that she characterized as having a CTL flavor, such as writing assignments, portfolios, small-group work with presentations, and hands-on activities.

Writing assignments. Lynn used two different kinds of writing assignments: articles and poems. For the articles, students had to find mathematical information outside the classroom, for example in a newspaper or on the web, and then write an article about the information they had identified.

> *The first time I assigned that I said, you gonna have to find an article in a magazine, I want you to write about the math involved, write about the statistics involved, make sure it has numbers in it because that will help you out a lot and see if they're talking about averages or different things like that.* (Interview 4/3/02)

Lynn related two reasons for the writing assignments. She wanted the students to have a mathematical writing outlet, and she wanted them to realize the amount and kind of mathematics found outside the classroom (Interview 2/21/02). At first, some articles were rather clumsy and not necessarily what Lynn had expected. For example, one of the

students from the Algebra 2 class simply described the numbers she found in an article on the Olympics, rather than analyzing the context.

> *One of the students picked out something completely random, with Olympics, which she could have really tied in with math, but she said, she picked out a person, she said, […] "The age of the person, this is a whole number," […] "This took place in 2001, 2001 has so many decades in it," different stuff like that.* (Interview 2/21/02)

Lynn assigned articles repeatedly, and the writing became a routine of which she was proud. Articles and all other homework were due on testing days. Lynn saw the articles improve, and the students thinking more critically about "government, about food, about politics, about everything" (2/21/02). For example, one student wrote an article on the USA birthrate exceeding the death rate for the first time since 1971, another student wrote on spending habits for Valentine gifts (Field notes 2/21/02). Both articles were based on information students found on the Internet (CNN.com/health and flowers.com, respectively). Lynn was particularly impressed by the work of one student who analyzed the information on the back of a baseball card and wrote the essay about the stats on the card. She was impressed because the student brought things to her attention that she had never thought of before.

Lynn got an idea about using poems from one of her classmates. She offered 5 extra points to the test score of anyone who incorporated "at least 10 bold-faced words from the chapter" (2/21/02) into a poem, and turned the poem in by test day. Writing a poem did not serve the same purpose as the essays because the students did not bring mathematics into the classroom from the outside, but it gave them a way "to express it

[mathematics] differently" (2/21/02). Lynn was surprised by the eagerness of the students and the quality of their work. The following statistics Haiku poem was written by a student who was president of the drama club and who intended to be drama major in college.

Statistics Haiku

An observation
of the double-blind cricket
reveals subtle joy

The distribution
of thin, variable clouds—
random, much like life

Each event, like the
hand's independent digits,
is disjoint, perfect

And in addition:
what's the probability
of enlightenment?

Portfolios. Lynn referred to portfolios only in connection with the statistics/probability class. Students assembled portfolios "at least two or three times" (4/3/02). For the portfolios, students collected "different activities that we had done, up to that point, that were involved in the chapter that they did" (4/3/02), including homework, the articles, and projects. Lynn referred to the grading of the portfolios as authentic assessment.

Group work and class presentations. Lynn used the jigsaw model for many of her small-group learning activities. This model fit well the purpose of the small-group arrangements: studying for a quiz or a test. If, for example, the test was over four sections of material, Lynn would first divide the class in four larger groups, each of which was charged to study one of the four sections. She would give them about 20 minutes in which to become experts on the section, "take notes, look at formulas, get examples

down, be able to teach it to other people" (4/3/02). For the second phase, students would assemble into groups of four so that the group consisted of one expert for each of the four sections. The designation into the groups of four required careful planning, which was complicated for large classes, and for classes with poor attendance patterns. In addition, some of the students did not like the small-group arrangements because "there were slackers in the group that didn't pay attention during phase one, so they didn't teach it very well in phase two" (4/3/02). Lynn realized that it would take time to educate all students to be responsible group members. Nevertheless, she liked the model and would use it again, but not make it the sole context for reviewing (4/3/02).

I observed two slightly different set-ups, although they were both based on the jigsaw model. In a review session on functions (Algebra 1), groups of students made presentations on function sub-concepts, such as end behavior, continuity, symmetry, and extreme. Each presentation included two quiz questions that the rest of the class had to answer directly after the presentation.

In another instance (Algebra 2), different groups of students would work through a section and select three problems from that section to be worked on the board. Lynn worked most of the selected problems, but asked for student questions and elicited student input. Finally, some of the hands-on activities also provided a context for setting up a small-group working environment.

