

Implementing Contextual Teaching and  
Learning:  
Case Study of Julia, a Middle School Science  
Novice Teacher

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**Abstract**

Research has shown that school science is often taught as a decontextualized narrative that fails to take into account the experiences, skills, values and lifeworlds of students and their communities. This study grew out of an interest in expanding our notions of what might constitute “contextual science teaching and learning.” In this interpretive case study, Julia, a novice science teacher, and Deborah, an experienced science teacher educator, collaboratively examined what it means to learn to teach science contextually. The tools of inquiry which were at the heart of this study included interviews, journal reflections and field notes from classroom observations. Secondary data sources included teacher-generated curricular materials, impressionistic tales and classroom artifacts. Findings of the study suggest that the strengths and weaknesses of a contextual teaching and learning approach are rooted in many factors including: the role of science teaching and learning within larger community narratives, tensions between the narrative of school science and contextual teaching and learning, and the teacher’s role as a mediator of knowledge. Implications of the study shed light on criteria that are needed for a contextually-based, transformative science education that addresses the needs of middle school learners.

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**Introduction**

Increasingly, as science educators attempt to address the challenges of teaching diverse learners, they must think deeply about the purposes of “science education.” Whose interests are addressed in current practices of science teaching and learning? What might science education be like if we seriously consider how it fits within the lifeworld of the broad community of learners who occupy K-12 classrooms? Over the past decade, science educators have begun to explore the substance of what it means to “know” and “learn” and the sorts of navigational challenges teachers and learners experience in the midst of the diverse interests and life histories they bring to the classroom.

In recent years, the focus on preparing science teachers as technical decision makers has given way to preparing critically reflective practitioners (Anderson & Mitchner, 1994). The current interest by science teacher educators in contextual teaching and learning models stems from the increasing belief that teacher’s knowledge is 1) contextual and situation specific, 2) interactive, and 3) speculative, involving many uncertainties and ambiguities. In contrast to traditional approaches to teaching and learning which emphasize the transmission of codified subject matter, a contextual teaching and learning approach emphasizes the importance of examining social structures, exploring community issues and helping others live meaningful lives. In their book *Contextual Teaching*, Kincheloe, Slattery & Steinberg (2000) stress that education

must “help us connect students and their sociocultural environment through an emphasis on autobiography, community relationships, reflective and interdisciplinary practices, creative problem solving and social action in the schooling process” (p. 2). From our perspective, there is a critical need for a contextualized view of teaching and learning which generates local knowledge and builds community memory. Thus, at the heart of this collaborative case study is a concern for examining common places that intersect the lifeworlds of children and the science education experiences they have in the classroom. Accordingly, the focus of this study was to understand contextual teaching and learning as it was practiced by a middle school science teacher within particular professional development and classroom communities. The study was framed within the following research questions:

1. What does contextualized teaching and learning mean to a practicing middle school science teacher?
2. What enabling strategies does a middle school teacher draw on to build relationships between school science and contextualized forms of teaching and learning?
3. What factors constrain the use of a contextual teaching and learning approach in the context of science teaching and learning?
4. In what ways does science teaching and learning in Julia’s class differ from that of more traditional classes?

### **Context of the Study**

This study is situated within the context of an on-going preservice teacher education model that was inductively derived and based on tenants of contextual teaching and

learning (CTL). Julia, a recent university graduate with a major in secondary science education, was a participant in the CTL program since its initial inception. One of the highlights of Julia's participation in the CTL program was her involvement in an internship experience at the Center for Disease Control (CDC) in Atlanta. Working with scientists at the CDC, Julia collaborated in developing a science education curriculum designed to engage middle school learners in the study of epidemiology.

After graduating in the summer of 2001, Julia found herself in a period of professional transition. Unable to immediately assume a teaching position, Julia accepted a temporary position as a consultant and participant in the Altamaha Watershed Project, a professional development experience for middle school science teachers. The Altamaha Watershed Project frames professional development of science teachers in terms of two key organizers: service learning and contextual teaching and learning. One of Julia's major roles in relation to this project was that of "curriculum-maker"—drawing on her experience at the CDC, she was asked to design a model unit on endangered species of the Altamaha Watershed that could be adapted for use by middle school teachers working in counties situated along the Altamaha river basin.

With the approach of the 2002 academic year, Julia assumed her first teaching position as a Grade 7 science teacher. She began her work in a nearby middle school, hoping to work alongside several experienced teachers who had been integrally involved in the Altamaha Watershed Project; however, by the beginning of the school year these teachers had already resigned or transferred to other middle schools. Julia was assigned to teach five sections of Grade 7 science in one of four middle schools located within a small city university community in Georgia. The school population consists of 68%

African American, 11% Hispanic and 23% Caucasian students. Approximately 85% of the students in the school qualify for free and reduced lunches for the 2002 academic year. As a new science teacher, Julia planned to draw on her CDC internship experience and use her “Altamaha watershed: Pollution as a cause of extinction” unit and others like it as focal points for her Grade 7 science curriculum. This study explores how Julia attempted to translate her understanding of contextual teaching and learning theory into practice.

