A SCIENCE CURRICULUM DESIGN USING CRITICAL PROBLEM SOLVING

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B.A., Fort Lewis College Durango, CO 1998

PROJECT

Submitted in partial satisfaction of the requirements for the degree of

MASTER OF ARTS

in

EDUCATION
(Curriculum and Instruction)

at

CALIFORNIA STATE UNIVERSITY, SACRAMENTO

FALL
2009
A SCIENCE CURRICULUM DESIGN USING CRITICAL PROBLEM SOLVING

A project

by

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Abstract

of

A SCIENCE CURRICULUM DESIGN USING CRITICAL PROBLEM SOLVING

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Statement of Problem

The classic European model of education sees students as containers waiting to be filled. The problem with this model is that it promotes a Eurocentric memorize and recall style of learning. As a result, students assume a small and inactive role in their own learning. Consequently, this method of depositing information in students does not fully utilize the exploratory nature of science. When students become involved with their learning as opposed to just reciting facts it promotes problem solving skills and increases self-actualization in learning (Bridges, 1992). Schools of today are far more ethnically diverse and with this diversity many of these cultures do not share the European cultural view of self independence. Despite this, most classrooms are still teacher-centered and individuality is preferred over communal effort. This project utilizes problem based learning combined with Afrocentric and critical pedagogy as counter to Eurocentric style of education where community and questioning is emphasized over the individual and the memorization of facts. This project uses meta-analysis of current literature surrounding problem based learning (PBL), Afrocentric pedagogy, and critical pedagogy in order to create a framework for middle school science teachers called Critical Problem Solving (CPS). Lesson ideas, sample unit outlines and lesson modification ideas in the appendix are designed to foster inquiry, community, critical thinking and reflection within the science classroom. The teacher guide also includes a framework calendar to help sequence the development of a successful CPS curriculum.

Sources of Data

Information was obtained through program coursework as well as research of the related literature. This project uses an analysis of three existing educational models and forms them into a cohesive idea. The first model used and analyzed was problem based learning. The second was critical pedagogy; and the third was Afrocentric pedagogy. These models all have parts that are unique and also have parts in common. These models have been formed into a framework that an educator can apply to their current classroom. A teacher’s guide can be found beginning in appendix A.
Conclusions Reached

Science instruction in the lower grades often focuses on the facts and relies heavily on the student's ability to memorize the information. The reliance on memorization may work for testing purposes but does not teach the student how to solve a problem which is what scientists in the real world do. Additionally, science instruction rarely accesses the student's culture nor does it access the power of the classroom community. Critical Problem Solving is the authors attempt to help teachers move away from the traditional teacher-centered classroom and to promote the students ability to think about science from a more critical viewpoint. Problem based learning to an excellent vehicle to facilitate this process; however, it does not address the socio-cultural needs of the classroom. Afrocentric pedagogy with its dual emphasis on community and self-identity helps PBL address cultural needs of the classroom. Where as critical pedagogy helps the students to think critically about the overall scope of the information on an individual as well as a global level. Students often do not see the connection between the science classroom and the outside world and the current culture of high stakes testing further cements this blindness. In the end a classroom that is carefully led loses its ability to think for itself. Therefore Critical Problem Solving is intended to bring this connection of thinking, solving, and learning back and promote a culture of critical scientific thinking.

___________________________, Committee Chair
Dr. Frank Lilly

___________________________
Date
DEDICATIONS

To my wife for all the support and encouragement she has given me throughout this process.

and

To my parents who always told me to follow my dreams and that I could do anything. Dad, thank you for teaching me to think on my own and how to solve problems when I face them. This project has much of your influence. Mom, thank you for listening and supplying a mother's advice, it has served me well.

Thank you all.

Bryan Gast
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Chapter 1

INTRODUCTION

‘I can't think outside the box because they never let me out’
-unknown

**Background**

‘Memorize this material; there will be a test on Friday.” How many times as students have we heard this phrase? This is all too often the case when teachers are faced with shortened timelines or simply lack the ability to teach the subject matter any other way. In science classes this challenge is no different as teachers attempt to teach difficult material and objectives within a limited time frame. Despite the fact that science is a process of discovery few teachers use that quality as a resource for teaching. Many science teachers still emphasize the memorization of facts and scientific jargon which is often influenced by mandated testing. Unfortunately, past and current teaching practices have replaced scientific discovery with memorization in the classroom.

The ability for a student to learn and reflect on information then act upon that knowledge to from a possible solution is far more powerful than simply the memorization of facts. Although some may argue that to pass state mandated tests students need to learn and memorize facts that will be appearing on that test is required. The author however is arguing the opposite, that if a student has the tools, confidence and support to analyze and solve problems they will not only pass a test, but still have the skills to continue solving problems well the future. Doctors, lawyers, scientists, and other professionals frequently consult reference books and other sources when solving a difficult problem or situation. Notice that they consult, not have memorized information. True, they have memorized
some information, but they rely on their ability to work through a problem to find a solution using prior knowledge. Scientists and non-scientists alike regularly, with confidence, problem solve within a professional community using a praxis based strategy of, analyzing, thinking, planning, acting and reflecting. This is the embodiment of what this project is trying to accomplish in the classroom.

Modern day scientists use an inquiry style called the scientific method to seek solutions to a problem. Additionally, this process is often not done in isolation; it is accomplished as a communal effort. A community of scientists enables all the participants to learn and become masters of the problem as well as the solution. This collaboration has another benefit as it allows many minds to view the problem and present many possible answers. A classic example of this process was Thomas Edison who used a team approach to discovery that led to such inventions as the light bulb and the x-ray machine. Edison created one of the first commercial laboratories wherein a team of people were charged to pursue invention and discovery without restriction.

In the classroom with adequate scaffolding, a similar method can be employed to help students become masters of the material being taught.

The science classroom of the 21st century has changed greatly since Edison's time. While some things have changed (like the use of computers and up-to-date resources) the core process of discovery has not. Today a teacher can recite various ways in which student-led-discovery can occur. A few of these methods include problem based learning, case studies and discovery learning. These methods of teaching are well and good but the problem is they are rarely used by most teachers (Murrel, 2002). The
The process of creating an inquiry or problem based lesson can be long and time consuming. Often teachers feel that they cannot afford the time out of their busy schedules to plan lessons that incorporate true discovery. Also, as mentioned before, many teachers today feel or are constrained by the pressures of mandated testing thus limiting student centered learning.

Lastly, modern schools are sites of diversity never imagined by early educators and this presents unique challenges to teaching science as well. This work will address the needs of that teacher who feels they have no time to plan problem based lessons, help them better manage multicultural needs, move away from rote memorization, promote critical thinking and help teachers rediscover how true science can be put back into the classroom.

Statement of Problem

The classic European model of education sees students as containers waiting to be filled. Paulo Freire states, “Education thus becomes an act of depositing, in which the students are depositories and the teacher is the depositor.” (1990). The problem with this model is that it promotes a memorize-recall style of learning. This style of teaching is commonly called the banking or Eurocentric model of education. As a result, students assume a small and inactive role in their own learning. Consequently, this method of depositing information in students does not fully utilize the exploratory nature of science. On the other hand, the discovery nature of science allows for student contextualization and requires an intimate involvement from the student. John Dewey expressed his belief that subject matter should not be learned in isolation, and that education should begin
with student experience and should be contextual (Dewey, 1938). When students become involved with their learning as opposed to just reciting facts it promotes problem solving skills and increases self-actualization in learning (Bridges, 1992).

Kliebard (1998) notes that Eurocentric model of education has its strongest roots during the Victorian era in England. Here one was considered educated if the individual knew facts. Noted author Charles Dickens scorned the educational practice of the time by writing “Plant nothing else, and root out everything else. You can only form the minds of reasoning animals upon facts; nothing else will ever be of any service to them.” This belief of individuality and self-reliance has been promoted in European culture ever since. However, in today’s classrooms this is less true where the use of ‘group work’ or cooperative learning is often employed. As mentioned earlier, schools today are far more ethnically diverse than the schools found in America just 50 years ago. Along with this diversity many of these cultures do not share the European cultural view of self independence. Despite this, most classrooms are still teacher-centered and individuality is preferred over communal effort. Hence, this project will focus on the use of Afrocentric pedagogy and critical pedagogy as counter to Eurocentric style of education where community and questioning is emphasized over the individual and the memorization of facts without question. This project aims to help students realize that science is a process or culture of discovery and not just the memorization of facts.
Methods

This project uses meta-analysis of current literature surrounding problem based learning (PBL), Afrocentric pedagogy, and critical pedagogy in order to create a framework for middle school science teachers called Critical Problem Solving (CPS). Therefore, this project will provide an alternative method to teaching science that employs a progressive problem based learning methodology grounded in the principles of Afrocentric and critical pedagogy and PBL. By incorporating ideas of critical pedagogy wherein one names the problem and seeks a solution within a community created through principals of Afrocentrism, students will become more competent problem solvers.

These two ideas will be combined with a problem based learning model into a progressive format that guides the student in successful CPS. A teacher's guide will provide middle school teachers a frame-work to create a problem based science curriculum that incorporates self reflection, community effort, critical thinking, and the discovery nature of science. Sample lesson ideas and outlines in the appendix are designed to foster inquiry, community, critical thinking, and refection within the science classroom. The teacher's guide also includes a framework calendar to help sequence the development of a progressive semester long CPS implementation.

The teacher's guide will also provide a method of scaffolding objectives over the course of a semester to enable students to become more confident autonomous problem solvers. Emphasis will be placed on community effort, student culture, emotional confidence, problem solving techniques, critical questioning, and praxis. Additionally, the use of real world problems and case study will guide the learning within the
classroom environment. The teacher in this curriculum acts a facilitator, supports knowledge through scaffolding, direct instruction, and supplies students with help and guidance when needed.

**Theoretical basis of the Project**

This project is based on three main ideas: 1) Afrocentric pedagogy, 2) critical pedagogy, and 3) problem based learning. First, Afrocentric pedagogy is a theory of practice that stems from the ideas of Afrocentrism. Afrocentrism is a world view that emphasizes the importance of African people in culture, philosophy, and history. It also emphasizes the starkly different views between European cultural thought and African culture (Murrel, 2002). Peter Murrell uses this basis then to define what Afrocentric pedagogy is:

“This theory views teaching and learning as a unitary activity and adopts an interactionist conception of teacher and learner engagement. This theory views teaching and learning as a joint activity where teacher and learner have mutual participation, but different roles. The teacher's actions and the students' actions are interdependent, codependent and jointly determine the learning achievements of students as well as the pedagogical acumen of the teacher.” (Murrel, 2002)

Murrell's analysis is in stark contrast to the traditional Eurocentric view of `education where the pupils sit and receive information from a knowledgeable source, the teacher, and have very little interaction in their personal education. Afrocentric pedagogy
therefore provides a strong counter to the Eurocentric model of education; and also provides a framework for teachers facing diverse classrooms.

Critical pedagogy was made somewhat famous by Brazilian Paulo Freire in 1970 when his work entitled *Pedagogy of the Oppressed* was translated from Portuguese to English. Since that time it has become a full fledged topic of study in many colleges and universities around the world. Freire proposed that common people can, with organization, solve problems and thus educate themselves in the process. Freire endorses students’ ability to think critically about their educational situation; this way of thinking allows them to ‘recognize connections between their individual problems and experiences and the social contexts in which they are embedded. Freire goes on to reshape the idea of praxis within the educational setting by defining it as; ‘Praxis involves engaging in a cycle of theory, application, evaluation, reflection, and then back to theory (Freire, 1990).

Another critical pedagogist, Ira Shor (1992), defines critical pedagogy as ‘Habits of thought, reading, writing, and speaking which go beneath surface meaning, first impressions, dominant myths, official pronouncements, traditional clichés, received wisdom, and mere opinions, to understand the deep meaning, root causes, social context, ideology, and personal consequences of any action, event, object, process, organization, experience, text, subject matter, policy, mass media, or discourse’.

Finally the last educational theory used us problem based learning or PBL. Teachers have been using PBL strategies for years as a tool to help students solve problems in a more real world context. Problem based learning attempts to help students solve problems using prior knowledge to construct solutions to a task put forth by the
teacher. This is a common practice in many science classrooms as teachers try to help students ‘discover’ a solution to a pre-determined scientific idea.

Hypothesis

Therefore the end goal is that students are able to independently problem solve science in a community-like environment. Additionally, students will be able to apply these skills to many other aspects of school and life. Thus, by using Afrocentric pedagogy where community, (i.e.) meaning making practices and identity development are central themes students develop the strong team building skills necessary for successful inquiry practice. This combined with praxis, the cyclical process of naming a problem, analysis, action and reflection; creates a classroom atmosphere where students take charge of their learning. The curriculum guides the learner in this approach in a progressive manner starting from a simple, non-threatening beginning and giving them the tools to be more independent and competent problem solvers by the end.

Definition of Terms

This project uses the following terms within the work:

Progressive curriculum: A curriculum designed to start students with simple, introductory strategies and problems then moving incrementally to harder more complex ones.

Problem Based learning: (PBL) is a student-centered instructional strategy in which students collaboratively solve problems and reflect on their experiences.
**Praxis**

Praxis is the process by which a theory, lesson, or skill is enacted or practiced. As used by Paulo Freire, ‘praxis’ is a synthesis of theory and practice in which each informs the other.

**Critical pedagogy or critical theory:** Critical pedagogy is a teaching approach that attempts to help students question and challenge various social dominations, and the beliefs and practices that promote that domination.

**Afrocentric Pedagogy:** A practice of teaching that is defined by five major tenants that include; Identity development, community identity, Inquiry, meaning making practices, and engagement as defined by Peter Murrell 2002.

**Critical Problem Solving (CPS):** The amalgamation of Afrocentric pedagogy, critical pedagogy and problem based learning in an effort to create individuals and communities with the ability to critically analyze and solve problems in science as well as in other applications.
Chapter 2

REVIEW OF THE RELATED LITERATURE

This review of literature will be broken into three sections. The first will cover the concepts of problem based learning, Afrocentric pedagogy and critical pedagogy as viewed in the educational realm. The second section will assess how the above mentioned categories apply directly to the science classroom. Finally, conclusions as to how all of these ideas need to integrate to promote effective inquiry based science learning in the classroom.

What is Problem Based Learning?

Problem based learning is certainly not a new idea in the world of education but its definitions and uses are complex and varied. John Dewey was one of the first to use a form of problem based learning in his laboratory school in Chicago. One of Dewey’s major philosophical beliefs was experiential education. His theory of experience based learning continues to be read and discussed not only within education, but also in other fields such as psychology and philosophy. In Dewey’s pedagogic creed he states:

“...The nature of experience can be understood only by noting that it includes an active and a passive element peculiarly combined. On the active hand, experience is trying -- a meaning which is made explicit in the connected term experiment. On the passive, it is undergoing. When we experience something we act upon it, we do something with it; then we suffer or undergo the consequences. We do something to the thing and then it does something to us in return: such is the peculiar combination. The
connection of these two phases of experience measures the fruitfulness or value of the experience (Dewey, 1916)."

It is interesting to note that even in 1916 the value of being active in one’s education has merits over being a passive observer of it. Confucius is credited with saying “I hear and I forget. I see and I remember. I do and I understand” (Moncur, 2007). Even around 400 BC the power of doing and not just hearing was recognized. Therefore, the context in which information is learned resembles the context in which it will later be applied (Bridges, 1992). This is more technically termed ‘encoding specificity’ and research shows that knowledge is much more likely to be remembered or recalled in the context in which it was originally learned (Godden & Baddeley, 1975). Encoding specificity in problem-based learning is achieved by having students acquire knowledge in a functional context, that is, in a context containing problems that closely resemble the problems they will encounter later in life (Bridges, 1992).

The promotion of cognitive processes in children has long been sought by educators. According to Vallance (1999), one body of curriculum writing views the greatest concern of curriculum development as the promotion of the cognitive processes in children. The theory here is that providing cognitive skills will enable them (children) to attack problems and master material presented in class (Vallance, 1999). Additionally, the advantages of PBL have been used in medical training since the 1940's. The experience inherent in the PBL process assists doctors as they learn how to diagnose problems with patients (Gürses, Aşıkylı, Doğar, & Sözbilir, 2007). Prawat (1989) notes that the advantage of PBL is that students become much more aware of how the
knowledge they are acquiring can be put to use. Additionally, having a problem-solving mentality, even when it is marginally appropriate, reinforces the idea that the knowledge is useful for achieving particular goals. Prawat (1989) states that “Students are not being asked to store information away; they see how it works in certain situations which increase the accessibility” (p.18). Clearly the power of PBL can be seen in the medical field since it is a doctor's job to correctly diagnose and correct patients' needs through the use of deduction. These examples from Dewey in the early 1900s to modern day medical training reinforces the fact the problem based learning approach works in education.