Activities. Lynn tried to implement many of the activities "that we have done within my math education classes that were contextual, I tried to bring them into my statistics class" (4/3/02). Lynn was particularly fond of the staircase activity mentioned earlier. She said, "I remember measuring these, like I have an experience to connect with

the stairs that I was looking past everyday before I did the experience" (4/3/02). Later in the interview, Lynn highlighted again the importance of experience, "I think that I'm gonna relate that from my learning experience and try to transfer it so that other people can have the same experience" (4/3/02).

I observed the implementation of two activities, the *blood-type activity* and the *ball activity*. Lynn introduced the blood-type activity to her statistics class because the activity highlighted concepts from probability and statistics. She used two days, one for the initial introduction and one for the "clean-up." I observed only the second day. Lynn found the activity in the February edition of the *Mathematics Teacher.* The activity consisted of an introduction by the teacher, instructions for a survey to be completed at home before the activity, and a set of student activity sheets. Lynn assigned the homework then handed out the activity packets the next day. From what I could gather from the interviews, there was no verbal introduction or explanation of the different components.

> *I handed them out a packet, and it was directly from the magazine […]. And I thought, and I really didn't look over it that well because I thought that was pretty self-explanatory, I thought, oh cool, we get to do something with blood types, […] and I looked at it, while they were working on it, and I thought, "Oh, they can do that, they can make a bar graph*. (2/21/02)

As Lynn found out during the lesson, the activity was in no way explanatory.

> *Well, I didn't realize how un-self-explanatory it was, until they started working on it, and I had a flock of students coming up to me saying, "I don't understand this,*

this is stupid, I don't, I don't get this, why are we working on this," and they were very frustrated, and it was because of my lack of planning. (2/21/02)

For the activity, the students had to correlate and compare three sets of blood-type data; class data based collected during the survey, data collected through a random number game, and Red-Cross data provided in the activity package. The Red-Cross data were presented as percentages, whereas the survey data and the simulation data were raw data with different sample sizes. Because Lynn did not think through the activity in detail, she did not anticipate the confusion over the different representations of the data.

After the rather chaotic lesson, Lynn went home and prepared a second handout with data and instructions. She said, "I cleaned it up a lot, and I made it a lot more straightforward, and I really (with emphasis) read the introduction to this article more. And that helped a lot" (2/21/02). The next day Lynn handed out a work sheet that contained the introduction and instructions, which were more concise than in the original packet. The students read through the introduction and a brief discussion followed including what it means that two blood types match, are compatible or incompatible, and what is means to be a universal donor or receiver. She lead the class through the rest of the assignments, and the lesson ended with a survival game in which the class determined who of their classmates would have the best chance of survival in case of a natural disaster with no hospital blood supply available.

It was pure coincidence that the school had a blood drive later that week, and thus the activity provided a connection between the wider realm of school life and the more narrow life within the mathematics classroom. At the time of the interview, Lynn had no clear image of how to take more conscious advantage of this connection. In the later

interview in April, however, Lynn considered more seriously how to extend the blood-type activity and to take advantage of opportunities such as the school blood drive. She thought about taking advantage of student volunteer work for data collection, or finding out more about hospitals and how they work.

The second activity I observed was the ball activity. A ball was dropped from a certain height, and the time it took the ball to bounce twice was measured. Thus, the initial height was the independent variable, and time was the dependent variable. Lynn had done in the activity during a workshop, and thought it suitable for her Algebra 2 class. The class was studying quadratics, and Lynn wanted to give her students an example of quadratic function "outside the classroom."

The activity was performed on two days with some other class work preceding the activity on each day. The first day was planned for data collection; the second for graphing and data analysis. However, because most students did not keep their data sheet, data collection had to be repeated on Day 2. Thus, data analysis was cut short. There was only time to enter the data from one group into a graphing calculator and run a quadratic regression. The regression parabola had a maximum in the first quadrant and opened downward. The correlation coefficient was above 0.9.

However, as I thought about the regression function, I realized that the result did not make sense. Because the parabola opened downward and the maximum was in the first quadrant, the time had to be zero again at some future height. It made no sense that the time would decrease as long as the height increased (see Figure 1).

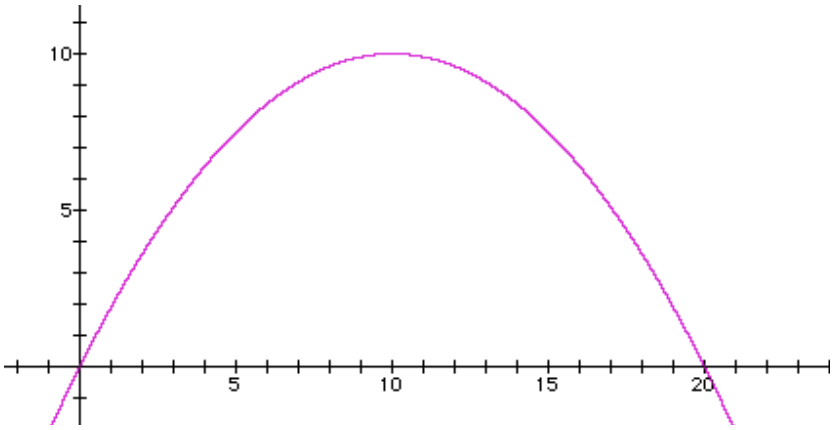

Figure 1: A parabola with maximum in the first quadrant an opening downwards with two x-intercepts.