### **Methods of the Study**

“The methodologies and methods of research, the theories that inform them, the questions which they generate and the writing styles they employ all become significant acts” in the research process (Smith, 1999, p. 39). A careful consideration of perspectives, purposes and goals led us to choose an interpretive case study methodology which was collaborative in nature. An interpretive research approach (Erickson, 1986) was perceived to be appropriate for this study as the goal was to examine the nature of contextual teaching and learning in light of the perspectives of two co-researcher participants. An interpretive methodology allowed for exploration of participants’ understanding of contextual teaching and learning and its meaning in the context of a 7<sup>th</sup> grade science classroom. This approach also enabled an examination of participants’ views about contextual teaching and learning in the context of a project aimed at placing CTL at the center of reform.

### ***Participants***

This case study involves members of two overlapping science education communities: a science teacher learning community and a science teacher education

research community. Participants in this study include two science educators—Julia, a first-year middle school teacher and Deborah, an experienced science teacher educator. Julia initially enrolled in the university as a biochemistry major in September, 1997. “I had decided as a fourth grader that I would find the cure for pancreatic cancer so that no one else would have to go through the pain that I had when I lost my grandfather.” While working part-time in a pharmacy lab, Julia gradually began to experience a sense of isolation. She came to value the fleeting opportunities to interact with and assist others in the laboratory. Simultaneously, Julia began to recall her positive experience as a tutor for middle school students during her high school years. A short while later, Julia made the decision to change her major to science education. Julia noted that shortly thereafter “I received a flier in the mail about a program called Contextual Teaching and Learning which promised a stipend at the end to assist in purchasing teaching materials. Being one to never turn down free money, I decided to give it a try. The more that I learned about the contextual teaching and learning approach, the more I began to wonder why more teachers were not using it in their science classrooms.”

Deborah, a former elementary and middle school science teacher, and a faculty member in the science education department, first met Julia through her involvement in the CTL program. As the instructor for the CTL Seminar # 3: *Contextual Teaching and Learning in the Schools*, she had the opportunity to work closely with Julia and other students. Deborah initially became involved in the CTL program because of an interest in expanding her understanding of science teacher preparation and scholarship contextualized in the experiences, skills and values of the local community. During the early stages of this study, Deborah was a Fulbright Scholar in Iloilo City on the island of

Panay in the Philippines. Iloilo is a thickly populated province located along the shoreline of the South China Sea where the majority of the people earn their living through fishing and rice farming. In her capacity as a Fulbright Scholar at West Visayas State University, Deborah shared her understanding of the CTL principles with other faculty, which ultimately led to the development of a new course entitled “*Contextual Teaching and Learning through Community Immersion.*” During this preliminary stage of the study, Deborah and Julia communicated regularly through e-mail and exchange of curricular materials.

### ***Data construction and data sources***

The primary conceptual tools we selected as investigative strategies for this study included interviews, journal reflections and field notes from classroom observations. Secondary data sources included teacher-generated curricular materials, impressionistic tales and classroom artifacts. Data collection initially commenced with a series of informal e-mail conversations between the two collaborators, leading to more formal phases of data collection and analysis.

### ***Procedures***

During the initial phase of the study, a semi-structured interview protocol was used to pose questions which guided subsequent interview conversations. At this time, Julia was working as a consultant on the Altamaha Watershed Project and developing curricula pertaining to endangered species of this ecosystem. More than 30 different definitions of “curriculum” can be found in the science education literature. The workshop instructor, however, did not provide Julia with an a priori definition of curriculum; rather, Julia was encouraged to define curriculum in a way which personally

made sense. It was during this initial experience that Julia refined her previous understandings of CTL to generate a working definition. The primary phase of data collection began when Julia started her first teaching position as a middle school science teacher. Throughout the semester Julia kept a journal and recorded impressionistic tales related to CTL while Deborah observed Julia's classroom. The two co-researchers conducted conversational interviews to discuss their analyses and interpretation of data.

### ***Data analysis***

The concept-indicator model of grounded theory (Strauss, 1987) was used based on constant comparison of various data sources. Because the goal was to examine contextual teaching and learning in light of participants' perspectives, analysis began by independently coding primary data sources to produce indicators of concepts and categories fitting the data. No a priori set of concepts or categories were used; instead, categories were derived from the different data sources. Categories representing convergences and contradictions were considered. Connections between categories were identified by returning to the data sources to confirm or negate possible connections. After completing independent analyses, the co-researchers discussed, clarified and negotiated categories. Themes were generated through further comparative analysis of the concepts and categories in relation to the questions of interest. The tenability of the themes emerging from one data source were ultimately tested against other relevant data sets.