Bridges (1990) lists four reasons on the basis of cognitive learning as to why PBL should be used. 1) Students retain little of what they learn when taught in a traditional lecture format (Bok, 1989). This is supported by Gregg and Farnnham (1975) who contend that verbal instruction requires problem solving and thus students may have a difficult time in remembering instructions. Additionally, Gregg and Farnnham (1975) provide support by stating that symbolic cue's like mathematic figures may only be retained for a quarter of a second. 2) Students often do not appropriately use the knowledge they have learned (Schmidt, 1983). 3) Since students forget much of what is learned or use their knowledge inappropriately, instructors should create conditions that optimize retrieval and appropriate use of the knowledge in future professional practices (Bridges, 1992). 4) PBL creates the three conditions that information theory links to subsequent retrieval and appropriate use of new information. These conditions are the activation of prior knowledge, similarity of contexts in which information is learned and later applied, and opportunity to elaborate in that information (Schmidt, 1983).
Teachers know that verbal information is often missed or misused. Additionally teachers want students to remember the information that they have learned. The simple act of memorization is just that, memorization and is often forgotten. Problem based learning is one way to avoid many of the pitfalls of the traditional direct instruction format commonly used in classrooms.

*Problem versus Inquiry Based Learning*

Eggen and Kauchak (1996) discuss two types of student directed learning. The first is inquiry based learning and the second problem based learning. Both employ different methods however; the intended outcomes are the same. In inquiry based learning is a process of systematically answering questions based on evidence. The use of hypotheses and data gathering are used to assess and form a conclusion about a problem. This method is very similar to what many would call the scientific method. The steps of the inquiry method include: 1) identify the question; 2) generate a hypothesis; 3) gather data; 4) assess the hypothesis; and 5) generalize or conclude. These steps are very close to the accepted inquiry model known as the scientific method. This method requires advanced critical thinking skills (Eggen & Kauchak, 1996).

The other method is problem based learning. In this method the students assume primary responsibility for the problem and the teacher facilitates. Here teachers want students to investigate the problem and take control of their own learning (Eggen & Kauchak, 1996). The goal for PBL students is to gain a deep understanding of a specific topic. This model differs in the fact that there may not be a hypothesis or the analysis of data. The PBL model employs four steps and then a question, they are: 1) assess
knowledge relative to the problem; 2) identify additional information needed; 3) develop and implement plan to gather new information; 4) use new knowledge in problem solving. Once the students have worked through the four steps they ask whether or not the problem was solved, if not then the student's return to step two. Otherwise the problem was solved (Eggen & Kauchak, 1996).

Both methods require the students to investigate and seek a solution to a problem. The major difference is in inquiry based learning the problem may not necessarily get solved where in PBL learning there is a concrete answer. For advanced students where mandated state testing is not an issue, ambiguous outcomes are fine. In a middle school science classroom however, the solution needs to teach an important skill and support critical thinking at the same time.

Specific Aims and Goals of Problem Based Learning

What do students learn from a problem-based learning exercise? That is, what and how much knowledge do students acquire? People who ask this question have frequently been trained in discipline-based education (traditional education) (Gürses, Açıkyıldız, Doğar, & Sözbilir, 2007). As mentioned earlier, PBL has been used extensively in the field of medicine for some time. Barrows and Tamblyn (1980) suggest the reason why this method of teaching future doctors is used is because ‘the learning that results from the process of working toward the understanding or resolution of a problem’ (p. 18). In other words, the problem is encountered first in the learning process and serves as a focus or stimulus. Once the problem is isolated then the application of problem solving or reasoning skills can be applied. The students also need to search for information and
knowledge needed to understand the problem and how it might be resolved (Barrows & Tamblyn, 1980). Bridges (1992) asserts that the rationale for using this approach for training of doctors can be applied to other areas of education as well. He specifically cites the training of administrators but this can be used in any subject where students will need to assess a problem and come up with an applicable solution.

In a study of chemistry students by Gürses (2007), 40 percent of the students surveyed after a PBL approach to a lesson commented that “PBL encouraged us to investigate, and therefore, use library and Internet resources which made us to take the course more seriously and work intensively” (p. 9). This fits with what Bridges (1992) states where he writes that:

“Information is better understood, processed, and recalled if students have an opportunity to elaborate in that information. Elaborations provide redundancy in the memory structure, which in turn reduces forgetting and abets retrial. Elaboration occurs in problem based learning in various ways, namely, discussing the subject matter with other students, teaching peers what they first leaned themselves, exchanging views about how the information applies to the problem they are seeking to solve, and preparing essays about what they have learned while seeking to solve the problem.” (Bridges, 1992, p. 9)

Therefore problem based learning is a process that when properly employed intimately involves the students in their own learning. It provides opportunities for students to confront, analyze and solve problems. Additionally it forces students to access
and use prior knowledge on a regular basis. All of these characteristics are needed and are regularly used in the scientific community and can be successfully used in the science classroom.

**Afrocentric Pedagogy**

Afrocentric pedagogy has its roots in Afrocentrism. Afrocentrism is a world view that emphasizes the importance of African people in culture, philosophy, and history (Gates & Appiah, 2005). This history has its roots in Egypt, but more importantly it is a way of doing that is profoundly different than the Eurocentric point of view. Murrell states that African American children are ascribed with “relational traits” and European American children are ascribed with “analytical traits” (Murrell, 2002). As mentioned earlier the educational philosophy of Europe emphasized facts over practical knowledge; the individual over the community. In contrast, in Afrocentric pedagogy the community and its cultural knowledge are emphasized over the individual.

To access these “relational” traits Murrell (2002) presents a model that features five central practices. They are; 1) engagement and participation practices; 2) identity development practices; 3) community integrity practices; 4) practices of inquiry and; 5) meaning making practices. Much of Murrell's work centers around the education of African Americans however, much of his work can be adapted to any culture not just that of African Americans.

In Murrell's (2002) model, engagement and participation practices are tools used by the instructor to establish the significance of the activity to the learner. Murrell suggests employing classroom activities that create productivity towards a social
consciousness and self reflection and which utilize the socio-cultural background of students. Additionally, teachers should employ new methods for knowledge transmission.

Identity development practices are the second foundation of Murrell's (2002) pedagogy. Here teachers develop activities that promote internal reflection, investigation, reflection and meaning. Murrell outlines three avenues for identity development. The first is creating multiple opportunities for oral development that utilize student experiences. The second is by emphasizing the use of information in multiple contexts and encouraging investigation of the curriculum content. Third and last, teachers need to focus on creating interpersonal interaction for the purpose of developing initiative within students and the community.

The third part of Murrell's pedagogical model involves community integrity practices. This is a classroom that promotes academic and social organization of students within their community. To do this Murrell again outlines three ways in to accomplish this. Instructors need to create familiar societal bonds as coping mechanisms for shared inimical conditions. Teachers need to encourage collaboration and communal success. Last, the use of culturally relevant communication patterns are needed in order to effectively transmit information.

Practices of inquiry are the fourth spoke of Murrell's models of Afrocentric pedagogy. Classroom interactions that promote critical engagement and examination of phenomena are used. Murrell suggests that educators should help to encourage and establish ‘collective memory’ that the students can draw upon. One way to help with the creation of this collective memory of the students' is to tap into cultures of the pupils.
Thus, teachers need to utilize the culture of the student as part of the instruction. Also in creating practices of inquiry the establishment of goals and the anticipation of those accomplishments is clear and unmistakable to the participants.

The last of Murrell's five points is perhaps the most critical. The concept of meaning making practices is used to increase student knowledge. Classroom interactions that utilize student's culture are used to create meaning in the lesson. Students need an understanding of theories of knowledge as they differ between Afrocentrism and Eurocentrism. The utilization of literature that encourages examination of the media for the purpose of exploring fallacies presented regarding the student's culture and place in society as a whole. In the case of Murrell's work, fallacies specifically regarding African Americans illustrated, but any culture can use this as a tool to examine information within their socio-cultural setting.

Other authors such as Ginwright (2004) emphasize more of the everyday life experiences. Ginwright's Afrocentric pedagogical model focuses more on the social, cultural, political and economic background of the students. Ginwright presents five distinct parts to meet the needs of African American students. 1) encourage students to critically address the hierarchal power constructs and systems within American society; 2) emphasize the relationship and correlation between racial individuality and maturity with issues of social justice and equity; 3) education of students in methods of changing paradigms and constructs of society; 4) allowing and educating students to organize collaboratively; and 5) the embracement of urban adolescent culture (Ginwright, 2004).
There are many other models of Afrocentric pedagogy and they use similar principals as outlined by Murrell and Ginwright. Wood (2007) effectively summarizes the many models of Afrocentric pedagogy. Wood notes that all Afrocentric models emphasize different aspects of African history and culture. However, these models share several common features; they challenge Eurocentric cultural norms, seek educational equity, and embrace African American history, culture and learning styles as an asset. Finally, and perhaps most importantly, Afrocentric pedagogy accounts for the generational needs of African Americans in order to increase their success in academia.

Afrocentric Pedagogy in the Classroom

Afrocentric pedagogy in the classroom has a very different feel and look than a traditional Eurocentric environment. Schultz (Schultz, 2008) presents a good model of what an Afrocentric pedagogy looks like in the classroom. Schultz creates an entire curriculum around topics that are directly affecting the students. In this situation the classroom is in the infamous Cabrini Green projects of Chicago. The students identified problems facing their school and set to rectify them. Schultz “inverted” the curriculum and designed it around the student needs, not on the mandated state tests. Students were allowed to decide, design, manage and implement the learning goals. Murrell (2002) states that: “Engagement in social practice is the fundamental process by which we learn and become who we are” (p. 82). In Schultz’s classroom many of the principals of Afrocentric education were employed including identity development, cultural knowledge and community effort. Schultz’s work demonstrates without a doubt that when
students are given a real challenge, with real world implications, the [the students] rise to the occasion and show their true abilities.

Bridges asserts that when prior knowledge is activated students understand the new information better. That is, students apply knowledge they already posses in order to understand the new information. This prior knowledge and the kind of cognitive structure in which it is stored determine what is understood from the new experience and what is learned from it. Problems are then selected and sequenced to ensure that this activation of prior knowledge occurs (Bridges, 1992). When Schultz (2008)“inverts” his curriculum to meet the needs of the students based on what the students express Schultz is accessing prior information then designing problems to draw upon this knowledge.

Since Afrocentric pedagogy utilizes the store of cultural knowledge and community effort, much of the responsibility for learning is placed on the student. Teachers assist in creating a community of practice where learning, inquiry, interrogation and deliberation pose and solve problems situated in world activity (Murrel, 2002). In short the Afrocentric classroom in based in reality and emphasizes the culture, community and prior knowledge of the learners.

**Critical Pedagogy**

Critical pedagogy at its heart is a radical ideology of creating real social change from a grass-roots effort. Thus, critical pedagogy is the critical analysis of race and class in society. In order to create a classroom where open inquiry is possible ideas of race and class must be addressed. Without doing so true free and open questioning of ideas will not take place. In order to better answer this question of race and class, an understanding
of its history is needed. Antonia Darder (2003) provides a good history on the subject of race and class in education. She states that “Critical pedagogy is fundamentally committed to the development and evolvement of schooling that supports the empowerment of culturally marginalized and economically disenfranchised students” (p.11). Darder begins her discussion of race and class by assembling a series of quotes from various authors regarding the subject. It is interesting to note that the first quote she chooses is from John Dewey in 1916.

A society which makes provision for participation in its good of all members on equal terms and which secures flexible readjustment of its institutions through interaction of the different forms of associated life is insofar democratic. Such a society must have a type of education which gives individuals a personal interest in social relationships and control, and the habits of mind which secure social changes. (John Dewey, 1916)

Dewey makes note that education must be flexible, democratic, and, most importantly, focus on the individual. From a modern view, bell hooks also embraces and praises the idea of the individual and its value in education. In her book Teaching to Transgress, she discusses how teachers should embrace multiculturalism in the classroom to be an effective teacher. In order to engage students they must be allowed to speak with their own voice and relate school to their personal values and beliefs (hooks, 1994).

Darder also examines several other factors of race and class in society and how critical pedagogy has influenced education. One of the underlying factors discussed in depth is the concept of hegemony. Hegemony is a process of social control carried out
through the intellectual and moral leadership of a dominant class over subordinate groups (Darder, 2003). This term can also relate to other connections within society such as politics, economics, and culture. In the United States hegemony can be linked to the ruling class, in this case white males (Lynn, 2004).

There is a second dynamic however that plays in opposition to hegemony. This resistance of the oppressed counters the dominant and can affect change. Darder (2003) spends a section discussing what she calls resistance and counter-hegemony. This is a very important factor as to why very little action occurs to change the current system. It asserts that the people who are being oppressed lack the knowledge and ability to change what is happening to them. It is assumed, though, that all people have the ability to resist and promote change. It is this ability that is needed to be accessed in order to create real and lasting change. However, this ability is heavily influenced by the social and material conditions in which people have been forced to live in, as well as the ideological formations that have been internalized in the process (Darder, 2003). bell hooks also suggests that language has a counter hegemonic power as well. When a common language is used it allows a group to organize and share information (hooks, 1994). On the other hand, hooks also points out that language can also play a part in keeping people oppressed by hindering the access to the educational system with a language barrier. With this said, educators are constantly struggling against the current hegemony that perpetuates through our society and many try to create a counter hegemony within our classrooms. However, within the current culture this is a difficult and challenging process.
One example provided by McLaren, Martin, Farahmandpur, and Jaramillo (2004) is of the National Reading Panel and how it often defines reading levels. The panel decides (scientifically) what is considered to be appropriate reading passages based on pre-determined reading levels. This leads to the proliferation of corporate reading programs that support highly regimented, rote and prescriptive reading instruction claiming to be scientifically valid (McLaren, 2004). McLaren et al. cites one example of this, ‘California will follow suit by funding only those schools adopting Houghton Mifflin and McGraw-Hill reading programs’ (California Department of Education, 2003). This kind of hegemonic control over reading and other programs make it very difficult for any educator to design and implement a program that is free of bias and culturally relevant.

In 1964 Paulo Freire, when politically exiled from Brazil, used the time to analyze the socio-political situation in his home country and proposed some unique ideas about critical pedagogy. In his work Pedagogy of the Oppressed, he describes how the oppression of one people by another more powerful group can be challenged. Freire suggests a method of liberation for such people in any situation through education and action. Through these ideas Paulo Freire became a major influence in the development of how to promote change between a ruling class and an oppressed class the world over. However, many of his ideas and thoughts are easily transferred to the realm of education. Freire discusses at length how education is one of the keys to changing an oppressive situation. Freire (1990) states that “the pursuit of full humanity, however, cannot be carried out in isolation or individualism, but only in fellowship and solidarity; therefore it
cannot unfold in the antagonist relation between oppressors and oppressed” (p. 73). In this quote Freire expresses the fact the people must work together to solve problems.

Currently the dominant class sets up and controls the educational system. Educators like Horace Mann helped to put in place the education system that we know today (Tanner, 2007). Unfortunately, that system has changed very little since then and it still favors the dominant class in this country. Freire would say that fear is one reason that the educational system has not changed. Indeed fear as a powerful factor in race and class interactions from the classroom the administration building. Freire describes how both the oppressor and the oppressed are afraid of change. It is interesting to note that he speaks of men’s fear of freedom, as if freedom will be horrible or unjust in some way. Freire states: “Men rarely admit their fear of freedom openly, however, tending rather to camouflage it- sometimes unconsciously- by presenting themselves as defenders of freedom.” (p, 21). This brings up questions, are educators afraid of change in the system? Since the majority of educators are white, are they trying to maintain, perhaps unconsciously, the status quo? Or are they so afraid that when change in the system is proposed they are frightened of the unknown?

Freire also speaks of dehumanization and the oppressors who cause it. Are educators dehumanizing the students because they are promoting a system of oppression? As teachers, we strive for an idealistic classroom; one where race and class are less important and every student is capable of achieving tremendous goals. Freire states that the “freedom to create and to construct, to wonder and to venture. Such freedom requires that the individual be active and responsible, not a slave to a well-fed cog in a machine.”
This again brings up numerous questions such as: when white, middle-class teachers work in low-income, non-white schools, are they teaching creativity or producing another cog? Are teachers inadvertently contributing to the oppressive nature of the dominant society by dehumanizing students into a submissive position? Although schools today may not be the harsh and oppressive conditions that Freire speaks of, are they acting on a more subversive level, just under the consciousness of public understanding?

In the end, Critical pedagogy is needed to break free of the Eurocentric teaching styles that dominate classrooms today. For teachers to be able to do this an awareness of race and class inside and outside the classroom is needed. Critical pedagogy also encourages teachers to assess and critique the information they are expected to teach for bias and hegemonic undertones. All science educators need to look critically at their curriculum and decide whether or not they are perpetuating a system of controlled, predetermined facts, or promoting true scientific inquiry open to all peoples.