I discussed the activity with Lynn during the interview following the second lesson and again during the interview in April. As it turned out, Lynn did the activity as she remembered it; she had no written record. However, she insisted that the relationship was quadratic. But she also agreed that the quadratic relationship did not make sense. Lynn was not able to resolve the issue during the interviews.

The graphs below (Figure 2, a-d) show that with a limited set of measurements the regression function can be ambiguous. Figures 2a and 2c show quadratic functions, Figures 2b and 2d square root functions. The general shapes are similar and both could be—considering measurement errors during the experiment—solutions to a small set of data.

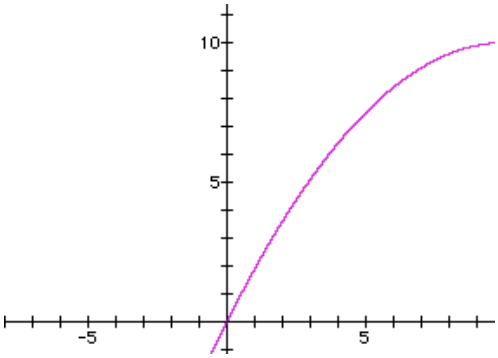

Figure 2a: A quadratic function.

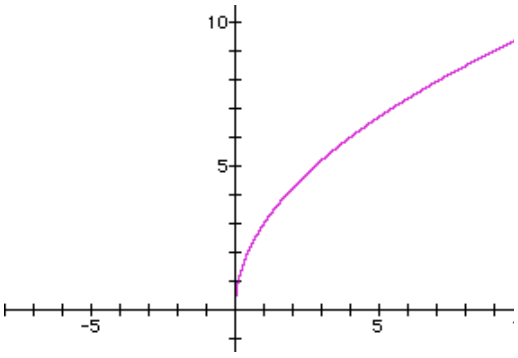

Figure 2b. A square root function.

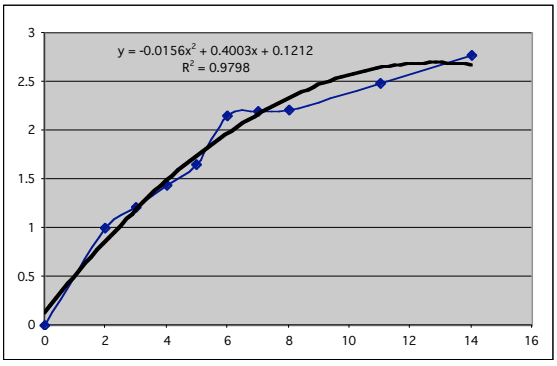

Figure 2c. Experimental data with quadratic regression.

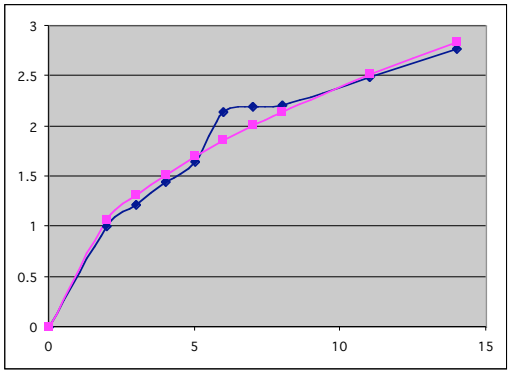

Figure 2d. Experimental data compared to a square root function.

Like the blood-type activity, the ball activity was not well prepared and not thought through with all its consequences. This lack of thorough planning was one of the factors that interfered with a more comprehensive implementation of contextual teaching and learning.

Factors That Hindered Implementation

From the observations and the interviews, I inferred several factors related to extensive and thorough planning that hindered the implementation of CTL: the textbooks used in the Algebra classes, a lack of time, difficulties with class management, lack of thorough planning, and lack of experience.

The algebra textbooks. Both algebra classes used traditional textbooks with their usual two-page per lesson layouts. Typically, a lesson starts with an introductory word problem, followed by a how-to-do section, practice, more practice, and finally some more word problems. Within the lesson, the steps to be performed are small. Students can go through the lesson and complete the practice assignments with minimal thought. The lessons within a unit follow the same principle: small steps and few, if any, challenges. In short, work from most traditional textbooks can be boring.