### **Theoretical Perspectives of the Study**

The theoretical perspectives of this study are drawn from assumptions surrounding notions of contextual teaching and learning and the situated nature of

teachers' knowledge. The concept of contextual teaching and learning frequently draws on the premise that science, mathematics, and other kinds of learning can more powerfully engage students when they are connected to workplace contexts. From this perspective, the emphasis is on making science more relevant and useful to the lives of children through applications of concepts and real-life examples across diverse workplace settings (Britton, Huntley, Jacobs & Weinberg, 1999). Other scholars conceptualize CTL in a broader philosophical sense, calling on the need for teachers to understand that “no body of facts should ever be taught in isolation” (Kincheloe, Steinberg & Tippins, 1999, p. 22). Pointing out that students will unlikely be motivated to learn a body of abstract, unconnected facts, they call for a more holistic science education which emphasizes knowledge creation through experiences which “clarify connections among political, religious, familial, environmental, social, economic, athletic, aesthetic and academic lives of students”(Kincheloe, Slattery & Steinberg, 2000, p. 3).

Taking this idea a step further, a number of scholars have suggested that teachers' knowledge is situated, social and distributed across individuals and tools (Cobb, 1994; Greeno, Collins & Resnick, 1996). They emphasize that what we know and learn is created, interrogated and questioned through the mutual conversations of members of diverse learning communities. This study recognizes the need for a more situated knowledge base. In contrast to a more generic model of CTL practice characterized by a “one size fits all” approach, we are interested in thinking about generating situated teacher knowledge with relevance to contextual science teaching and learning.

### **Common Places and Emerging Tensions**

As a storied landscape, multiple narratives are interwoven throughout Julia's experience with contextual teaching and learning. The intersections of these narratives or tensions created common places or focal points for discussion. Some educational researchers (e.g., Abell & Bryan, 1997) frame what they learn in a study in terms of tensions that represent struggles as the basis of learning. We approach the use of tensions in a broader sense to include not only struggles, but the more positive aspects of teacher learning that took place for Julia in this study. Our use of "tension" is one in which struggles are viewed as "movements of excitement that spur us on to continue striving in our learning"(Arellano, et al., 2001). In this section we first explore Julia's understanding of contextual teaching and learning; we then share and discuss the themes generated as commonplaces of understanding and emerging tensions in relation to the research questions of interest.

Question 1: What does contextual teaching and learning mean to a practicing middle school teacher?

As a new teacher, one of Julia's first goals was to get to know her students and their life worlds outside the classroom. "I need to have an understanding of students' prior experiences and knowledge, of what interests and excites them. It means I have to try to understand their cultures and take time to go into their communities." Julia quickly discovered,

Most of my students come from the Nellie Dee housing projects and the surrounding trailer parks. My students are the ones that hang out in the 'Iron Triangle' (a part of the community where the selling and buying of drugs is pervasive). These students are consumed with worry about who they will have to

fight in order to maintain a status which keeps them safe within this community. They could care less about the scientific method or the different kinds of cells that can be found in blood, what we know as QCC objectives (journal reflection).

As Julia learned about the life worlds of her students she began to ask “what kind of science do my students see at home—a small patch of grass between buildings falling down from disrepair...a cockroach infestation?” Disturbed by what she was learning, Julia’s understanding of contextual teaching and learning began to shift.

### **Theme 1: A Question of Purpose**

Early in this study, Julia, in attempting to articulate her vision of contextual teaching and learning, integrated what she had learned from her previous CTL seminars and experiences into a definition that worked for her. Reflecting in her journal she wrote,

I have come to the conclusion that everyone involved in CTL tries to create a definition that personally makes sense. While I have been struggling with my definition, I have come to view CTL as an approach used to identify student needs and then use students’ real-life experiences to teach science lessons in the classroom. It’s based on the idea that both students and teachers can engage in and have ownership for their learning. They can learn to reflect more deeply on their learning.

As Julia’s first semester of teaching progressed, however, her understanding of CTL also began to shift:

I am no longer thinking about CTL only in terms of how I can help them learn science through relevant experiences connected to the community, home and workplace. Instead, my goals and understanding of CTL has shifted from “cells” to “survival.” I want to see my students live beyond 25 years (e-mail communication).

At the heart of Julia’s changing understanding of CTL is a critical question: what happens to students when they leave the classroom community wherein scientific knowledge is no longer the centerpiece for their everyday knowledge and activities? In short, Julia is beginning to critically reflect on the question of what is *meaningful* science education in relation to students’ life worlds beyond the classroom.

Question 2: What enabling strategies does a middle school teacher draw on to build relationships between school science and contextualized forms of teaching and learning?

This study sought to identify and describe CTL enabling strategies. An enabling strategy is one which can assist teachers in developing and implementing CTL-based science teaching and learning plans that are effective in helping students learn. Throughout the study, Julia tried many strategies and met with both success and failure. Several enabling strategies emerged as important themes and are described in detail in the sections that follow: a) connecting to students’ interests, b) bringing the history and nature of science into the curriculum, c) enacting the work of scientists through simulation, and d) using alternative assessments.