Critical Pedagogy in the Classroom

Henry Giroux speaks to critical theory as a “self conscience critique” (Giroux, 2003, p. 27). However, Giroux, as cited by Bartolome (2003) states that the debate regarding the improvement in student academic achievement occurs at a level that treats education as primarily a technical issue. Thus if education is seen as a technical issue then it becomes taught that way. Bartolome (2003) contends that because education has been reduced to technical provisions the solution to the problem of academic underachievement tends to be constructed primarily in methodological and mechanistic
terms (Bartolome, 2003). The No Child Left Behind Act of 2001 (Public Law 107-110) requires that all states give standardized testing. This has led to teachers teaching students to pass the test which is a mechanistic device to attempt to solve educational problems. Dewey (as cited by Tanner, 1997) hypothesized that intellectual initiative and independence of judgment - qualities that are essential in a democratic society - are incompatible with closely constrained movement. As long as education is thought of as rote or mechanistic, the ability of a teacher to foster the critical thinking that is needed for science will be extremely difficult.

Critical pedagogy is also somewhat unique in its use of dialectical thinking. Dialectical thinking is a critical review of society that searches out contradictions. The dialectical nature of critical theory enables the educator to see the school not simply as an area of indoctrination or socialization or a site of instruction, but also as a cultural terrain that promotes student empowerment and self-transformation (McLaren, 1989). McLaren goes on to state that “For the critical educator, there are many sides to a problem” (1989, p. 168). Critical pedagogy thus allows for students to view problems from multiple analytical as well as socio-economic angles. With this in mind when children are engaged in activity of interest to them that presents difficulties, they look for a method of coping with the difficulties and thus acquire new skills (Tanner, 1997). When this occurs additional opportunities are provided for the child to use their newly acquired skills and complete the learning circuit. In this circuit, what is learned must be present to the child as a desirable end or objective and therefore as a motive to exert effort (Tanner, 1997).
Finally, PBL helps to foster this learning circuit by promoting problems with a tangible solution.

So what is critical pedagogy in the classroom? Giroux (2003) states that critical theory is the nature of a self-conscience critique and the need to develop discourse that does not cling to its own dogma. In other words it is both a ‘school of thought’ and a process of critique. Therefore a classroom that is employing critical pedagogy is constantly analyzing and critiquing the knowledge being acquired as a way of learning and knowing. Tanner (1997) cites Katherine Camp, a director of elementary science teaching as saying, ‘From the point of view of this psychological principal the problem of elementary science, then is: What activities furnish opportunities to be used in the growth of scientific method and concepts?’ (p.42). Critical theory would answer this question by arguing that through the analysis of the methods and concepts, they [methods and concepts] will create the opportunities of growth and learning.

Conclusions

As one looks closer at these three ideas of problem based learning, Afrocentric pedagogy, and critical pedagogy they have many similarities. However, in the literature they are often treated separately. Stein (2008) asserts that learning occurs in a wide range of interactions. Multimodal education is a theory of communication that holds that meaning is always made in the many different modes and media which make up the communicational ensemble (Stein, 2008). By employing all three educational theories when teaching science a wide range of multimodal interactions can be achieved.
Both Murrell (2002) and Freire (1990) speak of *praxis*. Praxis is at the heart of both pedagogy’s and both call upon the learner to take charge of their learning and challenge the traditional social order in which they find themselves (Freire, 1990; Murrel, 2002; McLaren, 2004; Ginwright, 2004). Problem Based Learning can access the principals of both theories to create a more effective framework for inquiry based science instruction. Dewey stated in his pedagogic creed (1897) “I believe that education, therefore, is a process of living and not a preparation for future living.” Bridges states (1992) that information is better understood, processed, and recalled if students have an opportunity to elaborate on that information. Elaborations provide redundancy in the memory structure, which in turn reduces forgetting. Additionally Tanner (1997) asserts that “The [PBL] activities supply occasions for creating difficulties and motives for dealing with them, and there is no sudden transition as children acquire new skills.” Clearly PBL strategies work in the classroom from doctors to kindergartners; therefore when the proven strengths of PBL are combined with the social constructs of critical and Afrocentric pedagogy strong multimodal learning and positive student engagement can occur in the classroom.

Science however, is not always black and white and discoveries are often made when they are not expected. In today’s current climate of high stakes testing, the opportunity for students to be able to engage in this type of learning is very limited. Indeed the whole notion of high stakes testing harkens back to Victorian times when only facts were considered important (Kliebard, 1998). Additionally many would argue that the current system of education promotes a limited world view that does not access those
strengths of individual cultures or thought processes (Giroux, 2003; Ginwright, 2004). As simply stated by John Dewey (1897), “I believe that under existing conditions far too much of the stimulus and control proceeds from the teacher” (p.2).

In this project the author uses an amalgamation of these three separate ideas (PBL, Afrocentric and critical pedagogy) to create a new framework for teaching science called Critical Problem Solving. With the tools of Afrocentric pedagogy which focuses on the learner’s cultural strengths and builds upon a community of learners; combined with critical pedagogy that seeks out to critique and analyze current issues facing individuals; united with a PBL framework a strong Critical Problem Solving program can be built.

With this in mind teachers should embrace the cultural strengths of students as well as the classroom, teach them to question the curriculum (and science), and foster the development of a culture of thinking. The fact that students who actively engage, question, and solve problems learn and retain more information than in traditional methods is a powerful argument. When the power of PBL methods combine with cultural power of the learner along with a combined knowledge of a community of learners in a science classroom significant learning can occur.
Chapter 3

METHODS

I believe that the school must represent present life--life as real and vital to the child as that which he carries on in the home, in the neighborhood, or on the playground (Dewey, My Pedagogic Creed, 1897).

Setting and Intended Participants

This project is intended to be used in a sixth through eighth grade middle school science classroom. These grade levels are a critical time for establishing the ability to think critically. In the primary grades scientific emphases is placed on broad over-reaching concepts and simple facts. Once students enter high school subject matter and teachers expect students to be come prepared with the skills to work through problems. The middle school years are therefore a critical transition time where scientific problem solving skills must be learned. Additionally, this framework can be applied in both rural and urban settings. Since CPS has a focus that specifically addresses race and culture it can impart the ideas of critical thinking across a wide range of gender, cultural, and is not limited to one socio-economic group.

Instruments

This project uses an analysis of three existing educational models and synthesizes them into a cohesive idea. The first model used and analyzed was problem based learning. The second was critical pedagogy; and the third was Afrocentric pedagogy. These models all have parts that are unique and also have parts in common. These models
have been formed into a framework that an educator can apply to their current classroom.

A teacher's guide can be found beginning in appendix A.

Design

Through a review of the literature very little information was found that linked science with the student's culture. Nor was there any significant literature regarding science and social theory. The author used this gap in the literature to design a curriculum that brings more of these concepts to play in a science classroom. To do this the author adapted concepts from PBL, Afrocentric and Critical pedagogies.

Many of the concepts in both critical pedagogy and Afrocentric pedagogy overlap. However despite this overlap there is a surprising lack of connective literature. There is significant research on subjects such as problem based learning and the socio-economic status of students and how these may affect their ability to learn. It seems however that these studies have been done in isolation and simply focus on either cultural issues or teaching methods, never both simultaneously.

In the tables below the ideas of both critical and Afrocentric pedagogy are listed and described for comparison. Also major concepts of problem based learning are listed as well as described. These three ideas have been combined to form one idea called Critical Problem Solving.
Critical pedagogy is a living theory used to challenge the social structure and to question power relationships within society. At the heart of this pedagogy is this idea of praxis, a circular method of doing that encourages the student to take personal action to better their lives and that of others. This is always done in a real world context and the problems as never abstract or vague. Critical theory often uses race and class differences as a vehicle for the starting and ending point to cause change within an oppressive system.

Afrocentric pedagogy is grounded in ideas of Afrocentrism which believes that all peoples descended from Africa. However, it moves beyond this by applying the ideas of a student's unique culture to learning. This theory makes a point to access the latent socio-cultural knowledge of the learner. In Afrocentric pedagogy community is emphasized over the individual. The learning and the success of the entire group is desirable over just
one individual. Conversely, Afrocentrism recognizes that the individual needs to be aware of their place, or how they fit into the overall community.

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<tr>
<th>Problem Based Learning</th>
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<tr>
<td>Contextual learning</td>
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<td>Student control of learning</td>
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<td>Application of knowledge</td>
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<tr>
<td>Activation of prior knowledge</td>
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<td>Creation of new cognitive pathways</td>
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Table 3 Problem Based learning

This old idea is often used in the sciences as teachers use it to frame real world contextual problems for learners. Problem based learning asks the learners to find the solution to a given task. To solve the problem students must be able to access prior knowledge and apply it to a new situation. By doing this [accessing then applying] the learner forms new cognitive pathways and thus remembers the concept needed better (Bridges, 1992).

Procedure

These three previously discussed ideas were analyzed and then merged into one new theory for teaching science. The amalgamation of the three methods is called Critical Problem Solving. The tenants of Critical Problem Solving are listed below and discussed later.

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<th>Critical Problem Solving</th>
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<tr>
<td>Communal effort</td>
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<td>Culturally applicable problems</td>
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<td>Problem solving techniques</td>
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<td>Self identity within the whole</td>
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<td>Hegemonic deconstruction</td>
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<td>Praxis</td>
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Table 4 Critical Problem Solving
Problem versus Inquiry Based Learning

As mentioned earlier, Eggen and Kauchak (1996) discuss two types of student directed learning. The first is inquiry based learning and the second problem based learning (PBL). Both employ different a different process however; the intended outcomes are the same. In inquiry based learning a process of systematically answering questions based on evidence is used to seek the answer to a problem. The use of a hypothesis and data gathering are used to assess and form a conclusion about a problem. This method is very similar to the scientific method. The down side to this method is it can produce ambiguous answers. For middle school students these ambiguous answers can be difficult to accept or even understand. This method is best suited for more advanced students that have acquired advanced reasoning and problem solving skills.

Even though inquiry based learning may be more scientific in nature at its heart students need the fundamental skills and knowledge to successfully implement it.

Therefore the problem based learning model is more appropriate for the middle grades since teacher facilitation is a key part. This method of problem based learning as described by Eggen and Kauchak (1996) provides for a more guided experience that produces more concrete results. In this method the students assume the primary responsibility for the problem or task and the teacher facilitates. Here teachers want students to investigate the problem and take control of their own learning. The goal for PBL students is to gain a deep understanding of a specific topic. This model differs in the fact that there may not be a hypothesis or the analysis of data (Eggen & Kauchak, 1996).
Problem based learning allows students to learn both the process skills and the background knowledge needed for more complicated inquiry later.

APPLICATION OF CRITICAL PROBLEM SOLVING

*CPS and the Student*

Every problem is unique and requires the students to follow a different path each time to solve. By using CPS students can collectively create a map to solve problems they are faced. Rarely is a solution to a problem simple and black and white, nor is every problem solved the same way. By employing a team, or in this case a community of students to confront a problem, unique perspectives can be applied toward a solution. When a student can personally relate to the problem it takes on more depth and meaning. Therefore when students apply prior knowledge and learned problem solving tools the path to the solution becomes a journey which produces more concrete knowledge. During this process of problem solving students gain self confidence and begin to find a place within the community of learners. As students use their tools to tackle the problem advanced CPS students question where their search is leading them, if tools and information are biased or even inappropriate for the situation for the problem. When students do reach an acceptable solution they have learned yet another avenue to solve a problem. This new found information can then be reflected upon and used again when presented with a new challenge through praxis.
CPS and the Teacher

Teachers use CPS to present problems and provide the tools for student investigations toward a solution. When teachers allow for students to work in communal effort students gain the feeling of independence and autonomy. Students who work within a community learn from each other and help with understanding. This technique also suggests that teachers who present culturally applicable problems will make content connections faster with the learners. Teachers using CPS provide and teach a verity of problem solving techniques for students to use as tools necessary to solve problems presented later. Teachers promote roles and identities within the learning community. This identity development enables students realize that even though this is a communal effort, in order for the community to function their individual contribution is necessary. One of the biggest and most difficult roles the teacher has in CPS is hegemonic deconstruction. This is vitally important for the instructor to practice since without it teachers are simply promoting information without thinking of its history or background and its influence on the students. Without hegemonic deconstruction the ability to promote open and creative thought is severely limited. When teachers stop questioning where the curriculum is coming from and what it is trying to teach true scientific thought is lost. Finally, teachers who apply praxis within their curriculum and provide opportunities to students to apply prior knowledge will create students that can do more than just recite facts, they take a problem, question it, analyze, and apply strategies as well as use facts to achieve a solution.
Communal Effort

In Afrocentric pedagogy Murrell (2002) discusses the merits of why community is necessary. This idea if community integrity makes sense as often scientific, or for that matter, any discovery is rarely made in isolation. In today’s technologically connected world many students are connected in ways that were impossible 10 years ago. This newfound digital community can and should be applied to a classroom. Murrell suggests the use of culturally relevant communication patterns. The internet, music, and other digital
media are all now culturally relevant communication patterns to the modern student that can promote community.

Community also means that students feel that they can express new ideas to the group without fear of retribution. There is a sense of belonging that accompanies efforts and students should not feel isolated. Classroom communities also need to feel supported by the teacher in their efforts. Teachers need to respect the path and the decisions of the community. This is vital if the community is to grow and learn about the process of solving a problem. A classroom that is carefully led loses its ability to think for itself. Critical Problem Solving at its core is about being able to think through a problem, not shown the way.

A classroom that promotes academic and social organization of students within the classroom and within, the larger community will help to establish credibility of the learning. Often students do not see the relevance to a lesson outside the classroom but if the lesson is allowed into the community then a relevant connection can be made. To do this, instructors need to create familiar societal bonds within the classroom to help with interaction with the outside community. This is necessary as not all interactions outside the community are positive and some may even be hostile. Teachers need to encourage as much collaboration internally and externally as possible to create learning connections. Last teachers need to recognize communal success when achieved.
Culturally Applicable Problems

In both the Afrocentric and critical pedagogy models the idea that problems are of immediate and of socio-cultural significance is key. Too many times science lessons are abstract and contain little or no cultural connection with the learner. For example; a rural instructor when teaching physics would use perhaps a tractor when describing force relationships. The same lesson in an urban area might use the local commuter train as an example. There is more to this than just picking lesson objects that students recognize, it involves creating a lesson that allows the culture in and become part of the lesson.

Critical pedagogy directly addresses the cultural foundations of the learner and challenges them to analyze and critique a problem from a unique perspective. The advantage to this is that in science there is never just one way to solve a problem. Every student brings a culturally unique point of view to the table that just might be the best approach to the situation. In this way students can engage on multiple levels in a more personal way.

Afrocentric pedagogy stresses that engagement and participation practices are tools used by the instructor to establish the significance of the activity to the learner. Murrell (2002) suggests employing classroom activities that create productivity towards a social consciousness should be used. Murrell also argues that instructors should use meaning making practices as a way to increase student knowledge. That is, classroom interactions that utilize student's culture are used to create meaning in the lesson.

Conceptualization of the science problems is often lagging in science instruction. Many students may be able to do mathematical computations or recite facts but do not
have deep understanding of the concepts (Lin & Chou, 2004; Gaigher, Rognab, & M.W.H., 2007). Gaigher, Rognab and Brauna (2007) cite that success in calculating correct numerical answers did not necessarily imply that a corresponding level of conceptual understanding was reached. In fact, instruction focusing on mathematical problem-solving often ignores intellectual objectives and could encourage students to concentrate on algorithms instead of exploring a conceptual understanding. Gaigher, Rognab and Brauna (2007) cite McDermott (1991) who advocated that students should be intellectually engaged in the learning process in order to bring about significant conceptual change. She suggested that a deep mental engagement could be developed when students were required to explain their reasoning in their own words. Therefore by directing students to examine problems beyond the standard requirements will develop a greater understanding of the concepts.

**Problem Solving Techniques**

In order for students to be able to tackle and solve problems in the science classroom they need the cognitive tools to do this. With government mandated assessment of student learning often science teaching is reduced to memorization of facts. This leaves little room for teachers to teach the skills needed to solve problems that may be encountered later on in life. There are many techniques to acquire these skills such as think pair share, teammates consult, cause and effect, case based, and cooperative learning. Additionally students should be allowed to collaborate to form their own conclusions, apply them and see them either succeed or fail as a community. Also in
creating practices of inquiry the establishment of goals and the anticipation of those accomplishments is clear and unmistakable to the participants.

In both critical theory and in Afrocentric pedagogy students are asked to apply skills and techniques to assess and solve the problem at hand. Instructors create classroom interactions that promote critical engagement and examination of the situation. Murrell suggests that educators should help to encourage and establish “collective memory” that the students can draw upon. One way to help with the creation of this collective memory of the students is to tap into the culture of the students. Thus instructors need to utilize the culture of the student as part of the instructional techniques.