In order to turn a unit from such a textbook into a more exciting sequence of tasks with problem-solving emphasis, the teacher needs experience, has to invest considerable effort and planning, and has to be secure enough to tolerate some level of student frustration inherent in problem solving. As a student teacher, Lynn did not have this experience. She was just starting to gain this experience. For example, she did not have previous teaching experience that would have facilitated her knowing which parts of a textbook unit to de-emphasize, which to expand, or how to consistently frame a presentation from a conceptual rather than a procedural point of view.

In addition, it appeared that Lynn took the non-contextual approach of the textbooks as given. For example, she said about algebra, "If you just give these kids just random functions that are abstract and only exist or are alive on a Cartesian plane, and that's it, there is no Cartesian plane that those kids can touch and feel and relate on a daily basis […], it's much harder to find that those abstract ideas in the real world" (4/3/02).

I do not claim, however, that Lynn did not attempt to address the contextual development of her algebra students. For example, when the class studied factoring

quadratic functions into linear factors, Lynn introduced algebra tiles and guided the students to interpret the trinomial as the area of a rectangle, and the linear factors as the length of the sides of that rectangle. But, in general, the algebra textbooks did not foster a contextual approach. In addition, Lynn felt that her university courses did not prepare her well to deal with the kind of textbooks she had to use in the algebra classes. She highlighted the discrepancy between "these interesting themes and projects that go on for four weeks" (3/8/02) and the charge to student teachers to "using the books, [and] going by chapters" (3/8/02).

The time factor. Time seems to be the most precious and scarce commodity for any teacher, and this is even truer for student and novice teachers. Lynn saw herself having more time problems than the other student teachers in the school. For example, Lynn accompanied her mentor teacher, who was the department head, to all meetings the mentor teacher attended. These extra meetings diminished her preparation time. Also, Lynn was generous in her time before and after school when students asked for help. In addition to the tutoring of her own students, Lynn tutored other students in order to earn some extra money. Finally, Lynn visited several of her students' extra curricular activities. She attended the presentation of the drama club, participated in senior night of the basketball team, watched a tennis match, went to a mock trial on a Saturday morning, visited some of her students at their work places, and intended to go to the graduation ceremony. As commendable as Lynn's interest in her students' life outside the classroom was, it again took a lot of time, time not available for planning.

Class management. Classroom management was the single largest issue that permeated all aspects of Lynn's student teaching experience. For example, in the

interview after my first visit, classroom management dominated about 75% of the interview. The interview took place at the end of a week that had brought Lynn to tears after one particular lesson in the Algebra 1 class of seniors.

> *It was just really sad, it got so chaotic, the class I have the hardest problem with—the other two classes were fine—but that one class, it messed up my whole week, that one class during that one period on that one day has messed up my whole week. And, and it was horrific.* (2/21/02)

Lynn's problems seemed to be greatest in the Algebra 1 class. Lynn saw several factors that contributed to her difficulties. First, with 32 students, this was the largest class she had to teach. The room was filled to capacity, and Lynn felt she had only limited options to rearrange the seating and accommodate students who wanted and needed to be in the front of the room (2/21/02). Second, most of the students were seniors who needed the class to graduate, and they simply wanted to finish it with the least amount of work. Third, Lynn felt her age and her tendency to be very casual contributed to her difficulties in this particular class.

> *I'm so casual and that's the way I am. The students I'm working with are mostly seniors and so they don't look at me as teacher a lot of times—which they should, they look at me as a big sister or as a college student, or someone who is there who knows a lot about math. But they don't take instruction very well.* (2/21/03)

Furthermore, the class—although a college-preparation class—was not an advanced class and was made up of students with a wide range of abilities. Lynn mentioned quizzes as one example of her difficulties with students of diverse abilities.

A quarter of the students will be done with it in three minutes, the majority will be done within five minutes, a few will be done with it in eight minutes. Between that interval, the ones who get finished first start talking. (2/21/02)

Again, Lynn thought more options to change seating of the students could solve the problem with "the hot spots," whereas a more experienced teacher would have chosen some productive work assignment for the fast-working students.

Finally, the Algebra 1 class was the last class to be picked up by Lynn, and it would be the first one she would return to her mentor teacher.[5] Lynn couldn't wait to turn the class back to the teacher. She felt that she was in a mode of "survival teaching" (Field notes 3/1/02).