### **Theme 2: Connecting to Students’ Interests**

For Julia, one of the basic goals of CTL was to incorporate the cultural knowledge which all children bring to school into the science curriculum. She continually sought out

ways to make science relevant to the life worlds of her students. Several examples illustrate Julia's successful attempts to create culturally relevant learning experiences.

Caught in a speed trap!: One of the concepts that students seem to struggle with is the idea of instantaneous velocity. I wanted students to see the application of this concept in their everyday lives. What came immediately to mind is the idea of speed traps. I invited a local police officer to my classroom. As a class, we went outside and stood next to the road that runs parallel to our school. Officer Martin showed us how to use laser speed guns to determine the average velocity of cars traveling between two points. He then placed students at each end of the road to time cars. Students were really interested in this practical application of an abstract concept. This activity really served as the basis for them understanding the whole idea of instantaneous velocity (conversational interview).

Bacteria is everywhere!: On Monday I used a slide show to facilitate discussion about bacteria. At the end of the day, students left with the thought that bacteria could be present anywhere. Then yesterday we tested our theories about bacteria using blood agar that I obtained from the hospital. We tested either a hand or a mouth for bacteria (knowing that it would be present there). Because many of the students asked about the difference between bacterial and anti-bacterial soap, we decided to wash our hands using one type of soap or the other and then retest the same area. If a student had selected the mouth they compared Listerine with water in terms of cleaning. Today you saw us take this one step further by testing for bacteria at sites we had selected throughout the school. Some of the most popular selections were the lock on the bathroom stall, the water fountain, desk tops,

tables in the cafeteria and locker doors. Students used one of three cleaners to clear the area they had washed and re-swab it (conversational interview).

Grocery store classification!: Classification is one of the basic processes of science and an integral aspect of the Georgia QCC's. However, most of the textbook examples used to illustrate classification are not connected to the experiences of students. I chose a different approach, a more contextual approach, to develop students' understanding of classification. As a starting point, I asked students about examples of classification they were familiar with. We discussed why these classification systems were used, and the system that students were most interested in was the grocery store. I decided that we could use the grocery store as the starting point for building our own classification system, rather than looking at the Dewey Decimal System or some other classification scheme (journal reflection).

One of the most popular ways to study genetics is through the process of determining the blood types of children and adults. With the advent of the AIDS crisis, authentic experiences with blood typing were soon outlawed. At this point, scientific equipment companies began to produce "simulated blood typing kits" for teachers. In thinking about how she could illustrate genotypes and phenotypes in a contextually meaningful way, Julia decided against using blood typing as the typical example.

The genetics of dog breeding!: I try to limit the use of blood typing as an example as much as possible because of the diverse makeup of the families of many of my students—children who are adopted, families where every sibling has a different father...instead, I focus on traits such as dimples, widow's peaks, and attached

earlobes—but even these examples can be problematic. It was only when I took the opportunity to find out the personal interests of students that I came upon the idea of dog breeding. I found out that two of my students were in the business of breeding dogs. We took this opportunity to try to figure out what coloring the parents needed to have to get the coloring desired in the offspring. Unfortunately, the coloring on the coat was a little more complicated than we had expected, but all of the students learned a lot trying to figure out the alleles their dog might have—I found that every student could relate to dogs as an example (conversational interview).

If science teachers are to truly prepare students through science to live in an increasingly complex world, they must move beyond the notion of cultural relevancy. Both Julia and Deborah agreed that it is necessary to consider how to connect curriculum to the lives of children as a starting point for creating contextual learning experiences. However, they concede that a relevant curriculum is simply not enough—what seems to be missing is students’ personal sense of identity, a sense of who they are as individuals and as science learners—that ultimately will affect their success.

### **Theme 3: Bringing the History and Nature of Science into the Curriculum**

Julia’s emphasis on the history and nature of science was a powerful tool for helping students explore different interrelationships that connect the past, present and future of particular science issues. Reflecting on this aspect of her teaching, Julia stressed that

The history of science allows for contextual teaching and learning. Scientists, for the most part, are simply individuals who questioned what went on around them

and how things come to be. Through their experiments they learned about the world around them. I think that our students must understand that some of the ideas that to us might seem silly were just beliefs of the time. This helps students to feel secure while experimenting in their own world (journal reflection).

Drawing on her internship experience at the Center for Disease Control, Julia developed a powerpoint presentation to chronicle the historical evolution of epidemiology (the study of disease). Julia's goal was to help students develop a better understanding of how modern theories of disease have evolved and changed over time. *The National Science Education Standards* (1996) emphasize the need for students to develop an understanding of the nature of science. Julia felt that bringing history into the curriculum was an effective strategy for developing students' understanding of science as an ever-changing, dynamic construct which is characterized by the search for understanding. Throughout her powerpoint presentation Julia was able to engage her 7<sup>th</sup> grade students in a lively discussion, which almost bordered on a scientific discourse, of the following ideas:

What is epidemiology?