There is a wide array of problem solving strategies and techniques. The teacher needs to have a good working knowledge of many of these techniques in order to teach students multiple ways a tackling a problem. No two problems are the same and therefore may require multiple strategies applied at different points to reach a solution. Research suggests that science students who are able to conceptualize problems using problem-solving techniques have a greater understanding and working knowledge of the topic (Gaighera, Roganb, & Brauna, 2007). This suggests that if students use multiple tools to problem solve and can in some way identify with the task have a greater chance of remembering the information. A list and a discussion of problem-solving strategies and how to apply them is given in the teacher’s guide in appendix A.

**Self Identity**

One of the foundations of Afrocentric pedagogy is identity development. In order for students to be successful in a community they must recognize that they have a role to
play. Teachers know that students who feel that they have no purpose quickly become a focus point. Murrells (2002) also suggests that students need to identify with their culture as well to be successful. When students recognize that they can be successful and apply their knowledge outside the classroom, learning increases. Teachers develop self identity activities that promote internal reflection, investigation, reflection and meaning. Murrell outlines three avenues for identity development. The first is creating multiple opportunities for oral development that utilizes student experiences. The second is by emphasizing the use of information in multiple contexts and encouraging investigation of the curriculum content. Third and last, teachers need to focus on creating interpersonal interaction for the purpose of developing initiative within students and the community.

Freire (1990) states that “I cannot think for others, nor can others think for me” (p. 100). This idea is exactly what students need to realize when creating a self identity. Once students recognize this they gain a new level of creative autonomy. Students can then bring this confidence to bear on the community and provide needed insight and ideas to solving the problem at hand.

*Hegemonic Deconstruction*

The process of hegemonic deconstruction in CPS is used when students are actively searching for answers to the problems they are trying to solve. Here students are encouraged to look at where the information is coming from, who wrote it and for what purpose. They are encouraged to look for alternate solutions not necessarily found in the mainstream media.
For teachers, this is also a critical juncture in lesson planning. Here the teacher needs to decide for them self if the information they are presenting is biased towards a specific group in both content and in presentation. This often difficult for teachers as they may unknowingly be contributing to these preconceived social restrictions about race and class. For example; most scientific discoveries in textbooks are credited to men from Europe. Teachers who teach exclusively from a book often fall into this trap as they don't realize there may be other information available. Unfortunately many teachers feel constrained by the social constraints leveled against many groups in education. Current practices such as No Child Left Behind (NCLB) promote the Eurocentric style of teaching which does little to allow for cultural uniqueness not to mention looking at the controlling aspects of education. Many would argue that NCLB itself is a form of hegemonic control over education (McLaren, 2004).

Additionally the historic trend of testing such as the SAT or the Stanford Tests emphasize that the facts themselves are more important than the application and use of those very same facts. Students need to realize that their culture or race may have preconceived societal restrictions placed upon them from outside the classroom.

*Praxis*

Both critical and Afrocentric pedagogy employ the term praxis. Praxis is the process by which a theory, lesson, or skill is enacted or practiced. As used by Paulo Freire, ‘praxis’ is a synthesis of theory and practice in which each informs the other (1990). Critical Problem Solving cannot effectively work without this idea. These skills, communal effort, culturally applicable problems, problem solving techniques, self
identity, and hegemonic deconstruction must be constantly revisited. Finally, both models encourage self reflection and utilize the socio-cultural background of students. Praxis is the key to all of these models and without it they do not function properly.

If all problems were the same, then problem solving would not be necessary. One could simply apply the same formula again and again and the solution would present itself. In effect there would no longer be problems to solve. Math teachers routinely use problem solving when asking students to work a math equation. This is not problem solving since many math equations can be solved using a formulistic or algorithmic process that guides the pupil to an answer. True problems are ones where the path to the solution is not known. This unknown path is one that requires the use of praxis to travel down. The very nature of problems is that they are challenges that are individually unique; if they were not then they would not be problems. In effect praxis as applied to CPS is the ability for a community or an individual to use all the knowledge already known, and seek or discover the new knowledge needed to solve each unique problem faced. Teachers as well as students need to continually apply praxis to their learning and teaching practice. If this does not happen the ability to problem solve does not evolve. When this ability to problem solve is practiced, applied and studied (praxis) teachers as well as students become life-long learners.

**Summary**

In summary, the classic European model of education sees students as containers waiting to be filled. The problem with this model is that it promotes a Eurocentric memorize and recall style of learning. As a result, students assume a small and inactive
role in their own learning. Consequently, this method of depositing information in students does not fully utilize the exploratory nature of science. When students become involved with their learning as opposed to just reciting facts it promotes problem solving skills and increases self-actualization in learning (Bridges, 1992). Schools of today are far more ethnically diverse and with this diversity many of these cultures do not share the European cultural view of self independence. Despite this, most classrooms are still teacher-centered and individuality is preferred over communal effort. By utilizing problem based learning combined with Afrocentric and critical pedagogy as counter to Eurocentric style of education where community and questioning is emphasized over the individual and the memorization of facts an alternative method of teaching can be achieved. Through the analysis of current literature surrounding PBL, Afrocentric pedagogy, and critical pedagogy a framework of teaching was developed called CPS. This model was created by the author for middle school science teachers to promote critical thinking in science. With the outlined tools teachers can design lessons to foster inquiry, community, critical thinking and reflection within the science classroom. Thus, the science teacher can begin to create a classroom community where critical thinking is the norm and not the exception.
Chapter 4

SUMMARY, LIMITATIONS AND RECOMMENDATIONS

“If the only tool you have is a hammer, you tend to see every problem as a nail.”
Abraham Maslow (1908 - 1970)

Science is about asking questions and solving problems. This process though is not one that is easily learned or put into practice. The idea of Critical Problem Solving allows for students to learn the needed techniques to critique and solve problems faced in science. Additionally, it allows students to work in a non-threatening environment that also promotes free thought. As discussed earlier, scientific discoveries are often made when restrictions to convention are lifted. Being able to critically address a problem is a great benefit to any student. The application of CPS by the student and the teacher is different depending on the role. Teachers are facilitators by presenting problems, working to foster a culture of scientific thought as well as recognizing and remove hegemonic barriers. Students on the other hand work to find the solutions to a task as an individual while working within a community to critically examining a problem.

With the tools of Afrocentric pedagogy which focuses on the learner's cultural strengths and builds upon a community of learners; combined with critical pedagogy that seeks out to critique and analyze current issues facing individuals a strong CPS based program can be built. Teachers should embrace the cultural strengths of students, teach them to question the curriculum (and science), and foster the development of a culture of inquiry. The synthesis of these three separate ideas by the author (PBL, Afrocentric and critical pedagogy) creates a Critical Problem Solving framework for teaching science.
Limitations

Every classroom is different and although this work attempts to provide the tools necessary for a teacher to successfully establish a successful CPS based science classroom there may be factors that may impede this. Teaching requires great flexibility and understanding of the class at hand. This work is not intended to replace current curriculum but instead to supplement and reshape it into a more student centered inquiry based program that takes advantage of student culture, community and the discovery nature of science. Since many teachers already have some PBL lessons on file that they use in their classroom CPS allows for current lessons to be modified to help better access the cultural and communal strengths of the class.

For teachers this program may take time to develop as they learn about their students. Since no classroom is ever the same and often teachers and students come from different backgrounds, time is required to learn about the students and the world they come from. This program [CPS] requires that teachers use culturally applicable lessons. Teachers in their first year (even ones not new to teaching) at a new school may not be able to successfully implement CPS since the teacher does not know the full culture of the students being taught.

Recommendations

The author recognizes that many teachers must or feel they must conform to overarching teaching practices that are influenced by their employers. This program [CPS] produces a classroom that is significantly different than that of the typical teacher centered classroom format. In order to implement this program teachers will need to be
flexible and work with-in their current situation to clearly explain what it is they are doing and why. The effectiveness of this program will hinge on the teacher's ability to allow the students to take an active role in their learning and step back from the traditional role of a teacher. This means that teachers must give the students the freedom to stumble, struggle and ultimately discover the solutions when presented with problems.

Conclusions

Science instruction in the lower grades often focuses on the facts and relies heavily on the student's ability to memorize the information. The reliance on memorization may work for testing purposes but does not teach the student how to solve a problem which is what scientists in the real world do. Additionally, science instruction rarely accesses the student's culture nor does it access the power of the classroom community. Critical Problem Solving is the author's attempt to help teachers move away from the traditional teacher-centered classroom and to promote the student's ability to think about science from a more critical viewpoint. Problem based learning is an excellent vehicle to facilitate this process; however, it does not address the socio-cultural needs of the classroom. Afrocentric pedagogy with its dual emphasis on community and self-identity helps PBL address the cultural needs of the classroom. Critical pedagogy then helps students to think critically about the overall scope of the information on an individual as well as a global level. Students often do not see the connection between the science classroom and the outside world and the current culture of high stakes testing further cements this blindness. In the end, a classroom that is carefully led loses its ability to think for itself. Critical Problem Solving at its core is about being able to think through
a problem, not shown the way. Therefore Critical Problem Solving is intended to bring this connection of thinking, solving, and learning back and promote a culture of critical scientific thinking.
APPENDICES
# APPENDIX A

Teacher's User Manual for Applying Critical Problem Solving in the Classroom.

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INTRODUCTION

“Each problem that I solved became a rule which served afterwards to solve other problems.” Rene Descartes (1596 - 1650)

Many teachers who have been teaching for years have their own style and are comfortable with how they teach. Indeed, resistance is often encountered when a teacher feels that they are being forced to change. Additionally, asking a teacher to reinvent their curriculum will elicit groans and questions. For many teachers the idea of re-inventing the wheel seems like a fruitless task and often question what good will come of all the effort. This teacher's manual is designed with that teacher in mind.

Many science teachers often already have good lessons surrounding a topic, however many may be teacher centered or ‘pseudo-student’ centered. These ‘pseudo-student’ lessons often appear to be student driven but lack the critical thinking aspect and in the end are really teacher centered. The ideas of Critical Problem Solving are meant to enhance your classroom to encourage more critical thinking on the part of the student.

This manual helps the teacher determine what aspects of the classroom environment need improvement to encourage a more open and critical atmosphere. Once that is determined then the manual goes on to help the teacher assess and modify existing lessons to fill the gaps.

As with any new program, do not expect instant results when using CPS. This style of teaching takes some break-in time on the part of the student and teacher. Since many of today's students have not been asked or required to think critically this process may begin with struggles and complaints from the students. Students need to be taught
and shown how to think critically. For teachers, the idea of allowing students to fail and assess their own failure may be difficult to swallow. It is in the nature of the teacher to catch a student when they stumble or perhaps “guide” a little too much. Also many teachers rely on worksheets and rote work to fill gaps in lessons; this trap often reinforces the Eurocentric model of education that relies on the memorization of facts, not the ability to critically apply those facts to solve a problem. In other words, worksheets have their place just be careful that the worksheet has a purpose and it is not just ‘busywork’.

Finally, a brief note regarding standardized testing and CPS pedagogy. Schools and teachers alike are feeling the pressure for students to perform well on mandated testing. Some may ask, how can CPS improve scores when the test often asks for specific information? As many successful test takers will tell you, the ability to assess the question and deduce what it is asking combined with a logical assessment of the possible answers will often produce a successful result. It is impossible for a teacher to cover all the possible questions a student may face on a standardized test. Alternatively, teaching a student to critically analyze a problem will increase the possibility that even if a student does not know the answer outright, the ability to critically work out an answer is the next best thing. Critical Problem Solving can greatly improve a student's ability to reason out an answer instead of just skipping it because they did not know the answer. With factual knowledge combined with the ability to problem solve students can master any test.
THEORETICAL BACKGROUND

What is Problem Based Learning?

Problem based learning (PBL) is certainly not a new idea in the world of education but its definitions and uses are complex and varied. John Dewey was one of the first to use a form of PBL in his laboratory school in Chicago during the turn of the century (1900). One of Dewey's major philosophical and educational beliefs was experiential learning. Simply put, Dewey believed that learning should be contextual and meaningful to the learner. His [Dewey's] theory of experience based learning continues to be read and discussed not only within education, as well and the benefits of PBL in the classroom.

Contextual learning can be defined as the context in which information is learned resembles the context in which it will later be applied (Bridges, 1992). This is more technically termed“encoding specificity’ and research shows that knowledge is much more likely to be remembered or recalled in the context in which it was originally learned (Godden & Baddeley, 1975). Encoding specificity in problem based learning is achieved by having students acquire knowledge in a functional context, that is, in a context containing problems that closely resemble the problems they will encounter later in life (Bridges, 1992). The theory here is that providing cognitive skills will enable them (children) to attack problems and master material presented in class (Vallance, 1999).

Having a problem-solving mentality, even when it is marginally appropriate, reinforces the idea that the knowledge is useful for achieving particular goals. Prawat (1989) states that "Students are not being asked to store information away; they see how it works in
certain situations which increase the accessibility’ (p.18). Consequently, this theory of education has been used in medical training since the 1940’s with great success.

The promotion of cognitive processes in children has long been sought by educators. According to Vallance (1999), one body of curriculum writing views the greatest concern of curriculum development as the promotion of the cognitive processes in children. Bridges (1990) lists four reasons on the basis of cognitive learning as to why PBL should be used. 1) Students retain little of what they learn when taught in a traditional lecture format (Bok, 1989). This is supported by Gregg and Farnnham (1975) who contend that verbal instruction requires problem solving and thus students may have a difficult time in remembering instructions. Additionally, Gregg and Farnnham (1975) provide support by stating that symbolic cue’s like mathematic figures may only be retained for a quarter of a second. 2) Students often do not appropriately use the knowledge they have learned (Schmidt, 1983). 3) Since students forget much of what is learned or use their knowledge inappropriately, instructors should create conditions that optimize retrieval and appropriate use of the knowledge in future professional practices (Bridges, 1992). 4) PBL creates the three conditions that information theory links to subsequent retrieval and appropriate use of new information. These conditions are the activation of prior knowledge, similarity of contexts in which information is learned and later applied, and opportunity to elaborate in that information (Schmidt, 1983). These four points are strong reasons that PBL promotes cognitive processes that are sought by educations. Since all teachers want students to remember the information that they have learned PBL methods are a highly effective tool to achieve this goal. The simple act of
memorization is just that, memorization is often forgotten or learned without context. Therefore, PBL is one way to avoid many pitfalls commonly found in traditional, direct instruction classrooms.

Afrocentric Pedagogy

Afrocentric pedagogy, in brief, has its roots in Afrocentrism. Afrocentrism is a world view that emphasizes the importance of African people in culture, philosophy, and history (Gates & Appiah, 2005). This history has its roots in Egypt, but more importantly it is a way of doing that is profoundly different than the Eurocentric point of view. Murrell states that African American children are ascribed with ‘relational traits’ and European American children are ascribed with ‘analytical traits’ (Murrell, 2002). The educational philosophy of Europe emphasizes facts over practical knowledge; the individual over the community. In contrast, Afrocentric pedagogy the community and its cultural knowledge are emphasized over the individual. This section could be a book in of itself but we will briefly touch on a few authors who generally represent the ideals of Afrocentric Pedagogy. If the reader is interested in more there are some suggested readings in Appendix B.

Peter Murrell asserts that “An effective pedagogy should provide teachers with a unifying framework for how they are to apply understanding of human cognition, learning, and development” (p. x). With this in mind Murrell spends a great deal of time defining and explaining his pedagogical theory. In his pedagogy to access these ‘relational’ traits of African American student’s Murrell (2002) presents a model that features five central practices, they are: 1) engagement and participation practices; 2) identity
development practices; 3) community integrity practices; 4) practices of inquiry and; 5) meaning making practices. Much of Murrell's work centers around the education of African Americans however, much of his work can be adapted to any culture not just that of African Americans.

Other authors such as Ginwright (2004) emphasize more of the everyday life experiences. Ginwright's Afrocentric pedagogical model focuses more on the social, cultural, political and economic background of the students. Ginwright presents five distinct parts to meet the needs of African American students. 1) encourage students to critically address the hierarchal power constructs and systems within American society; 2) emphasize the relationship and correlation between racial individuality and maturity with issues of social justice and equity; 3) education of students in methods of changing paradigms and constructs of society; 4) allowing and educating students to organize collaboratively; and 5) the embracement of urban adolescent culture (Ginwright, 2004).

There are many other models of Afrocentric pedagogy and they use similar principals as outlined by Murrell and Ginwright. Wood (2007) effectively summarizes the many models of Afrocentric pedagogy. Wood notes that all Afrocentric models emphasize different aspects of African history and culture. However, these models share several common features; they challenge Eurocentric cultural norms, seek educational equity, and embrace African American history, culture and learning styles as an asset. Finally, it accounts for the generational needs of African Americans in order to increase their success in academia.
Critical Pedagogy

Critical pedagogy at its heart is a radical ideology of creating real social change from a grass-roots effort. Thus, critical pedagogy is the critical analysis of race and class in society. In order to create a classroom where open inquiry is possible ideas of race and class must be addressed. Without doing so true free and open questioning of ideas will not take place. In order to better answer this question of race and class, an understanding of its history is needed. This section, like the previous concerning Afrocentric pedagogy merits far more discussion than what is presented here, again the reader is directed to appendix B for further study.