The Algebra 1 class was not the only class she had problems controlling. In a break between classes (3/1/02), Lynn talked about how she had been called to the counselor's office. Several students from the Algebra 2 class had gone to the counselor and complained that they were not able to learn in the class atmosphere of constant disruption and talking. The counselor had recommended that Lynn use a circle discussion about the behaviors in the class, what she could do to improve the learning atmosphere, and what the students could do. Lynn had followed that advice for her first period class (seniors, statistics/probability) and her third period class (sophomores, Algebra 2), but not with the second period class (seniors, Algebra 1).

From my perspective of a limited number of classroom visits, Lynn's primary problem was that she had a difficult time establishing a focused presence in the class. I

[5] In a typical student teaching experience, a student teacher starts with teaching one class only, gradually adds more classes to her schedule until she teaches the full load of classes. After about two weeks of full teaching, the student teacher returns one class after the other to her mentor teacher.

observed several lessons as having sliding beginnings, unclear starting points of when students' attention was required. During the lessons, I noticed parallel activities that I saw as distracting. For example, Lynn used the time during individual seatwork to return papers to the students. By going from student to student, commenting on the work done, she introduced some restlessness that then translated into student-student conversations. Another time, Lynn interrupted a quietly working class with an unrelated theme. She was, however, able to reestablish the working atmosphere in the class. Possibly, my interpretation of Lynn's unfocused presence and her view of being casual, "the way I am," describe the same phenomenon from two different perspectives, an outside view, and an inside view.

Lesson planning. I already highlighted the lack of thorough planning for the blood type activity and Lynn's insights into the consequences of this. Similarly, the ball activity was not thoroughly prepared. Her preparation was limited to the surface features, that is, getting balls, stopwatches, tape measures and yard sticks for the lesson, determining the different groups, and producing the worksheets. What she failed to do was the deep, conceptual work on the mathematics involved. That is, Lynn did not think through the meaning of the independent (height) and dependent (time) variables, and the appropriate function that would express the relationship between these variables. However, in this particular case, this lack of conceptual preparation was not visible within the lesson itself. It only surfaced during the interview when I asked her to clarify the mathematics of the activity.

I observed a few smaller incidents when Lynn's insufficient preparation was visible. In a quiz, Lynn wanted the students to find the roots of a quadratic equation by

applying the quadratic formula. However, she did not determine ahead of time if the function she provided actually had any real roots. As Lynn presented the quiz, she had to change the function twice to make it work for the intended purpose.

In the same context of developing and working with the quadratic formula, Lynn introduced imaginary and complex numbers. The students were hesitant to accept those numbers. They called imaginary numbers "fake numbers" and did not see any reason to invest time and effort into something "fake" that did not even exist. A brief excursion into the history of mathematics and the conceptual development of imaginary and complex numbers (indeed, of all numbers) as "answers to questions" could have provided a context for students to attach meaning to this new kind of numbers and thus accept them more willingly.

Finally, Lynn felt that she was not prepared to produce effective lesson plans under time pressure. The development of a plan for a single lesson and a sequence of lesson plans for a 5-6 day unit had been requirements during the methods semester preceding student teaching. For both assignments, students had ample time, resources, and the support and advice of the instructors and a cadre of doctoral students. Although the "the lesson plan was really good" (3/8/02), Lynn rejected the assignment as a model for future planning because,

> *Spending the three weeks to work on a one-week lesson plan was not realistic, […]. Neither did it prepare me for student teaching. I don't write out day-by-day lesson plans with the five-bullet thing like we were talking about, I don't do it, I don't do it, I don't have time to do it.* (3/8/02)

In addition to feeling unprepared, lesson planning had not been the "super duper focus during my student teaching" (3/8/02). However, I do not claim that Lynn did no planning for teaching. She planned her lesson to the detail that she felt comfortable with at the time.

Lack of experience. Many of Lynn's problems can be seen as problems typical for a student teacher who simply does not have a wealth of experience on which to draw. With continued teaching experience, Lynn will know that instructional packages are not self-explanatory. She will be able to foresee student questions and difficulties and thus avoid frustration because of students' uncertainty with a task. She will know her textbooks, and will be able to evaluate a textbook lesson in context of the unit and the unit in the context of the year's curriculum. She will be able to distinguish between important new concepts that need to be highlighted, such as the quadratic formula and it's derivation and use, and side issue that could be postponed, such as the imaginary numbers. With more experience, classroom management issues will fade into the background of her attention and planning will move into the foreground.

Factors That Fostered Implementation

The following factors fostering instruction in the spirit of contextual teaching and learning evolved from the analysis of the interview transcripts and field notes; the textbook used, some of Lynn's mathematical experiences during high school, experiences in her professional college classes, and her ability to reflect on her actions and to evaluate them in light of her goals.