Origin of the Word

Early Ideas About Disease Causation

Buddhism's Six Causes of Disease

He Got Sickly, He Must Have Done Something Wrong

Inhabited by Evil Spirits—African Native Healers

Disturbances in Humors or Atmospheres (Florentine physicians of the 1600's)

Supernatural Contract or "Curse" (Burning German Jews accused of poisoning wells and causing Black Death)

Using Leeches to Remove "Bad Blood" from the Body

Removing (cutting off) a Body Part that Causes Pain

Development of Germ Theory

Van Leeuwenhoek's Description of "Wee Beasties" (microbes)

Louis Pasteur's Ideas of Fermentation, Anthrax, Spontaneous Generation, Silkworm Diseases and Rabies Vaccine

Robert Koch's Postulates for Disease Causation (tuberculosis, cholera and anthrax)

John Snow as the "Father" of Epidemiology (1854 outbreak of cholera)

#### Development of Public Health

Immunization Clinics of the Late 1800's

Public Health Service Formation in 1912

STD's—Social Hygiene Commissions

Rise of Public Health Departments

Sanitation and Hygiene Movements (sanitary privies are cheaper than coffins)

Smoking and Lung Cancer

Communicable Disease Center of the Mid 1900's

Polio Vaccines

Epidemic Intelligence Service of 1951

Center for Disease Control in 1970

Legionnaire's Disease

Agent Orange Studies

Abestos and Mesothelioma

HIV Infection

Violence and Injury Prevention

Bioterrorism

(classroom observations and anecdotal records)

Through an informal survey of her students, Julia learned that the inclusion of the history of science was very effective in terms of increasing students' class participation and interest in the subject. However, her discussions with Deborah highlighted several issues that still need to be considered with respect to this strategy: a) whose version of the history of epidemiology is being reenacted?, b) how can more student-centered strategies be used to incorporate the history of science?, and c) how can students' understanding of the nature of science be assessed?

It was interesting to note that Julia's presentation of the history of science excluded the role of females as some of the earliest physicians to study disease. This presentation of history privileges a history of science emergent from ancient Greek and White European cultures—a type of science that might be described as masculine and objective. During their discussion of this strategy, Deborah shared with Julia some

additional resources that could be used to facilitate a more student-centered approach to the history of science. In particular, Deborah recommended Joan Solomon's series of historical role plays which provide a basis for students to dramatize such events as "Jenner's Discovery of the Smallpox Vaccine" or "Galileo's Trial." A final point that came to light in their discussion of this strategy concerned the issue of assessment. While recognizing that student understanding of the nature of science was an important standards-based goal, Julia expressed some uncertainty concerning how best to assess this understanding.

#### **Theme 4: Enacting the Work of Scientists through Simulation**

*"Pack your bags, EIS officer! Your first assignment is to find the source of a food-borne illness outbreak at a church supper. Church members who ate the supper reported symptoms of nausea, vomiting, diarrhea, and severe abdominal pain."*

An authentic curriculum and assessment is one which is often described as "mirroring the work of scientists." Julia viewed activities which mirrored the work of scientists as an important strategy in building students' conceptual understandings. She emphasized that "students do not have to know everything about a subject to experiment—as they experiment they can build their knowledge by using the same methods that scientists use."

The work of scientists is not something that can be captured easily in the brief, fragmented periods of science instruction that characterize the typical middle school schedule. Scientists' work evolves over time in a manner that is not neat and tidy. Julia believed that the best way to contextualize learning in the work of scientists was to engage students in simulations that mirrored current events in science. Drawing on her

CTL summer experience with the Altamaha Watershed Project, Julia designed a simulation to investigate “Water Pollution as a Cause of Extinction.” Later, as Julia began her own teaching, she engaged students in the simulation study of “Illness Strikes the County of Oswego.” This simulation corresponded with students’ interest in the “anthrax scare” that was currently headlining the news, and was a timely fit with the study of diseases in the 7<sup>th</sup> grade life science curriculum. Describing how she came up with the idea of an outbreak simulation to complement her unit on epidemiology, Julia stated:

Many of my students have attended a potluck dinner so they are familiar with the concept of multiple individuals bringing in food to share with others. We could have one food product that is contaminated and every individual with a glow-in-the-dark marble would be infected. Once we have established the outbreak we will use the EIS Officer Handbook to figure out how the outbreak occurred. This handbook describes how an individual at the CDC would solve an outbreak if it was reported to them by a local health department. They will actively be gathering information to solve an outbreak of food poisoning (conversational interview).

Over a period of ten days, Julia’s students participated in an outbreak simulation that involved seven major themes: a) exploring possible causes of food-borne illness; b) collecting data: interviewing people to gather information about the outbreak; c) organizing and confirming information through the development of an epidemic curve (a type of graph); d) mathematically charting the range of incubation periods (incubation period=time of experiencing symptoms=time of meal); e) using tally charts to determine the attach rate of each food item served at the supper; f) calculating risk for food items

that were determined to be high risk; and g) interpreting data to support or refute initial hypotheses (anecdotal records). Julia points to her use of this simulation, and others like it, as a way of showing students that science does not always occur in a linear fashion. The work of scientists is far more complex and even involves a great deal of intuition and trial and error. Julia believes that students are often unmotivated because science is simply taught as a linear set of facts. Both Julia and Deborah agreed that contextualized knowledge is at the heart of motivation, and that facts are irrelevant unless seen as part of a larger context.