One such author, Antonia Darder (2003) states that "Critical pedagogy is fundamentally committed to the development and evolvement of schooling that supports the empowerment of culturally marginalized and economically disenfranchised students." (p.11). In her discussion, Darder examines several factors of race and class in society and how critical pedagogy has influenced education. One of these influential factors discussed at length is the concept of hegemony. Hegemony is a process of social control carried out through the intellectual and moral leadership of a dominant class over subordinate groups (Darder, 2003). This term can also relate to other connections within society such as politics, economics, and culture. In the United States hegemony can be linked to the ruling class, in this case white males (Lynn, 2004).

There is a second dynamic however that plays in opposition to hegemony. This resistance of the oppressed counters the dominant and can affect change. This is a very important factor as to why very little action occurs to change the current system. It asserts
that the people who are being oppressed lack the knowledge and ability to change what is happening to them. It is assumed, though, that all people have the ability to resist and promote change. It is this ability that is needed to be accessed in order to create real and lasting change. However, this ability is heavily influenced by the social and material conditions in which people have been forced to live in, as well as the ideological formations that have been internalized in the process (Darder, 2003). bell hooks also suggests that language has a counter hegemonic power as well. When a common language is used it allows a group to organize and share information (hooks, 1994). On the other hand, hooks also points out that language can also play a part in keeping people oppressed by hindering the access to the educational system with a language barrier (i.e. scientific vocabulary). With this said, educators are constantly struggling against the current hegemony that perpetuates through our society and many try to create a counter hegemony within our classrooms. However, within the current culture this is a difficult and challenging process.

In 1964 Paulo Freire, when politically exiled from Brazil, used the time to analyze the socio-political situation in his home country and proposed some unique ideas about critical pedagogy. In his work *Pedagogy of the Oppressed*, he describes how the oppression of one people by another more powerful group can be challenged. Freire suggests a method of liberation for such people in any situation through education and action. Through these ideas Paulo Freire became a major influence in the development of how to promote change between a ruling class and an oppressed class the world over. However, many of his ideas and thoughts are easily transferred to the realm of education.
Freire discusses at length how education is one of the keys to changing an oppressive situation. Freire (1990) states that “the pursuit of full humanity, however, cannot be carried out in isolation or individualism, but only in fellowship and solidarity; therefore it cannot unfold in the antagonist relation between oppressors and oppressed” (p. 73). In this quote Freire expresses the fact the people must work together to solve problems. Currently the dominant class sets up and controls the educational system. Educators like Horace Mann helped to put in place the education system that we know today (Tanner, 2007). Unfortunately, that system has changed very little since then and it still favors the dominant class in this country. Freire would say that fear is one reason that the educational system has not changed. Indeed, fear is a powerful factor in race and class interactions from the classroom to the administration building. Freire describes how both the oppressor and the oppressed are afraid of change. It is interesting to note that he speaks of men’s fear of freedom, as if freedom will be horrible or unjust in some way. Freire states: “Men rarely admit their fear of freedom openly, however, tending rather to camouflage it- sometimes unconsciously- by presenting themselves as defenders of freedom.” (p. 21). This brings up questions, are educators afraid of change in the system? Since the majority of educators are white, are they trying to maintain, perhaps unconsciously, the status quo? Or are they so afraid that when change in the system is proposed they are frightened of the unknown?

In the end, Critical pedagogy is needed to break free of the Eurocentric teaching styles that dominate classrooms today. For teachers to be able to do this an awareness of race and class inside and outside the classroom is needed. Critical pedagogy also
encourages teachers to assess and critique the information they are expected to teach for bias and hegemonic undertones. All science educators need to look critically at their curriculum and decide whether or not they are perpetuating a system of controlled, predetermined facts, or promoting true scientific inquiry open to all peoples.

**Conclusions**

As one looks closer at these three ideas of problem based learning, Afrocentric pedagogy, and critical pedagogy they have many similarities. However, in the literature they are often treated separately. Stein (2008) asserts that learning occurs in a wide range of interactions. Multimodal education is a theory of communication that holds that meaning is always made in the many different modes and media which make up the communicational ensemble (Stein, 2008). By employing all three educational theories when teaching science a wide range of multimodal interactions can be achieved.

Both Murrell (2002) and Freire (1990) speak of praxis. Praxis is at the heart of both pedagogy’s and both call upon the learner to take charge of their learning and challenge the traditional social order in which they find themselves (Freire, 1990; Murrel, 2002; McLaren, 2004; Ginwright, 2004). Problem Based Learning can access the principals of both theories to create a more effective framework for inquiry based science instruction. Dewey stated in his pedagogic creed (1897) “I believe that education, therefore, is a process of living and not a preparation for future living.” Bridges states (1992) that information is better understood, processed, and recalled if students have an opportunity to elaborate on that information. Elaborations provide redundancy in the memory structure, which in turn reduces forgetting. Additionally Tanner (1997) asserts
that “The [PBL] activities supply occasions for creating difficulties and motives for
dealing with them, and there is no sudden transition as children acquire new skills.”

Clearly PBL strategies work in the classroom from doctors to kindergartners; therefore
when the proven strengths of PBL are combined with the social constructs of critical and
Afrocentric pedagogy strong multimodal learning and positive student engagement can
occur in the classroom.

Science however, is not always black and white and discoveries are often made
when they are not expected. In today's current climate of high stakes testing the
opportunity for students to be able to engage in this type of learning is very limited.
Indeed the whole notion of high stakes testing harkens back to Victorian times when only
facts were considered important (Kliebard, 1998). Additionally many would argue that
the current system of education promotes a limited world view that does not access those
strengths of individual cultures or thought processes (Giroux, 2003; Ginwright, 2004).
As simply stated by John Dewey (1897), “I believe that under existing conditions far too
much of the stimulus and control proceeds from the teacher” (p. 2).

CPS is an amalgamation of these three separate ideas (PBL, Afrocentric and
critical pedagogy) to create a new framework for teaching science. With the tools of
Afrocentric pedagogy which focuses on the learners cultural strengths and builds upon a
community of learners; combined with critical pedagogy that seeks out to critique and
analyze current issues facing individuals; united with a PBL framework a strong Critical
Problem Solving program can be built.
In summary, the classic European model of education sees students as containers waiting to be filled. The problem with this model is that it promotes a Eurocentric memorize and recall style of learning. As a result, students assume a small and inactive role in their own learning. Consequently, this method of depositing information in students does not fully utilize the exploratory nature of science. When students become involved with their learning as opposed to just reciting facts it promotes problem solving skills and increases self-actualization in learning (Bridges, 1992). Schools of today are far more ethnically diverse and with this diversity many of these cultures do not share the European cultural view of self independence. Despite this, most classrooms are still teacher-centered and individuality is preferred over communal effort. By utilizing problem based learning combined with Afrocentric and critical pedagogy as counter to Eurocentric style of education where community and questioning is emphasized over the individual and the memorization of facts an alternative method of teaching can be achieved. With the outlined tools teachers can design lessons to foster inquiry, community, critical thinking and reflection within the science classroom. Thus, the science teacher can begin to create a classroom community where critical thinking is the norm and not the exception.

THE CPS PROCESS

Goals of CPS

The goal of CPS is to create an environment that promotes critical thinking both inside and outside the classroom while incorporating the student's culture and community. CPS creates students that are able to independently problem solve science in a
community like environment. Additionally, students will be able to apply these skills to many other aspects of school and life. Thus, by using Afrocentric pedagogy where community, meaning making practices and identity development are central themes students develop the strong team building skills necessary for successful inquiry practice. This combined with praxis, the cyclical process of naming a problem, analysis, action and reflection; creates a classroom atmosphere where students take charge of their learning. The curriculum guides the learner in a progressive manner giving them the tools to be more independent and competent problem solvers. In brief, the goals of CPS are listed below.

- Students work collectively
- The problems faced are relevant to the student
- The students’ ‘toolbox’ contains multiple problem solving strategies
- Students know their individual role and or purpose
- Problems are assessed from multiple view points (scientific and social)
- Continuous reflection and assessment of work, process and product

With these goals in mind teachers should embrace the cultural strengths of students as well as the classroom, teach them to question the curriculum (and science), and foster the development of a culture of thinking. The fact that students who actively engage, question, and solve problems learn and retain more information than in traditional methods is a powerful argument. When the power of PBL methods combine
with cultural power of the learner along with a combined knowledge of a community of learners in a science classroom significant learning can occur.

**Critical Problem Solving**

Since the classic Euro-centric (teacher centered) classroom is the one most teachers are familiar with the need to understand how CPS is different. We will begin by looking at the overarching goals of CPS then looking at six aspects of the pedagogy independently. Each aspect of CPS is critical and none is more important that the other, although beginning teachers may have some difficulty in attaining a balance at the beginning. The six areas are; communal effort, culturally applicable problems, problem solving techniques, self identity, hegemonic deconstruction, and praxis. These six parts will be discussed in-depth later on.

**The Six parts of CPS**

Teachers use CPS to present problems and provide the tools for student investigations toward a solution. The process involves six distinct facets that need to be touched upon in each lesson. These six areas are communal effort, culturally applicable problems, problem solving techniques, self identity, hegemonic deconstruction, and praxis. All six work together in concert to promote critical thinking.
CPS and the Student

Every problem is unique and requires the students to follow a different path each time to solve. By using CPS students can collectively create a map to solve problems they are faced. Rarely is a solution to a problem simple and black and white, nor is every problem solved the same way. By employing a team, or in this case a community of students to confront a problem, unique perspectives can be applied toward a solution. When a student can personally relate to the problem it [the problem] takes on more depth and meaning. When students apply prior knowledge and use problem solving tools both the path to the solution becomes a learning journey which produces more concrete
learning. During this process of problem solving students gain self confidence and begin to find a place within the community of learners. As students use their tools to tackle the problem, advanced CPS students question where their search is leading them, if tools and information are biased or even inappropriate for the situation for the problem. When students do reach an acceptable solution they have learned yet another avenue to solve a problem. This new found information can then be reflected upon and used again when presented with a new challenge through praxis.

The following sections brake down the six sections, one for each aspect of CPS. Each of the six sections describes in detail what that part entails. Also there are lesson examples, worksheets or tools to help the teacher apply each section. First however, a classroom diagnostic is given to help the teacher gain an understanding of where the students are already in terms of the six areas. For example, some classrooms may already be strong communities or perhaps students already have a strong sense of place in the classroom. If this is true then you already have one or more of the six areas done and you can focus on strengthening the remaining aspects.
**Classroom Diagnostic**

Think closely about each question and whether they are occurring in your classroom. Sections with two or more ‘no’ answers are areas which could use action.

**Answer each Statement with a yes or no**

**Community**

1. Students typically sit in groups in class ........................................... Yes  No
2. Students work in teams at least twice a week ................................. Yes  No
3. Community building occurs on a semi-regular basis .......................... Yes  No
4. Students are allowed to discuss problems as part of the lesson ........ Yes  No

**Culturally Applicable Problems**

1. Do lessons regularly reflect current events? ......................................... Yes  No
2. Are students allowed to incorporate their own ‘language’ when presenting their solutions? ......................................................... Yes  No
3. Lessons reflect the community in which the school serves ................. Yes  No
4. Students can draw upon personal experiences when relating to problems ......................................................................................... Yes  No

**Problem Solving**

1. Laboratory activities are conducted at least once a week .................... Yes  No
2. Students are allowed to create their own experiments ........................ Yes  No
3. Students can work problems slightly above their skill level ............... Yes  No
4. Students can easily create a ‘map’ to solve a new problem .............. Yes  No

**Self identity**

1. When students are in groups, each student has a role ......................... Yes  No
2. Students articulate how the task relates to them personally ............... Yes  No
3. Team tasks include both individual and group responsibilities ...... Yes  No
4. Students can describe how they contributed to the community ....... Yes  No
Hegemonic Deconstruction

1. Lessons often deviate from textbook to allow more analysis……Yes……No
2. Students often question where or how the content originated……Yes……No
3. Science content is often linked to national or global issues……Yes……No
4. Students are able to explore opposing views on scientific issues……Yes……No

Praxis

1. Students often reflect on their work………………………………………………Yes……No
2. Students can plan how to solve problems before they begin……Yes……No
3. Students use past experience to guide current activities……Yes……No
4. Students can identify weaknesses with the problem solving process, the community, them-self and work to improve each area………………………………………………Yes……No
Section I Communal Effort

In Afrocentric pedagogy, Murrell (2002) discusses the merits of why community is necessary. This idea of community integrity makes sense as often scientific, or for that matter, any discovery is rarely made in isolation. In today's technologically connected world many students are connected in ways that were impossible 10 years ago. This newfound digital community can and should be applied to a classroom. Murrell suggests the use of culturally relevant communication patterns. The internet, music, and other digital media are all now culturally relevant communication patterns to the modern student that can promote community.

Community also means that students feel that they can express new ideas to the group without fear of retribution. There is a sense of belonging that accompanies efforts and students should not feel isolated. Classroom communities also need to feel supported by the teacher in their efforts. Teachers need to respect the path and the decisions of the community. This is vital if the community is to grow and learn about the process of solving a problem. A classroom that is carefully led loses its ability to think for itself. Critical Problem Solving at its core is about being able to think through a problem, not be shown the way.

A classroom that promotes academic and social organization of students within the classroom and, within the larger community will help to establish credibility of learning. Often students do not see the relevance of a lesson outside the classroom but if
the lesson is allowed into the community then a relevant connection can be made. To do
this, instructors need to create familiar societal bonds within the classroom to help with
interaction with the outside community. This is necessary as not all interactions outside
the community are positive and some may even be hostile. Teachers need to encourage as
much collaboration internally and externally as possible to create learning connections.
Last, teachers need to recognize communal success when it is achieved. In order to
 recognize this success team or group activities need to be employed on a regular basis.
Many teachers already do this, however CPS asks those groups to conduct a more critical
analysis than most lessons require. Remember that community is just one of six parts that
work in harmony to promote critical thinking.

   Classroom layout can also either promote or discourage community. Classrooms
that are setup with students sitting as individuals will not promote community. When
planning lessons decide how you can rearrange the room into groups to facilitate
communication and discussion. Teachers who worry about off-task talking or behavior
problems need to address the community and identity roles within groups. CPS requires
that tasks be relevant to the student, culturally applicable, and have clear identifiable
roles within the group. If these conditions are met then teacher’s worries about unwanted
behavior should be minimal.

   Community Building Activities

   Community building activities are often seen as fun games to do if there is time.
This is a great error as a classroom that has a strong community will not only learn better
but also help with classroom management issues. The importance of building a strong
community cannot be overstated. Students will work together better in small group activities as well as large ones and more learning will occur. Time during the year *needs to be taken* to develop and promote community; not just once during the first or last week of school but several times throughout the term. Below are listed a series of Problem-Solving-Initiative Games adapted from the AwesomeLibrary.org that can be used to help form community bonds ranging from easy to hard (Adams, 2009).

Initiative games are fun, cooperative, challenging games in which the group is confronted with a specific problem to solve. In Exploring we use initiative games for two reasons: These games demonstrate and teach leadership skills to Advisors, which helps to promote the growth of Explorers; and these games demonstrate a process of thinking about experiences that helps Explorers learn and become responsible citizens.

Here are a few suggestions. Begin by clearly explaining the game. Make sure the rules are understood, including that everyone must complete the activity for the group to be successful. Don't offer ideas for solving the problem. Stand back and let the group work and play with it even if the group has a difficult time. Don't interfere unless something is unsafe or the group has fallen apart.

Reflect on the activity. Spend a few minutes afterward talking about what the participants learned. Talk about how effectively and efficiently they accomplished the task and how well they got along with each other. Ask open-ended questions to help the group talk about the issues. Don't be judgmental. In asking questions, first help the participants focus on what happened, then ask them to decide if what happened was good or bad. Finally, ask them to set some goals for the future.
The best impact that initiative games can have on your post program is for you to use the initiative game’s leadership style and the reflective methods in your post game lessons. While initiative games are fun and meaningful lessons can be learned, a lasting impact will be achieved only by using the principles behind the games in the complete post program. As an adult leader, you help the youth learn to make decisions and solve problems in everything you do in Exploring. Teach them the skills they need and let them do it. As someone once said: “Train them and trust them!” Use reflection during and after post activities and experiences to help the youth learn. Get them in the habit of thinking and sharing together as a group.

If a game is too easy or if you have other motives, you can vary the skills of the participants by not allowing some to talk, by blindfolding, by not allowing the use of various limbs, etc. You also can create a story line to go with the game.
Easy Community Building Activities

**RADIOACTIVE FIELD I**
Materials: three boards (pieces of plywood work fine) about a foot square. The goal is to transfer the entire group across an open, flat area using three protective shields without touching the ground with any body part. Boards must not be thrown across the open area.