The textbook. In contrast to the textbooks used in the algebra classes, Lynn saw the statistics textbook as promoting problem- and activity-oriented teaching. She said,

> *It's so much easier for me to find activities for them to do, because they're talking—their entire book is just laid out differently. Number one, it's in paragraphs, it gives over and over examples, all they're doing is word problems, that's what they're doing.* (4/3/02)

It was obvious that the layout of the textbook was quite different from the two-page, one-lesson layout. Because statistics is an applied science that naturally relies on context, students have to read and deal with the context before they can engage in the mathematics. Word problems are not the dreaded section at the end, but make up the meat of the text. In addition, probability lends itself naturally to experiments, and Lynn introduced several of the experiments she had encountered in her university math ed professional courses and her statistics course.

Finally, in preparing her lessons Lynn found herself reading through a whole section before attending to details, similar to what she had been requested to do during an investigation of a contemporary textbook series (Interactive Mathematics Program, IMP) in one of her curriculum courses.

> *The thing that helped me out a lot is with the—*
>
> *even though we're not using those kinds of books, those IMP books and all that stuff,…the way I had to go through the chapter is what I have to do for the stat class.* (3/8/02)

That is, Lynn had to read through and evaluate a chapter as a whole before she could attend to any details or design the first lesson. She also needed to work out the examples herself before she was able to use them in a lesson. However, Lynn did not use this kind of holistic and detailed preparation for the Algebra classes because "the book is set up

differently in that it gives all the formulas outright and give problems to work on" (3/8/03). The IMP books, on the other hand, are set up with a theme, and this was similar to the set-up of the statistics book. Thus, Lynn's preparation in the curriculum course with one particular set of books was valuable for her teaching the statistics class, but not for teaching the algebra classes.

Experiences in mathematics. The second factor that fostered Lynn's attention to CTL principles in her teaching was her memory of own positive mathematical experiences. These experiences had made a difference for Lynn in her view of mathematics and of mathematics in the world. For Lynn, the scavenger hunt in high school was a pivotal experience that opened her eyes for mathematics in the world around her. She would look at a water fountain and see a parabola. Se would draw a coffee cup and think, "This is an ellipse, where would the foci be, depending on the perspective, that kind of thing" (Interview 4/3/02). Like a staircase, the water fountain and the coffee cup are everyday objects that had become mathematical objects for her. It was important for Lynn that her students have similar experiences so that their world also would expand in a mathematical dimension.

The second facet of Lynn's previous experiences that was influential was the way the mathematics concepts were taught. Lynn cherished the way she was allowed to discover concepts on her own and the "open mathematics" in her first curriculum class. She remembered the hands-on activities and how much they changed her view of doing mathematics. Lynn wanted her students to have similar experiences and to remember the mathematics through those experiences. This seemed to be one of the reasons that she chose several activities as one way to bring CTL principles to life.

Reflection and openness. As long as I have known Lynn, I have always been impressed by her ability and willingness to look at herself and to reflect on her thoughts and actions. This willingness to reflect contributed to some valuable insights that surfaced during the interviews. For example, as she was reporting on the first day of the blood-type activity, she was also analyzing why the lesson had been so chaotic. She realized that her lack of preparation was one of the reasons for the students' confusion, and she went back to the activity and cleaned it up. Similarly, Lynn's preoccupation with classroom management led her to experiment with different strategies and to constantly evaluate these strategies. She was open to advice from the counselor and willing to follow this advice.

Finally, I value Lynn's disposition of seeing more in her students than what was visible in class. Although Lynn's visits to her students' extracurricular activities and workplaces did take valuable preparation time, it did contribute to a more positive relationship between her and her most troublesome students:

> *I sat with my, with my students that give me the hardest time, kind of blend, I don't know, "Hey, Ms L., how you're doing, Ms. L.," that kind of thing, so they knew I was interested in what they were doing*. (2/21/02)

Lynn knew important details about her students. She recognized that some students did not have the luxury of coming for extra help before or after school because their out-of-school work schedule did not allow for extra time in school. In addition, the out-of-school work was a necessary contribution to the family household.

Lynn's openness to her students was influenced by one of her own experiences and her reflection on that experience. While Lynn was in college, a student was murdered

in her home, which was only a few houses away from Lynn's home. For some time Lynn was haunted by this seemingly random murder, and consequently her grades suffered. In her CTL portfolio, Lynn wrote:

> *By reflecting on my own experiences, I will be able to understand more easily where some of my students are coming from. If one of my students are [sic] having problems at home, or in their community, hopefully I will be able to pick up on this, and help the student however I can. I think this experience will help me to be [a] more aware and sensitive teacher.*
>
> (http://www.coe.uga.edu/ctl/model/stud_portfolios.html, see link: Problem Based Learning)

Lynn's reflection on a personal life experience opened her eyes to her students' experiences as individuals. This contributed to her perspective that being a teacher of mathematics involves more than teaching mathematics, which, in turn, was a major factor in her approach to instruction.