Julia's use of simulation as a strategy was not without difficulties. Through the use of simulation, Julia hoped to show students how scientific methods are a part of everyday life. She notes, however, that at first "students were just blown away...they could not fathom at all the abstract idea of scientific methods as a part of everyday life." The role of mathematics in science learning created an additional dilemma. Julia believes that mathematics is a tool essential to learning science. Her simulations were based on an expectation of an average level of mathematical skill. However, as Julia soon found out, many of her students lacked what she considered to be very basic, foundational knowledge of mathematics skills such as division. While Julia saw simulation as a strategy which encourages curriculum integration, she was not prepared to deal with students' diverse levels of mathematics understandings. Nevertheless, this pedagogical approach does support a more authentic, contextualized view of science as a social practice—not just an activity of the intellectually privileged.

### **Theme 5: Using Alternative Assessments**

Julia felt that assessment of student learning should match the way in which science is taught. This type of seamless assessment can be illustrated by describing a lesson that Julia taught on force and motion. As part of a force/motion lab, Julia had students brainstorm examples where they could see different principles of force and motion both in the laboratory and outside the classroom. As part of this lesson Julia incorporated an alternative form of assessment which required students to build a roller coaster containing two hills, two loops and two banked curves. As a form of assessment, students had to explain at least seven principles of force and/or motion present in their roller coaster and the importance of these principles to the functioning of the roller coaster. Later, as a summative assessment at the end of the unit on force/motion, Julia showed a video of one of the school's football games. Students had to explain what principles of force and motion were used in the context of this football game.

Research Question 3: What factors constrain the use of a contextual teaching and learning approach in the context of science teaching and learning?

The identification of conceptual, structural and epistemological factors that constrain teachers' ability to successfully develop and implement CTL practices is inextricably linked to the design of effective enabling strategies such as those discussed previously. In this section we describe some of the constraints that emerged as themes relative to Julia's attempts to design and enact a CTL-based science curriculum. Factors that constrained Julia's ability to fully enact her vision of CTL include: a) a disembodied learning community; b) the tension of high takes testing; c) inequities in terms of access to resources; d) the influence of textbooks; e) the domain-specific nature of science topics; and f) the tradition of assessing understanding for grades.

## **Theme 6: The Disembodied Learning Community**

For Julia, as a new teacher, an important starting point for preparing students to learn involved the cultivation of a classroom community for understanding science. At the beginning of the year, Julia assumed that students would already have the knowledge needed to participate as a member of a learning community. She soon realized that “students do not know how to work together. They do not understand the meaning of collaboration.” Julia found herself taking the first part of the school year just helping students develop strategies of collaboration, something she considered essential to effectively fostering an environment conducive to contextual teaching and learning.

The importance of community goes beyond the four walls of the classroom. In Julia’s classroom, as is the case in many classrooms, there was frequently little time for anything more than daily survival. Time for further learning and reflection in collaboration with peers was a pipedream given the crisis management atmosphere of the school and the immediate attention survival necessitates. Julia lamented this lack of collegial support, commenting, “the CTL approach requires a lot of creativity—it is difficult to come up with novel ideas or workable projects without the input of other teachers.” When Deborah asked Julia about the mentoring support available to first year teachers, she was surprised to learn that there were very few experienced teachers in the school. Julia explained how low morale had contributed to a dramatic turnover in teaching staff, resulting in the loss of a historical memory. This in turn created a cycle where there was little support available for new teachers. This is a cycle that both Julia and Deborah agree must be broken.

Thomas Sergiovanni (2000) in his book *The lifeworld of leadership: Creating culture, community and personal meaning in our schools*, emphasizes the importance of place, memory, relationships, and practice for building community in schools. Julia also expressed the need for learning networks to be built between the school and the community, noting, “for our team’s open house only 15 out of 200 parents attended.” Julia emphasized that the school and community must join together in facilitating a vision of contextual teaching and learning, commenting, “perhaps parents see no real purpose for involvement.” Julia felt that integrating parents as speakers within the classroom was an important way to bring together community and school. She encountered difficulties, however, when she tried to do this:

Most parents, because of their work schedules, can only come in for one class period of the day. This does not fit with the way in which our middle schools are set up. Only one group of students will have the opportunity to benefit from the parent’s knowledge (conversational interview).

### **Theme 7: The Tension of High Stakes Testing**

As far as Julia is concerned, it is not what students learn, but how they learn that is fundamental to a contextual and quality education. However, as Julia experienced firsthand, schools are part of a larger system where educational change can not always be equated with quality.