**KNOTS**
A group of six to 12 people forms a circle. Each person puts the right hand into the center of the circle and clasps hands with one other person who is not standing next to him or her. Then everyone puts their left hand into the circle and clasps hands, again making sure that person is not standing next to them. They should be holding two different people's hands. The goal is to untangle the knot without letting go of anyone's hand.

**ALL ABOARD**
Materials: an old towel or rag or a pre-constructed platform about 2 feet by 2 feet. The goal is to get everyone in the group to stand on the towel or platform without touching the ground around it. You can start with the towel unfolded and gradually increase the challenge by folding it smaller and smaller. The only restriction is that you may not "stack" more than one person on another.

**REVERSING PYRAMID**
Have 10 people form a 4-3-2-1 horizontal pyramid (arranged like bowling pins). Tell them to reverse the apex and the base of the pyramid by moving only three people.

**QUICKSAND**
Materials: platform such as in "All Aboard," or a towel; Frisbee-size disks to step on. Place the platform or towel about six giant steps away from a boundary line. The goal is to get everyone from behind the line across the open area onto the platform without touching the ground. The disks can be used to cross the area, but once they are put on the ground they cannot be moved. Also, someone's foot must be on the disk at all times until the last person crosses.

**THE TOWER**
Students are divided into teams of 2 or 3, given one sheet of printer paper, 10cm of tape, scissors, and a ruler. The task is to use only tape and paper to create the tallest freestanding tower (not taped to the table or supported by things like chairs or books). The tallest tower that meets these requirements wins.
*Variation:* Offer two rounds of building to allow for refinement of ideas.
*Variation:* Have students sketch a "blueprint" before construction that they must follow during construction.
Moderately Hard Community Building Activities

THE BRIDGE
Similar to the tower problem in the easy community activities this requires a bit more problem solving. It may be a good idea to do the tower activity before this one. In the activity students are put in groups of up to four. Each group is given four textbooks of equal size (if students are issued books they can use those), three sheets of paper, 30cm of tape, ruler and scissors. Also needed is a weight of some kind. Any object with as mass between 250g and 500g works well. Set the books in stacks of 2, then place them 11 inches apart (or the width of one sheet of paper handed out). The objective here is to create a bridge that can span the books and support the chosen weight using only the paper and the tape. It should be noted to avoid damage to books students may not tape their bridge directly to the books.

Variation: Start with light objects and move to heavier ones to see which bridge is the best.

Variation: Offer two rounds of building to allow for refinement of ideas.

Variation: Have students sketch a ‘blueprint’ before construction that they must follow during construction.

Variation: Add limits such as no middle supports (columns) or bridges must have a ‘roadbed for cars’. Add other supplies such as drinking straws, or one piece of heavy paper and two regular sheets, or increase the span distance.

RADIOACTIVE FIELD II
The goal is to transfer the entire group across an open area using one pair of magic boots. No body part can touch the ground except for feet wearing the magic boots. The boots cannot be thrown across the field. They can be carried. Each foot on each person can only wear a boot safely for one trip across. After that foot is used, it cannot be used for any more trips.

GIMME A LEG TO STAND ON
The goal of this activity is to get your group to have a minimum of contact points with the ground. In other words, you want to find out how few legs and arms you must use to maintain a balance point for, say, five seconds.

SPIDERWEB
Materials: For this activity you will need to do some construction. A spider web will need to be built between two trees with about one hole in the web for each person in the group. Holes should be of varying sizes and heights. Nylon cord works well in constructing the web. The group is to pass people through the web without anyone touching it. If a person does touch the web, you must restart that player.
TRAFFIC JAM
Materials: something to mark spaces that individuals in the group stand on. (There should be one more space than the number of people in the group.) Half of the group stands in a row back to front facing the other half of the group, which also is back to front but, of course, facing the first group. It does not matter if you have an odd number of people in your group and one side has one more person than the other. Everyone should be standing on a marked spot. The empty spot should be in the middle between the two facing groups. The goal is for each group to exchange places. As you might expect, there are some restrictions on movement. First, only one person moves at a time. Second, a person may not move around anyone facing the same direction. Third, they may not move backward. Fourth, no one can move around more than one person on the other team at a time.

TWO BY FOUR
Have eight people line up shoulder to shoulder, alternating male and female, with everyone facing the same direction. The object is to get all the females on one end and all the males on the other. If you prefer, you can use some other identification to distinguish alternate people. These are the rules: First, the goal is to solve the problem in the fewest possible moves, with a maximum of four moves. It's probably a good idea not to tell the players the maximum until they have had some successes in solving the problem. Second, all moves are made in pairs. A pair is you and anyone standing next to you. Third, when a pair moves out of the middle of the group, the empty slot they left must be filled by another pair. Fourth, pairs may not pivot or turn around. Fifth, there should be no gaps in the solution of the problem.

Hard Community Building Activities

BLIND SQUARE
Materials: one length of rope 50-100 feet long; blindfolds. The group begins by forming a circle and putting the blindfolds on. Then each person picks up the rope, which has been tied into a circle. Everyone should be standing on the outside of the rope. The object is for the blindfolded group to form a square, triangle, pentagon, or any shape the players want to try.

LINE UP
Materials: blindfolds: Blindfold everyone in the group. Whisper to each person a number from one to the number of persons in the group. After you are done, tell the players they must line up by consecutive numbers without talking. Everyone should begin to move slowly around each other, putting palms up facing outward to protect themselves from collisions.

Variations: Line up by height, weight, age, Social Security number, etc. Or try this: Number all participants as above, but designate one player as the “fooler.” Do this by tapping a person on the shoulder without assigning a number. That person then opens his or her eyes (or removes a blindfold) and begins operating as the “fooler.” As the players attempt to align themselves, the “fooler” tries to mess up their attempts by giving
(nonverbal) wrong information. Each person, to combat the “fooler,” has one hypodermic needle (a finger) filled with “truth serum.” If players think they are being fooled, they point their finger at the supposed culprit, and if their finger is still pointed at the “fooler” when they say, “Squirt,” the “fooler” is obliged to moan, “You got me.” The group then is awarded one minute of pure honesty. If a player uses his or her “needle” and misses the “fooler,” the entire player’s serum is lost for the remainder of the game.

BLIND TENT PITCH
Materials: one tent with all equipment needed to set it up; blindfolds. The goal is to set up the tent with everybody in the group blindfolded.

HUMAN LADDER
Materials: one smooth dowel rod, at least three feet long and 1 ¼ to 1 ½ inches in diameter for each two participants. The group lines up in two rows with each row facing the other. Each pair of persons (one from each row) facing each other will hold a dowel. The object is to have one person standing at the end who will crawl across the horizontal ladder formed by the dowels. The group can hold the dowels in any manner desired—high, low, or forming a turn. The only restriction is to not hold the dowels above shoulder height. Caution: Make sure the dowels you have will support your group member’s weight!

POPSICLE PUSH-UP
This is a variation of the standard one-person push-up. The easiest way to teach it is to start doing a four-person push-up. The first person lies down on his or her stomach. The second person lies down perpendicular to the first, with feet and ankles over the lower back of the first. The third and fourth people do the same thing, with the first person’s feet over the lower back of the fourth so that the torsos form a square. The challenge is to have all four people do a push-up at the same time. When they have done this, the goal is to add more people until you are doing a push-up with everyone in the group involved. (It is possible with some creative thinking.)

Variation: A challenging alternative is to tell the group at the beginning that the goal is to get everybody off the ground with only their hands touching, without telling them about any possible solutions like the four-person variation.

THE GREAT EGG DROP
The goal is to build a structure that will prevent an egg from breaking when it is dropped from a height of 8 feet. The only materials allowed are 20 straws and 30 inches of ½-inch masking tape. Try to do it with as few materials as possible.
Section II Culturally Applicable Problems

In both the Afrocentric and critical pedagogy models the idea that problems are of immediate and of socio-cultural significance is key. Too many times science lessons are abstract and contain little or no cultural connection with the learner. For example; a rural instructor when teaching physics would use perhaps a tractor when describing force relationships. The same lesson in an urban area might use the local commuter train as an example. There is more to this than just picking lesson objects that students recognize, it requires creating a lesson that allows the culture in and become part of the lesson.

Critical pedagogy directly addresses the cultural foundations of the learner and challenges them to analyze and critique a problem from a unique perspective. The advantage to this is that in science there is never just one way to solve a problem. Every student brings a culturally unique point of view to the table that just might be the best approach to the situation. In this way students can engage on multiple levels in a more personal way.

Afrocentric pedagogy stresses that engagement and participation practices are tools used by the instructor to establish the significance of the activity to the learner. Murrell (2002) suggests employing classroom activities that create productivity towards a social consciousness should be used. Murrell also argues that instructors should use meaning making practices as a way to increase student knowledge. That is, classroom interactions that utilize student's culture are used to create meaning in the lesson.
Since not every classroom or school district is this same it is difficult to define what is culturally applicable for every situation. However, there are several things teachers can do in general to create more problems in the classroom that students can relate to. The idea is to know the world your students come from. For example; I was once teaching science at an inner-city school and used an example of driving over a high mountain pass and having your ears‘pop’ due to a change in air pressure. Even though there were high mountain passes only a few hours away, very few of my students had even been outside their immediate neighborhood. Once I realized this I then modified my lessons and activities to reflect more of what they could relate to. The moral of the story is to understand the culture and background of the students you are trying to teach.

Fortunately there are some simple ways to gain valuable insight into your students. The first is to simply listen to them; they have a lot to tell you. One clever way to do this is something called the‘weekend up-date’ Spend the last five minutes of class on Fridays and open up the classroom for people to announce their weekend plans. Have fun with it and in the process listen and learn what experiences your students are having so you can incorporate them into your lessons. Another way to gain insight is on your way home from work sometimes drive through the neighborhoods and observe what their world looks like. Odds are the world that you grew up in is nothing like that of your students, be aware of this difference and plan accordingly.

Another way to create culturally applicable problems is described by Schultz (2008) during his tenure at the infamous Cabrini Green School in one of Chicago’s poorest housing projects. In this case he used the students to create a curriculum to solve
a problem. In Schultz's case the problem was the school and the students worked to find solutions to those problems, no avenue was declared off limits. Students went as far as writing TV stations and writing the Governor's office. Now in most science classrooms the topics may be less dramatic but using the same concept students can be allowed to explore, solve and learn real world science. For example in an eighth grade physical science class during a chemistry unit a debate on the pros and cons of nuclear power or chemical preservatives in food is a possible way to bring science into the real world.

The final point is that students will not fully engage in science unless they can see the relevance it has to their daily life. The only way for that to occur is to listen to and step into the shoes of your students.

The following pages outline a lesson used in a natural resource unit for a sixth grade class. The problem on the surface seems simple and straight forward to the students but they quickly find out that it is much more complicated than first perceived. Additionally, very few restrictions have been placed on the students in terms of how they can solve the problem. Last, the 'culture' of the students was taken into account when it was designed. Since the school I was teaching at had no bus service all the students commuted in with their parents. This problem was designed knowing that all of my students relied on a car to get around. I also used the fact that at the time gas prices were approaching $4.00 a gallon. In the news 'green energy' was becoming a buzz word as well as the environmental impact humans are having on the Earth. Finally I invited an actual city planner in for a guest speaker to start the project off to impress that what they [the students] were doing was indeed 'real world'. Notice in the lesson that there are clear roles,
technology use, scheduled planning time for teams, and reflection built into the lesson. For the final presentations students were selected to form a ‘city council’ to review and vote on a winning team. Nearly any science problem can be constructed in this format weather it is an air pollution problem, global warming, building a bridge across a canyon or determining the bird species present in the neighborhood. Simply modify and give students the time and enough scaffolding to attack the problem.
The Metropolis Problem

Problem:

The year is 2035 and the world is running out of fossil fuels (oil, gas and coal). Gasoline is being rationed and is only for emergency vehicles and shipping food to the stores. The city of Metropolis needs to change to help its citizens who will no longer have the use of cars. There are electric cars, but very few people have them because they are very expensive. That means that most people will not have a car. Also the city needs to create its own electricity since the local coal fired power-plant no longer has any coal to burn for electricity. Last, the city land fill is full; there is no more room to put garbage in it.

Your job as city planners:

You and your team have been assigned to turn Metropolis into a town that produces no waste (garbage), eliminates the need for fossil fuels, and cars.

You must solve the following problems:

1. How will people get around if there are no cars? Even when it is raining?
2. How will the city produce electricity?
3. How will the city deal with garbage?
4. You must use technology available TODAY to solve your problems, not some made-up fictional device.
5. How much will this cost? (yes, find out prices on how much your changes will cost the city to implement)

Things to consider:

✓ What laws could you pass to help achieve your goals?
✓ What physical changes (moving streets stores and buildings) could you make?
✓ What new buildings are necessary and where should they go? Should any be eliminated?
✓ What changes must the citizens make to accomplish your goals?
✓ What new forms of transportation could your team put into place to replace the car?

Resources:

The internet, books, each other, a map of Metropolis

Presentation:

A group PowerPoint presentation telling the class of your new town design. Explain WHY your solutions will work and how they can be accomplished. Cite all your resources.
Teams:

Each Team will consist of 4 people

1. Team Leader: The team leader is in charge of making sure everyone is doing their job, keeping the group on task, establishing deadlines, resolving conflict, making final decisions, helping where necessary.
2. Researchers: Two people will be in charge of looking up information. They follow the directions of the team leader and report to the designer.
3. Designer. This person is in charge of creating the power point presentation. They are also in charge of the new city map. This person works with the researchers and team leader to help plan changes to the city. This person reports to the team leader.

Time Line:

Day 1 (Monday): Guest speaker
Day 2: brainstorm ideas and begin research
   ✓ From teams
   ✓ Create team name
   ✓ Brain storm
   ✓ Set goals
   ✓ Begin research

Day 3: Continue research, computer lab
   ✓ review ideas
Day 4: Team meeting day
   ✓ Meet as team and review research and ideas, finalize ideas, set goals, computer lab
Day 5: Research and plan, computer lab
Day 6: (Monday) Research and plan
Day 7: Research and plan
Day 8: Research and plan, presentations should be started, review goals, revise?
Day 9: computer lab, PowerPoint work,
Day 10: Work on final presentation
Day 11: (Monday) review and practice presentations
Day 12-13 presentations
Day 14 Reflection and discussion about the process and what was learned.
This is scaffolding worksheet for the Metropolis Problem to help guide students in brainstorming solutions and set goals.

As a team brainstorm and discuss ideas and set goals for what needs to be done by the end of class.

1. How will people get around if there are no cars?

2. How will the city produce electricity?

3. How will the city deal with garbage?

Goals for the next 3 class periods, be specific.
Section III Problem Solving Techniques

In order for students to be able to tackle and solve problems in the science classroom they need the cognitive tools to do this. With government mandated assessment of student learning, often science teaching is reduced to memorization of facts. This leaves little room for teachers to teach the skills needed to solve problems that may be encountered later on in life. There are many techniques such as think pair share, solution mapping, flow-charting, cause and effect, case based, and cooperative learning to choose from (more elaboration on these techniques will be described later). All of these techniques need to be taught, often teachers assume students already know how to solve a problem, this is a mistake. Additionally, students should be allowed to collaborate to form their own conclusions, apply them and see them either succeed or fail as a community and as individuals. Also remember that when using problem solving techniques that the establishment of goals and the anticipation of those accomplishments is clear and unmistakable to the participants.

In both critical theory and in Afrocentric pedagogy students are asked to apply skills and techniques to assess and solve the problem at hand. Instructors create classroom interactions that promote critical engagement and examination of the situation. Murrell suggests that educators should help to encourage and establish ‘collective memory’ that the students can draw upon. One way to help with the creation of this collective
memory of the students’ is to tap into the culture of the students. Thus, instructors need to utilize the culture of the student as part of the instructional techniques.

Problem solving strategies are wide and varied and range in difficulty to implement as well. This manual draws from several sources to give teachers an assorted mix of strategies that work in different situations. Some of these strategies come from the field of mathematics, English or directly from the sciences.

As mentioned before, problem solving strategies must be taught. It is sometimes said that students lack ‘common sense’ when looking at a problem. Where does this ‘common sense’ come from? As teachers we learned it from somewhere and now take that ability for granted. The fact of the matter is that we [teachers] learned it from someone or some experience. In CPS the area of culturally applicable problems addresses this area. Students have ‘common sense’ from their own experiences but may not know how to apply it to science or school. Therefore giving students a framework in which to apply their own brand of ‘common sense’ will allow them draw upon their own knowledge and construct new pathways in which to solve a problem in a way that they can conceptualize.
Listed below are five problem solving strategies that can be applied in a variety of lessons. Remember though that these strategies must be taught and understood by students before they can be of any use to them. Once they are taught however, they then can be inserted into existing lessons and used on a regular basis.