Discussion

Dependence of Factors

The factors that hindered implementation of CTL principles are not independent of each other. Although it is difficult to establish causal relationships between the factors, mutual influences among them are noticeable. Figure 3 depicts these mutual influences and relationships.

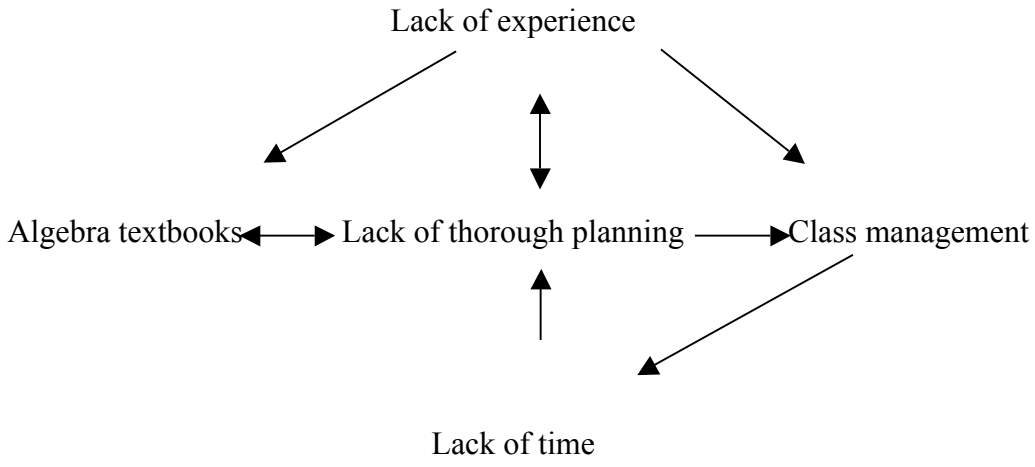

Figure 3. Relationship among factors that hindered implementation.

Algebra textbooks and planning. The designers of typical mathematics textbooks make it easy and time efficient for teachers to use the textbooks without a lot of serious preparation. The two-page sections suggest a linear progression through the book, that is, two sections per day for schools on 4x4 block schedule. The teacher editions contain the answers to every question, exercise, and problem. Again, the teacher does not have to work the problems assigned. Thus, the teacher will miss the opportunity to anticipate difficulties for the students, and a time estimate of how long it might take to complete an assignment.

On the other hand, a teacher does not have to accept the restrictions inherent in the design of the book. For example, the teacher can discard the teacher's edition, evaluate a unit as a whole, set priorities, bring in outside materials, and design instruction with a problem-solving focus. Although Lynn made some modification to the textbook and brought in activities; overall, she did not invest the kind of planning necessary for

problem-solving oriented teaching. The design of the algebra textbook let her get away with minimal preparation, whereas the design of the statistics book did not.

Class management, time, and planning. These three factors reinforced each other and led to a cycle that made teaching more and more difficult, in particular for the Algebra 1 class. Issues of class management occupied much of Lynn's attention inside and outside of the class. In turn, time spent on worrying about management issues was time not spent on planning the next lesson, which then led to more management problems.

Lack of experience. I see Lynn's lack of experience as the single most important factor. Lack of experience let her believe that the instructions for the blood type activity were self-explanatory. Lack of experience led to many of her management problems, and lack of experience made it difficult for her to divert from the convenient path of the algebra textbooks. In her lack of experience, Lynn was similar to many student teachers who are overwhelmed by the complexity of the daily teaching demands. What might have set her apart was that she kept her goals alive, despite her difficulties.

Transfer of Learning

For me, the teacher educator, Lynn's case highlights an important lesson. If I want to make experiences during the professional teacher education courses relevant for pre-service teachers, then these experiences have to be similar to the situations they will encounter in schools. For example, it is not enough to introduce pre-service teachers to textbooks that model contextual, problem solving- and communication-oriented teaching such as the IMP textbooks. What Lynn learned from her work with these textbooks was only of limited help in her student teaching situation. When I asked student teachers to

read through a whole unit and determine and verbalize the overall goal of the unit before attending to any kind of detail, I intended to provide them with a planning principle useful for any textbook. For Lynn, however, this principle was useful only for the textbook that was similar to the IMP books. It was not helpful for the work with textbooks that seemed worlds apart. Thus, because most pre-service teachers will encounter conventional, skill-oriented textbooks, we, as teacher educators, also need to provide explicit models of how to transform these textbooks into problem- and context-oriented planning and instruction that pre-service teachers can transfer into their own teaching situations. It seems that transfer from one situation to the next was only effective if the situations were similar to each other.