A question that I have no answer for right now is how to balance what I believe my students need to know in their lives right now with what they need to know to pass the CRCT [criterion-referenced competency test] at the end of the year. I am struggling to bring the QCC’s [quality core curriculum] to their lives in a way that

they do not resist. However, it is taking me some time to work through what they need to know, what they want to know, and how we will struggle together”

(journal reflection).

In concert with her belief in the importance of a democratic learning environment, Julia would like to see students and teachers working together to design appropriate methods of assessment at the grass roots level. As Julia shared, this approach—the idea that assessment should not be isolated from the construction of knowledge—was modeled in several of her university CTL seminar classes.

The tension of high stakes testing in the current era of reform seems to stand in stark contrast to the kinds of assessment called for in contextual approaches to teaching and learning. The premise of many high-stakes testing procedures is that “we need to specify precisely what students need to know and then check to see if they know it. We need to specify precisely what teachers need to do and then check to see if they are doing it” (Kincheloe, Steinberg & Tippins, 1999, p. 240).

### **Theme 8: Inequities in Terms of Access to Resources**

Equitable science teaching practice is not something that can be mandated. Julia held a vision of teachers, students, parents and community members working together to bring about learning in science. Her image of an equitable science was, in part, influenced by her CTL service learning class where democracy was a central organizer. Julia considered the notion of a democratic classroom to be an idea central to contextual teaching and learning. In trying to create such a learning environment, she found herself constantly experiencing structural, linguistic and epistemological tensions. Reflecting on

her struggle to encourage all students to participate in project-centered science activities, Julia commented:

I have trouble finding a way for all students to participate in projects which require information gathering and discussions. Many students do not have resources at home--books or newspapers--where they can gather information.

Often times these same students do not have access to a library or other resources (conversational interview).

As Julia and Deborah discussed this tension further, they came to the realization that students' participation in science, particularly girls, was influenced by their role as "othermothers." In this sense, many of Julia's students had after-school responsibilities serving as surrogate mothers for younger siblings which prevented them from readily accessing information from outside the classroom. Julia was quick to point out that this phenomenon was not just a reflection of lower socioeconomic status.

When students need a folder or other materials from home I have some parents that just send a note with some money, rather than helping their child secure these materials. For these parents, responsibility for helping their child develop a sense of accountability is often regulated to the background when juxtaposed with work and other child-rearing responsibilities (personal journal).

Julia was also concerned with the growing number of students who speak little or no English. As an issue of equity, Julia felt that these students were particularly disadvantaged when it came to science. "These students not only must learn the English language, they must also learn the specialized language of science." In this regard, Julia pointed to the example of *Celves: Fundamentals de la Vida*. "We have a CD Rom for

Spanish speaking students, but there are only two disks for 240 students. Furthermore, we have no computers with CD Roms!”

### **Theme 9: The Influence of Textbooks**

For the most part, Julia felt that the required science textbook did not provide contextually appropriate content for learning. The school district had adopted the *Prentice Hall Science Explorer* as a textbook. Julia described this book as

...consisting of guided reading and a study workbook. Essentially, students are supposed to write out definitions, and then copy sentences from the textbook into the workbook. Basically, this book does not seem to promote student thinking or transfer of knowledge to real-life situations (conversational interview).

Julia described a first-hand experience with the limitations of this textbook as it related to a unit on genetics:

After working through a problem in genetics in which we crossed heterozygous and homozygous parents using a punnett square, we began discussing mutations and how these mutations can be passed from one generation to the next. We talked as a group about how scientists use fruit flies to study mutations. I assumed that students would have a clear concept of fruit flies, since there were many pictures in their textbook. As I passed around the tiny flies in vials I overheard Kevin ask ‘when they grow up will you be able to see the red eyes?’ Similar questions followed. It took me awhile to realize that when students saw the tiny flies in the vials they assumed they were baby flies. The pictures in the textbook were enlarged and students did not realize that actual fruit flies would be much smaller. I was able to save this lesson by having students examine the fruit flies

under the dissecting microscope. Only in this way were students able to grasp the idea that the large pictures in their textbook were really the same tiny fruit flies under the microscope (anecdotal record).

Even more problematic than the textbooks, themselves, was the way in which the books and other curricula served to exclude teachers from the design of science teaching and learning. In many instances, Julia was able to move beyond this constraint, choosing to engage in the process of creating and involving her students in creating meaningful units of study. Yet, at the same time, Julia continued to feel the tug and pull of “teaching the book.”

### **Theme 10: The Domain-Specific Nature of Science Topics**

Julia’s major field of concentration in science education is biology. She has taken more biology courses at the undergraduate level than would typically be required of a biology major in the College of Arts and Sciences. Thus it would seem that Julia’s strong preparation in this area would enable her to more easily incorporate contextual examples from biology than examples taken from the physical sciences. Much to the surprise of both Julia and Deborah, this was not the case. Rather, it was the domain-specific nature of the topics that most influenced Julia’s ability to incorporate relevant examples. Julia used the topic of “the cell” to illustrate this point.