Selected Strategies:

1. George Polya (An adapted mathematics strategy)
2. The Classic scientific method
3. Qualitative vs. Quantitative
4. Solution Maps and Flow Charts
5. Think-pair-share
Problem Solving Strategies from George Polya

George Polya (1887–1985) was one of the most famous mathematics educators of the 20th century. Dr. Polya strongly believed that the skill of problem solving could and should be taught—it is not something that you are born with. He identifies four principles that form the basis for any serious attempt at problem solving.

1. Understand the problem
   ✓ What are you asked to find out or show?
   ✓ Can you draw a picture or diagram to help you understand the problem?
   ✓ Can you restate the problem in your own words?
   ✓ Can you work out some numerical examples that would help make the problem more clear?

2. Devise a plan
   A partial list of Problem Solving Strategies include:
   - Guess and check
   - Make an organized list
   - Draw a picture or diagram
   - Look for a pattern
   - Make a table
   - Use a variable
   - Solve a simpler problem
   - Experiment
   - Act it out
   - Work backwards
   - Use deduction
   - Change your point of view

3. Carry out the plan
   ✓ Carrying out the plan is usually easier than devising the plan
   ✓ Be patient—most problems are not solved quickly nor on the first attempt
   ✓ If a plan does not work immediately, be persistent
   ✓ Do not let yourself get discouraged
   ✓ If one strategy isn't working, try a different one

4. Look back (reflect)
   ✓ Does your answer make sense? Did you answer all of the questions?
   ✓ What did you learn by doing this?
   ✓ Could you have done this problem another way—maybe even an easier way?
Basic Scientific Method Problem Solving Model

**Ask a Question:** The scientific method starts when you ask a question about something that you observe: How, What, When, Who, Which, Why, or Where? And, in order for the scientific method to answer the question it must be about something that you can measure, preferably with a number.

**Do Background Research:** Rather than starting from scratch in putting together a plan for answering your question, you want to be a savvy scientist using library and Internet research to help you find the best way to do things and insure that you don't repeat mistakes from the past.

**Construct a Hypothesis:** A hypothesis is an educated guess about how things work: "If ____ [I do this] ____, then ____ [this] ____ will happen." You must state your hypothesis in a way that you can easily measure, and of course, your hypothesis should be constructed in a way to help you answer your original question.

**Test Your Hypothesis by Doing an Experiment:** Your experiment tests whether your hypothesis is true or false. It is important for your experiment to be a fair test. You conduct a fair test by making sure that you change only one factor at a time while keeping all other conditions the same. You should also repeat your experiments several times to make sure that the first results weren't just an accident.

**Analyze Your Data and Draw a Conclusion:** Once your experiment is complete, you collect your measurements and analyze them to see if your hypothesis is true or false. Scientists often find that their hypothesis was false, and in such cases they will construct a new hypothesis starting the entire process of the scientific method over again. Even if they find that their hypothesis was true, they may want to test it again in a new way.

**Communicate Your Results:** To complete your science fair project you will communicate your results to others in a final report and/or a display board. Professional scientists do almost exactly the same thing by publishing their final report in a scientific journal or by presenting their results on a poster at a scientific meeting.
Figure 2 Scientific Method Flow Chart
Quantitative Vs. Qualitative Problem solving Models

Science teachers often ask for quantitative answers. This kind of answer involves a specific fact or figure, for example an answer to a math question. There nothing wrong with asking students to produce a numerical or factual statement, this often leads rote memorization of a topic as opposed to a deeper understanding as to why the answer achieved is correct or valid.

Qualitative research or questioning is often used for policy and program evaluation research since it can answer certain important questions more efficiently and effectively than quantitative approaches. This is particularly the case for understanding how and why certain outcomes were achieved (not just what was achieved) but also answering important questions about relevance, unintended effects and impact of programs such as: Were expectations reasonable? Did processes operate as expected? Were key players able to carry out their duties? Were there any unintended effects of the task? Qualitative approaches have the advantage of allowing for more diversity in responses as well as the capacity to adapt to new developments or issues during the process itself.

When teachers focus on quantitative results critical thinking is often left by the wayside. For example, in a typical physics class students may be asked to find the acceleration of an object using the formula $A= \frac{(V_2-V_1)}{\Delta T}$ where $V$ is velocity and $T$ is time. For most students this is a simple “plug and chug” math problem. However, the answer is expressed in m/s/s, many students have difficulty relating what that means. In other words, putting in the correct numbers and working the math is simple and routine,
the quantitative part. Asking a student to express qualitatively what the answer means brings a whole new dimension to the problem. The point here is that asking a student to solve a problem qualitatively before asking them to solve it quantitatively can add depth to understanding and allow students to see a problem from a different angle.

Below is a table of terms for qualitative analysis of a problem. As a teacher can choose some terms and ask students to try and solve a task using these as starting points.

- Who
- What
- When
- Where
- How
- Why
- Explain
- Describe
- Evaluate
- Assess
- Clarify
- List
- Illustrate
- Judge
- Simplify
- Record
- Demonstrate
- Show
- Trace
- Prove

**Solution Maps and Flow Charts**

Computer programmers are well versed in the use of solution maps (map) and flow charts (chart). Both of these techniques are useful when the desired outcome is known but how get there is not. One way to achieve a goal is to create a map of how to get there. This is a visual map that illustrates a series of descriptive steps that logically moves from one task to the next. This process works particular well with brainstorming and concept mapping. Since this is a visual process it makes large complicated problems easier to navigate and understand.
Solution maps are different from flow charts as they are simply more in-depth and complicated. Solution maps may involve multiple paths each adding to the overall solution to a task. Both however, are constructed with same basic format. Maps and charts can be constructed forward or backward [from the goal to the beginning] and may be as simple or as complicated as need be.
Let's illustrate the process of creating a flow chart, with a flow chart as an example.

Clearly state the objective, task or goal. → Create a "know" list, that is what do we already know. → Create a "what do we need to know" list. → Using these 2 previous lists brainstorm ways of getting the second list (the need to know list) accomplished. → Compile, sort, add or delete ideas. → Arrange ideas into a flow chart. → Follow the steps of the plan.

Figure 3 Flow Chart Example

Now let's take a look at a Solution map. Remember this is similar to a flow chart but this allows for more complicated strategies.
Clearly state the goal, task or objective, there may be more than one.

Since there may be one or more objectives there may be multiple process happening at the same time, For this example we will use 2 separate tasks.

Define task 1

Assign team members to the task
Create possible flow chart for task or decide on a strategy for solving.

Report back to group

Define task 2

Assign team members to the task
Create possible flow chart for task or decide on a strategy for solving.

Report back to group

Combine

Solution? Is more work needed? redefine the map?

Use the same process to define what is known and unknown as described in the flowchart explanation.

Figure 4 Problem Solving Map Example
Think-Pair-Share (Jones, 2009)

Think-Pair-Share is a cooperative discussion strategy developed by Frank Lyman and his colleagues in Maryland. It gets its name from the three stages of student action, with emphasis on what students are to be DOING at each of those stages.

How Does It Work?

1) Think. The teacher provokes students' thinking with a question or prompt or observation. The students should take a few moments (probably not minutes) just to THINK about the question.

2) Pair. Using designated partners, nearby neighbors, or a desk-mate, students PAIR up to talk about the answer each came up with. They compare their mental or written notes and identify the answers they think are best, most convincing, or most unique.

3) Share. After students talk in pairs for a few moments (again, usually not minutes), the teacher calls for pairs to SHARE their thinking with the rest of the class. She can do this by going around in round-robin fashion, calling on each pair; or she can take answers as they are called out (or as hands are raised). Often, the teacher or a designated helper will record these responses on the board or on the overhead.

Why Should I Use Think-Pair-Share?

We know that students learn, in part, by being able to talk about the content. But we do not want that to be a free-for-all. Think-Pair-Share is helpful because it structures the discussion. Students follow a prescribed process that limits off-task thinking and off-task
behavior, and accountability is built in because each must report to a partner, and then partners must report to the class.

Because of the first stage, when students simply THINK, there is Wait Time: they actually have time to think about their answers. Because it is silent thinking time, you eliminate the problem of the eager and forward students who always shout out the answer, rendering unnecessary any thinking by other students. Also, the teacher has posed the question, and she has EVERYONE thinking about the answer, which is much different from asking a question and then calling on an individual student, which leads some students to gamble they won't be the one out of 30 who gets called on and therefore they don't think much about the question. Students get to try out their answers in the private sanctuary of the pair, before having to "go public" before the rest of their classmates. Kids who would never speak up in class are at least giving an answer to SOMEONE this way. Also, they often find out that their answer, which they assumed to be stupid, was actually not stupid at all...perhaps their partner thought of the same thing. Students also discover that they rethink their answer in order to express it to someone else, and they also often elaborate on their answer or think of new ideas as the partners share. These, it seems, are powerful reasons to employ Think-Pair-Share in order to structure students' thinking and their discussion.
Section IV Self Identity

One of the foundations of Afrocentric pedagogy is identity development. In order for students to be successful in a community they must recognize that they have a role to play. Teachers know that students who feel that they have no purpose quickly become a focus point. Murrells (2002) also suggests that students need to identify with their culture as well to be successful. When students recognize that they can be successful and apply their knowledge outside the classroom, learning increases. Teachers develop self identity activities that promote internal reflection, investigation, reflection and meaning. Murrell outlines three avenues for identity development. The first is creating multiple opportunities for oral development that utilizes student experiences. The second is by emphasizing the use of information in multiple contexts and encouraging investigation of the curriculum content. Third and last, teachers need to focus on creating interpersonal interaction for the purpose of developing initiative within students and the community.

Freire (1990) states that “I cannot think for others, nor can others think for me” (p. 100). This idea is exactly what students need to realize when creating a self identity. Once students recognize this they gain a new level of creative autonomy. Students can then bring this confidence to bear on the community and provide needed insight and ideas to solving the problem at hand.
Below is a simple job list for a four person group activity that helps to define roles. This list employs aspects of working as a community and it defines what role each member of the community has. It is important that each member of the community be involved with a purpose if problem solving is going to be accomplished. These roles can be modified as needed for any project or laboratory experiment. This list works better with 5th and 6th grade students. You may want to assign roles during the next activity and change the assignments so students rotate through jobs and or the teams.

**Lab Table Job List**

Every person at the table needs a job. If there are less than 4 people at the table, jobs must be shared so all 4 get done.

**Table leader:** This person is in charge of making sure all members of the table are on task and working (including themselves!).

**Supply Getter:** This is the ONLY person allowed to go get other supplies not found at the lab table or in the lab table cabinets. This person is also responsible for returning those supplies to their proper places.

**Clean-up:** Two (2) people are in charge of clean up. Duties include putting away ALL supplies in the correct cabinets. Making sure the table is wiped down if necessary and the stools are pushed in.
This sample job list is a more refined four person format for a group activity. While this also employs aspects of working as a community it defines what role each member of the community has adding more responsibility. It is important that each member of the community be involved with a purpose if problem solving is going to be accomplished. These roles can be modified as needed for any project or laboratory experiment. This list works better with 7th and 8th grade students.

Laboratory Job List

**Team leader**

The job of the team leader is to make sure EVERYONE is on task and participating. The team leader must be responsible, be able to communicate, listen, and resolve issues within the group. It is your job to make sure your team finishes on time and that everything is complete.

**Supply Person**

The job of the supply person is to get and return all supplies that the team needs for the job. If the team needs a special item they are responsible for finding it or asking the teacher for it. They are also responsible for making sure the area is clean before leaving the room.

**Data Recorder**

The job of the data recorder is to accurately record the results of the experiment, write down required questions, and other necessary information. The data recorder asks the team for answers to questions, and talks with the team to form the final conclusion.

**Research Specialist**

The job of the research specialist is to use resources such as a textbook or computer to look-up information that may help the team complete the experiment or task. Also, the research specialist assists the data recorder in gathering information and recording results.
Self-Identity Worksheet example:

Similar to the group reflection found in the community section this worksheet example can be used to facilitate personal reflection on an activity.

Team:_________________________ Name:________________________

**Personal reflections**: To be answered individually (not as a group)

1. How did you personally contribute to the team/ final product?

2. What did you personally learn during this project?

3. What can you do differently next time to improve the team and the final product?

4. How can this new information help you in the future?

5. Who could benefit from this kind of information and why? (business, industry, politicians, citizens?)
**Section V Hegemonic Deconstruction**

**HEGEMONY** (hegemonic): The processes by which dominant culture maintains its dominant position: For example, the use of institutions to formalize power; the employment of a bureaucracy to make power seem abstract (and, therefore, not attached to any one individual); the inculcation of the populace in the ideals of the hegemonic group through education, advertising, publication, etc.; the mobilization of a police force as well as military personnel to subdue opposition (Felluga, 2003).

Although your classroom may not seem as drastic as the above illustration it is still heavily influenced by many outside forces. Forces like mandated testing and textbooks designed around a preset scope of information influence the scientific freedom of a class. Certainly the media, advertising and the government exert a tremendous amount of influence over the populace. This influence also extends to the scientific community as well gently pushing ideas that one group wants to be ‘true’. Take for example global warming. For years starting in the 1980’s, scientists warned about global warming yet other influences controlled the flow of information and what was done about it. In the waning years of the Bush presidency the issue of global warming was finally addressed as the consequences were finally being seen. During that intermediate time many articles and papers were published either downplaying or presenting evidence that global warming was a threat. There is still conflicting information regarding the topic and what is done about it. Having the ability to judge the authors intent or bias is a skill few
have. Therefore the process of hegemonic deconstruction in CPS is employed when students actively search for answers to the problems they are trying to solve. Here students are encouraged to look at where the information is coming from, who wrote it and for what purpose. Students are encouraged to look for alternate solutions not necessarily found in the mainstream media. In other words, critically analyze for bias and validity.

Now for most teachers there is little to be done about mandated testing and the textbooks that are in use. However, the purpose of hegemonic deconstruction is to allow the chance for students to critically look at where information is coming from. For teachers and academics the process of looking at and judging the source of the information and how that information is used and disseminated is routine. Unfortunately there are many students as well as adults that do not have the ability to do this and just accept any ‘scientific’ information as fact. Many adults and teachers would like to believe that scientific information is pure and has not been skewed or altered, this sadly is simply not true.

For teachers, this is also a critical juncture in lesson planning. Here the teacher needs to decide for him/herself if the information they are presenting is biased towards a specific group in both content and in presentation. This often is difficult for teachers as they may unknowingly be contributing to these preconceived social restrictions about race and class. For example, most scientific discoveries in textbooks are credited to men from Europe. Teachers who teach exclusively from a book often fall into this trap as they don't realize there may be other information out there. Unfortunately many teachers feel
constrained by the social constraints leveled against many groups in education. Current practices such as No Child Left Behind (NCLB) promote the Eurocentric style of teaching which does little to allow for cultural uniqueness not to mention looking at the controlling aspects of education. Many would argue that NCLB itself is a form of hegemonic control over education (McLaren, 2004). Additionally, the historic trend of testing such as the SAT or the Stanford Tests emphasize that the facts themselves are more important than the application and use of those very same facts. Students need to realize that their culture or race may have preconceived societal restrictions placed upon them from outside the classroom.

Although this may be difficult to accomplish at first it is important for students to understand that often science has conflicted with current belief. Galileo for example was excommunicated from the early church for his theory of a sun centered universe. Science is about questioning the norm and looking beyond what is ‘accepted’. In today's media controlled environment some information is tightly controlled and sometimes is strewn with falsehood. As many science teachers know many groups use selected data or facts that support their cause or discredit others. Encouraging students to look deeper into a subject or form multiple sides will encourage critical thinking. Activities such as debates or current event reports about science trends can help students see through smokescreens put up by special interest groups.

To facilitate this allocate some time in each unit, even if it is only one period, to discuss how what is being studied could be used by industry, government or others who may or may not want the information public. Remember Galileo, the church saw him as a
threat to their credibility and sought to silence him. Modern day issues may include global warming, the tobacco industry, agriculture, medicine and the energy trade.