Similarly, I wonder how the lessons learned in the specific CTL courses transfer into the pre-service teachers' teaching environments. Lynn only connected a direct teaching situation—the episode with the snake—to her own teaching. She did not make a connection to teaching when the speaker in the children's hospital talked about communication. It might be up to us, the teacher educators, to make those connections more explicit.

Coda

In January 2003, Lynn started to work in a middle school in a neighboring county. She is teaching five 7th-grade classes, three regular (on-level) classes with about 17 students in each, one low-level class with 10 students, and one high-level class with 30 students. The school is not on block scheduling.

Within the first month, Lynn started a CTL-like activity for the three on-level classes. The students had studied scale and scale drawings. As an application of what the

students had learned, Lynn asked the students to design their dream house, and to present a model, that is, front view and floor plan, to the class. The students could choose whether they wanted to work alone or with a group of students. Lynn's instructions for the project are attached in an appendix.

Lynn invited me for presentation day, and I attended the presentations in all three classes. As can be expected, the presentations and the models were of various qualities. But it was obvious that most students were very involved in the project and had put considerable thought and time into their designs. Many houses included an indoor half- or full basketball court. Two students, both working alone, had designed log cabins, thus documenting their love for outdoor adventures. The dream house project seemed to have captured the interest of the 7th grade students!

Lynn had started the class project while she was still setting up classroom routines and learning about lunchroom and bus duties. In addition, she has already established a class website[6] that contains syllabi, general assignments, expectations, group pictures, examples of mathematics in the world, and the description of the project. It seems that Lynn's start in her first teaching position has provided her with renewed dedication to provide contexts to her students that make mathematics meaningful for them.

References

Goetz, J. P., & LeCompte, M. D. (1984). *Ethnographic and qualitative design in educational research*. San Diego, CA: Academic Press.

[6]http://jwilson.coe.uga.edu/emt668/emat4680.2000/parker.Lynn/msparkersclass/oconeemathclasspage.html

Appendix
Big Project : Dream House

Due: Day after Chapter 6 Test (Approximately Jan. 21st)

The object of this project is to use your knowledge of scales and measuring ratios and fractions to create the house of your dreams.

1. I want you to be **creative** and **inventive**.

2. Your dream house should be **accurate using proportions and scale drawings**, A scale must be included and therefore is required.

3. The actual scale drawing of your dream house must be done on **graphing paper**. (I have some if you need it.) The major parts of the house should include –
    a. Kitchen
    b. Bathroom
    c. Living room
    d. Bedroom
    e. Dining rooms, decks, patios, and garages are optional

4. A visual representation of the house must also be included in your project. (I want to see what you imagine the front of the house looking like.)

5. Project must be presented in a poster form to a class.
    a. You may work individually, in pairs, or in groups of 3. NO GROUPS OF FOUR.
    b. Organization and information on the board will be assessed. **THIS COUNTS AS A TEST GRADE**. A rubric of how you will be graded follows:
        1. Scale drawing of house (with scale included) - **40 pts**
        2. Neatness/creativity – **10 pts**
        3. Picture of the front of the house – **10 pts**
        4. Overall area of the house and outside perimeter of the house – **5 pts**
        5. Pick one room of the house and find – **30pts:**
            1. Cost for the walls
            2. Cost for the flooring (hardwood or carpeting)
            3. Perimeter and square footage of the room.
        6. Reference for the flooring and wall prices. **– 5pts** (What store did you actually talk to, and what prices did the give per square foot?)
        7. Bonus points will be given if you take the initiative to find out more about the pricing for building such a house. – **5pts** Examples include:
            1. How many bricks did it take to build the house

2. Give other statistics for other rooms
3. What about windows

~~~~~~~Good Luck and Have Fun !!!~~~~~~~

Dream House Rubric

Name(s):

_____

_____

Period: _____

Date: _____

Category	Possible Points	Points Received
1. Scale Drawing	40	
2. 1 Room Stats- Cost of walls, floors, perimeter, area	30	
3. Front of the house Drawing	10	
4. Neatness/Creativity	10	
5. Area/Perimeter of House	5	
6. References	5	
7. Bonus	5	
OVERALL POINTS	105	

Comments by Ms. Parker:

_____

_____

_____

_____

_____

_____

_____
~~~~~~~