What we are required to teach in terms of the cell is basic—the parts of the cell and their functions. I had students create cell models using household items, but only 1/3 of the class showed any interest in that activity. I have struggled to find a way to teach about the parts of the cell in a contextually meaningful way.

At the same time, Julia declared how easy it was to come up with relevant examples from the physical sciences and chemistry. “The nature of the topic is a big determinant in terms of how well it lends itself to a CTL approach.”

### **Theme 11: The Tradition of Assessing Understanding for Grades**

Assessing student understanding for the purpose of assigning grades has long been a task of teachers. While Julia was eager to focus on assessing student understanding beyond the traditional focus of assigning grades, she was unclear about the skills that were needed to develop and analyze embedded assessments as an ongoing part of instruction.

Repeatedly my CTL classes have emphasized that assessment is all about determining what students know, not what they don't know, and I agree with that. I also recognize that any kind of assessment should ideally consider the context in which students are being asked to create knowledge. At the same time I am not sure just how to go about this kind of assessment when it still boils down to the final grade.

Research Question 4: In what ways does science teaching and learning in Julia's class differ from that of more traditional classes?

At first glance, science teaching and learning in Julia's class might seem very similar to what can be found in middle school classrooms across the country. It was only as Deborah increasingly spent time in Julia's classroom that she came to understand and appreciate a significant difference:

What strikes me most is that students seem to have a genuine ownership in their learning. They are actually involved in making decisions about what, how and why they will learn particular science concepts (classroom observation notes).

### **Theme 12: Student Ownership of Learning**

In a conversational interview with Deborah, Julia explained how the concept of student ownership for learning had become an integral part of her teaching philosophy:

I remember during the first CTL seminar how I really had no understanding of the CTL philosophy. At first I hoped to just learn different perspectives on teaching and learning—some alternatives to lecture and recall. I knew that I like more interaction, hands-on activity and tactile experiences. But as my understanding of CTL grew I learned how teachers can transfer ownership for learning to students (conversational interview).

For Julia, the idea of student ownership in learning is what distinguishes CTL from culturally relevant approaches to teaching and learning. While this may not seem significant, Julia is quick to point out the difference:

With culturally relevant curriculum the teacher chooses the curriculum and the way it is to be taught, and just incorporates culture into the various lessons. To me, CTL is quite different than the idea of culturally relevant curriculum. It centers around students and is intended to give them ownership in developing curriculum. It stresses more of a connection between former knowledge and new information (email conversation).

The concept of student ownership was evident in Julia's use of alternative assessment practices. For example, as a way of assessing science projects, Julia involved

her class in creating evaluation rubrics. Students had a voice in the assessment process and developed a better understanding of what counts as “quality” in terms of their work.

### **Conclusion: Looking to the Future**

Julia is certainly a teacher who has come to understand contextualization and the opportunities for students to learn and grow in a democratic society. As she looks ahead to the rest of the school year, she is already beginning to work with her students in conceptualizing a CTL-based project. Through discussions with students and school social workers she has identified a need: many students living below the poverty line do not get nutritional, well-balanced meals during the summer months when school lunches are not readily available. The seed of an idea begins to grow—the cultivation and harvesting of a school garden. As Julia begins to plan for this CTL project she asks many questions of herself and her students:

What skills and knowledge will be needed for this project?

What areas of learning does this project encompass?

How will knowledge be constructed?

How does this project relate to the life worlds of my students?

How does this project relate to myself as a learner?

Who will be the participants and what role will they play in project development and implementation?

What service will be provided?

What preparation is needed?

How will I evaluate and document student learning?

What resources will be needed?

What timeline will be required?

How will I reflect on my learning?

How will the overall impact of the project be evaluated and by whom?

Together with Deborah, Julia recently developed a proposal to secure outside resources for this project. The proposal entitled “*Learning to teach contextually: What really happens?*” was selected for funding through the Georgia Systemic Teacher Education program (GSTEP). The proposal will provide Julia with project-related science equipment and supplies beyond that which is found in the classroom, giving her an added incentive to expand her knowledge of contextual teaching and learning. Expressing her enthusiasm for the CTL approach, Julia commented, “to have students excited about what they are studying excites me as a teacher. My experience with the contextual teaching and learning project has allowed me to see and experience the rewards of this kind of teaching even before I entered the classroom.”

In many ways, Julia seems highly atypical of many first year science teachers. At the same time, she is not unlike many new teachers who are struggling to find a balance between their personal and professional lives. A contextual teaching and learning approach envisions many more teachers like Julia who refuse to teach decontextualized information...teachers who continuously ask from where data came, and how this information can be used to help students confront the world and better understand themselves and the knowledge and skills they need in relation to it. At a time when many educational reforms reinforce the memorization and regurgitation of unconnected facts, contextual teaching and learning approaches hold promise for restoring meaning in the educational process.

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