Included below are some worksheets that can help students analyze information intent and bias designed by the U.S. National Archives. Both a document and a movie analysis are provided since so much information is relayed via visual media. More analysis worksheets are available at Http://www.archives.gov/education/lessons/worksheets/. Also an inquiry or I-chart/matrix that helps students investigate other sources of information and analyze the information presented. Last is a rubric that can be used to grade current event topics in science which can be assigned as an investigational assignment or as a community/world investigation for real world science.
Written Document Analysis Worksheet

1. TYPE OF DOCUMENT (Check one):
   ___ Newspaper    ___ Map    ___ Advertisement
   ___ Letter      ___ Telegram    ___ Congressional record
   ___ Patent      ___ Press release    ___ Census report
   ___ Memorandum   ___ Report    ___ Other

2. UNIQUE PHYSICAL QUALITIES OF THE DOCUMENT (Check one or more):
   ___ Interesting letterhead    ___ Notations
   ___ Handwritten    ___ "RECEIVED" stamp
   ___ Typed    ___ Other
   ___ Seals

3. DATE(S) OF DOCUMENT:
   ________________________________________________________________

4. AUTHOR (OR CREATOR) OF THE DOCUMENT:
   ________________________________________________________________

   POSITION (TITLE):
   ________________________________________________________________

5. FOR WHAT AUDIENCE WAS THE DOCUMENT WRITTEN?
   ________________________________________________________________

6. DOCUMENT INFORMATION (There are many possible ways to answer A-E.)

A. List three things the author said that you think are important:
   ________________________________________________________________
   ________________________________________________________________
   ________________________________________________________________

B. Why do you think this document was written?
   ________________________________________________________________

C. What evidence in the document helps you know why it was written? Quote from the document.
   ________________________________________________________________
D. List two things the document tells you about life in the United States at the time it was written:
____________________________________________________________________
____________________________________________________________________

E. Write a question to the author that is left unanswered by the document:
____________________________________________________________________
____________________________________________________________________

Designed and developed by the Education Staff, National Archives and Records Administration, Washington, DC 20408.
**Motion Picture Analysis Worksheet**

**Step 1. Pre-viewing**

A. Title of film: ________________________________________________  
   Record Group source: _______________________________________

B. What do you think you will see in this motion picture? List three concepts or ideas that you might expect to see based on the title of the film. List some people you might expect to see based on the title of the film.

<table>
<thead>
<tr>
<th>Concepts/Ideas</th>
<th>People</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
<td>3.</td>
</tr>
</tbody>
</table>

**Step 2. Viewing**

A. Type of motion picture (check where applicable)
   - ____ Animated cartoon
   - ____ Documentary film
   - ____ Newsreel
   - ____ Propaganda film
   - ____ Theatrical short subject
   - ____ Training film
   - ____ Combat film
   - ____ Other

B. Physical qualities of the motion picture (check where applicable)
   - ____ Music
   - ____ Narration
   - ____ Special effects
   - ____ Color
   - ____ Live action
   - ____ Background noise
   - ____ Animation
   - ____ Dramatizations

C. Note how camera angles, lighting, music, narration, and/or editing contribute to creating an atmosphere in this film. What is the mood or tone of the film?

____________________________________________________________________
____________________________________________________________________
Step 3. Post-viewing (or repeated viewing)

A. Circle the things that you listed in the previewing activity that were validated by your viewing of the motion picture.

____________________________________________________________________
____________________________________________________________________

B. What is the central message(s) of this motion picture?

____________________________________________________________________
____________________________________________________________________

C. Consider the effectiveness of the film in communicating its message. As a tool of communication, what are its strengths and weaknesses?

____________________________________________________________________
____________________________________________________________________

D. How do you think the filmmakers wanted the audience to respond?

____________________________________________________________________

E. Does this film appeal to the viewer's reason or emotion? How does it make you feel?

____________________________________________________________________

F. List two things this motion picture tells you about life in the United States at the time it was made:

1. 
____________________________________________________________________

2. 
____________________________________________________________________

G. Write a question to the filmmaker that is left unanswered by the motion picture.

____________________________________________________________________

H. What information do you gain about this event that would not be conveyed by a written source? Be specific.

____________________________________________________________________

Designed and developed by the Education Staff, National Archives and Records Administration, Washington, DC 20408.
Inquiry Chart or I-chart (Jones, 2009)

What Is An I-Chart?

Inquiry Charts were developed by James V. Hoffman, based on the work of McKenzie, Ogle, and others. I-Charts offer a planned framework for examining critical questions by integrating what is already known or thought about the topic with additional information found in several sources.

How Does It Work?

On a given topic, you'll have several questions to explore. These are found at the top of each individual column. The rows are for recording, in summary form, the information you think you already know and the key ideas pulled from several different sources of information. The final row gives you a chance to pull together the ideas into a general summary. It's at this time you'll also try to resolve competing ideas found in the separate sources or, even better, develop new questions to explore based on any conflicting or incomplete information.

How Does It Look, Generally?

The I-Chart that appears on the next page is merely a suggestion. You and your students can create for yourselves an I-Chart to help you analyze several sources of information. You should feel free to modify the I-Chart, such as including a bottom row to list new questions.
**Inquiry Chart Example Matrix**

<table>
<thead>
<tr>
<th>What I Think</th>
<th>Question Area 1</th>
<th>Question Area 2</th>
<th>Question Area 3</th>
<th>Question Area 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source #1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source #2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source #3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summary</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Another way to get students to become more involved with the scientific community outside of class is ask them to investigate current events in science. Below is a sample rubric for such an assignment.

**Current Event**

One page typed, double spaced, 12 point font, Times New Roman

Staple your report to the BACK of this page.

<table>
<thead>
<tr>
<th>CATEGORY</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format</td>
<td>One page, typed (not including pictures), double-spaced, 12 point font, Times New Roman.</td>
<td>Less than 1 page, typed (not including pictures), double-spaced, 12 point font.</td>
<td>Less than one page, font and/or graphics are incorrect or take up too much room.</td>
<td>Less than 1 page in total including graphics and font incorrect.</td>
</tr>
<tr>
<td>Sources</td>
<td>All sources (information and graphics) are accurately documented in the desired format.</td>
<td>All sources (information and graphics) are accurately documented, but are incomplete (missing information)</td>
<td>Some sources (information and graphics) are accurately documented</td>
<td>Sources are not accurately documented.</td>
</tr>
<tr>
<td>Mechanics</td>
<td>No grammatical, spelling or punctuation errors.</td>
<td>Almost no grammatical, spelling or punctuation errors</td>
<td>A few grammatical spelling, or punctuation errors.</td>
<td>Many grammatical, spelling, or punctuation errors.</td>
</tr>
<tr>
<td>Paragraph Construction</td>
<td>All paragraphs include introductory sentence, explanations or details, and concluding sentence.</td>
<td>Most paragraphs include introductory sentence, explanations or details, and concluding sentence.</td>
<td>Paragraphing structure was not clear and/or sentences were not typically related within the paragraphs.</td>
<td>No paragraphing structure, sentences were not typically related within report.</td>
</tr>
<tr>
<td>Own Words</td>
<td>Student used their own words for the entire report. Used quotes properly.</td>
<td>Student mostly used their own words, some sentences were copied directly without the proper use of quotes.</td>
<td>Extensive copying and pasting with few changes to the original text, proper use of quotes not used.</td>
<td>The report was plagiarized, no credit for the entire assignment.</td>
</tr>
</tbody>
</table>

Score ____/20
Section VI Praxis

Both critical and Afrocentric pedagogy employ the term praxis. Praxis is the process by which a theory, lesson, or skill is enacted or practiced. As used by Paulo Freire, “praxis” is a synthesis of theory and practice in which each informs the other. Critical Problem Solving cannot effectively work without this idea. These skills, communal effort, culturally applicable problems, problem solving techniques, self identity, and hegemonic deconstruction must be constantly revisited. Finally, both models encourage self reflection and utilize the socio-cultural background of students. Praxis is the key to all of these models and without it they do not function properly.

Of all the different aspects of CPS praxis is the section that brings it all together. Individuals who are good problem solvers employ ideas of practice all the time. In the scientific realm hypotheses are made which are for all purposes is an educated guess concerning the answer to a question. This guess to a possible solution is based on previous experience and observation. Scientific problems are often large, complicated, and require in-depth planning to succeed. Praxis is the embodiment of guessing, planning, testing, reflecting on the results and deciding what to do with the data.

The ability for a student to learn to reflect on information then act upon that knowledge to form a possible solution is more powerful than simply the memorization of facts. Although some may argue that to pass state mandated tests students need to learn and memorize facts that will be appearing on the test is required. The author however is
arguing the opposite that a student that has the tools and confidence to analyze and solve problems will not only help a student pass a test, but also give students the skills to continue solving problems well beyond the test. Doctors, lawyers and other professionals frequently consult reference books other sources when solving a difficult problem or situation. Notice that they consult, not have memorized information. Doctors and lawyers confidently problem solve within a professional community using praxis, thinking, planning, acting and reflecting. This is the embodiment of what CPS is trying to accomplish in the classroom.

The following pages preset outlines to structure a lesson or even a unit that incorporates all the ideas of CPS. Three outlines are presented, two for teachers and one for students. Both the teacher and the student outlines contain prompts to guide the student or teacher in CPS. The two teacher outlines come in a basic format and an advanced format. The reason for the two teacher outlines is for a progressive implementation to ease students and teachers into exploring the CPS process. There is also an example reflection worksheet when doing group activities as well as a lesson element to help students to reflect upon what is being or has been learned.
Lesson Format Guides (praxis)

Basic Lesson outline format for CPS
(Teacher Outline)

1. **Lesson Objective(s):**

2. **Application:** How will the students relate the lesson to their own life?

3. **PBL Techniques:** What PBL technique стрategy will students need/use to solve the problem.
   a.

4. **Community:** How will the learning community be structured (i.e. teams, pairs, whole class)

5. **Self identity (Roles):** What roles will be assigned within the community (every students needs a role)

6. **Praxis:**
   a. **Student:** What kind of student community assessment will you use?
      i. What needs to be assessed? What was the lesson objective?
      ii. How will assessment of learning be accomplished?
      iii. Student review and reflection of the effort, what improvements need to be made for next time?
   b. **Teacher:** Reflection on the effectiveness of the lesson
      i. Did the students relate to the topic?
      ii. How well did the communities work?
      iii. Where all individuals involved in the effort?
      iv. Were students able critically analyze the problem?
      v. Did students make any connections to society?
Advanced Lesson outline format for CPS  
(Teacher Outline)  

1. **Lesson title:**  
2. **Central task or problem:**  
3. **Lesson Objective(s):**  

4. **Application:** How will the students relate the lesson to their own life?  

5. **PBL Techniques:** What PBL techniques/strategies will students need/use to solve the problem.  
   a.  
   b.  
   c.  

6. **Community:** How will the learning community be structured (i.e. teams, pairs, whole class)  

7. **Self identity (Roles):** What roles will be assigned within the community (every student needs a role)  

8. **Deconstruction:**  
   a. Is the information being presented biased toward a specific group, who (beyond school) is promoting this or why is this important to know (who says so?)  
   b. Will students be given the chance to explore this beyond class to make connections to the outside world?  

9. **Praxis:**  
   a. **Student:** What kind of student community assessment will you use?  
      i. What needs to be assessed? What was the lesson objective?  
      ii. How will assessment of learning be accomplished?  
      iii. Individual and community assessment of what was learned and took place during the activity.  
      iv. Student review and reflection of the effort, what improvements need to be made for next time?  
      v. What tools were useful? Not useful?  
   b. **Teacher:** Reflection on the effectiveness of the lesson  
      i. Did the students relate to the topic?  
      ii. How well did the communities work?  
      iii. Where all individuals involved in the effort?  
      iv. Were students able to critically analyze the problem? Did they have the tools to do so?  
      v. Did students make any connections to society?
Lesson outline format for CPS
(Student Outline)

1. **Central Task or Problem; use complete sentences:**

2. **PBL Techniques:** What techniques/strategies do you think you will need to accomplish this task, why?
   a.
   b.
   c.

3. **What roles will be assigned within your team?**
   a. What do the roles require each person to do?
   b. Why is each role important?

4. **Application and Deconstruction:**
   a. How is this knowledge useful to you?
   b. How can this be used outside of school?
   c. For whom is it useful for besides you?
   d. What other groups or institutions may want this kind of knowledge and for what purpose?

5. **Praxis:**
   a. Did the team achieve the objective?
   b. What did you learn (paragraph)
   c. How well did your community work together? Why or why not?
   d. What needs to change for next time for your community to work better in the future?
   e. How did you as an individual function within the community?
      i. Did you feel a part of it? Why or why not?
      ii. How can you improve your interaction within the community for next time?
   f. What tools were useful or not useful in solving this problem and why.
Praxis Worksheet example:

Team:________________________    Name:________________________

**Group reflections**: Discuss these with your team.

Rate the following questions on a scale of 1-4, 4 being best.

1. How well did your team work together?  
   1  2  3  4
   Explain:

2. How well did your team compromise?  
   1  2  3  4
   Explain:

3. Did everyone contributed equally?  
   1  2  3  4
   Explain:

4. How satisfied is your team with the final product?  
   1  2  3  4
   Explain:

Describe what your team did to do to accomplish this task. (process)

What new things about working as a team did you learn?

What were some things that worked the best during this project?

Explain:
What were some things that did not work during this project?

Explain:

If you could do this project again what would you change? (i.e. Jobs, ideas, Research...)
Three-Minute Pause (Jones, 2009)

What Is a Three-Minute Pause?
The Three-Minute Pause (as suggested by Ralph Tyler and further developed by Grant Wiggins) provides a chance for students to stop, reflect on the concepts and ideas that have just been introduced, make connections to prior knowledge or experience, and seek clarification.

How Does It Work?
1) Summarize Key Ideas Thus Far. The teacher instructs students to get into groups (anywhere from three to five students, usually). Give them a total of three minutes for the ENTIRE process. First, they should focus in on the key points of the lesson up to this point. It's a way for them to stop to see if they are getting the main ideas.

2) Add Your Own Thoughts. Next, the students should consider prior knowledge connections they can make to the new information. Suggested questions: What connections can be made? What does this remind you of? What would round out your understanding of this? What can you add?

3) Pose Clarifying Questions. Are there things that are still not clear? Are there confusing parts? Are you having trouble making connections? Can you anticipate where we're headed? Can you probe for deeper insights?

Why Should I Take the Time for a 3-Minute Pause?
It depends on how much "stuff" you want students to be thinking about before they get a chance to process the new information. If you don't want to have to keep re-teaching information, then you should give your students time to think about, make sense of, organize, and reflect on their learning. The Three-Minute Pause is a perfect bridge, a chance for students to consolidate and clarify their emerging understanding, before you move on to teach more new ideas or concepts. It's simple, straightforward, productive, efficient, and instantly useful.
Section VII Progressive Implementation and Integration

The whole process of CPS cannot be implemented at one time as many students lack the fundamental skills to critically solve problems. Therefore, teachers need to use a progressive implantation of the process. Ideally, one would plan to use all six aspects of CPS every week or even in every lesson. This ambitious goal however would require a complete rewriting of your lessons and perhaps the curriculum as well. CPS is not asking teachers to rewrite existing curriculum. These are suggestions to modify your lessons to incorporate and promote more critical thinking. In the matrix on the following pages is a suggested timeline as to when to employ various aspects of CPS. Therefore activities and lessons are suggested in a progressive format drawing upon the six aspects of CPS as described in the previous sections to enhance your classroom instruction. Not every square is filled allowing for teachers to shift and modify the schedule to suit their unique classroom situation.

Remember, start simple. Add one or two aspects of CPS at a time. After all you are also learning and applying the concept of praxis to your own work, you are a student as well. As you add more elements both you and your students will become more comfortable addressing and solving problems of increasing difficulty.
Figure 5 Sample 15-Week Schedule for Progressive Implementation of CPS.

<table>
<thead>
<tr>
<th>Week</th>
<th>Community Exercise</th>
<th>Culturally Applicable Problems</th>
<th>Problem Solving</th>
<th>Self Identity</th>
<th>Hegemonic Deconstruction</th>
<th>Praxis</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Easy Community building exercise</td>
<td>Have discussion about science in the “neighborhood”</td>
<td>Introduce the flow chart method with attached lab to show process</td>
<td>Create teams with jobs attached</td>
<td></td>
<td>Start a routine of one day a week (Friday?) to discuss and review what was learned that week</td>
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<tr>
<td>2</td>
<td>Begin planning lessons use the “basic outline format”</td>
<td>Problem/ lab that requires students to create a flow chart to solve</td>
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<td></td>
<td>Have students think of other applications of the flow chart method</td>
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<tr>
<td>3</td>
<td>Have students link their experiment to their life/ world in think-pair share activity</td>
<td>Introduce the basic scientific method with attached lab/ activity to illustrate process</td>
<td>Create new teams with jobs attached</td>
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<td></td>
<td>Introduce students to the student CPS outline</td>
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<tr>
<td>4</td>
<td>Easy Community building exercise</td>
<td>Problem/ lab that requires students to apply the scientific method.</td>
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<td></td>
<td>Have students think of other applications of the scientific method</td>
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<tr>
<td>5</td>
<td>Lesson to find scientists that fit students culture</td>
<td>Introduce solution maps with attached lab/ activity to illustrate process</td>
<td>Create new teams with jobs attached</td>
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<td>6</td>
<td>Begin planning lessons use the “advanced planning outline”</td>
<td>Problem/ lab that requires students to apply solution mapping to solve</td>
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<td>Have students think of other applications of the solution mapping</td>
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<td>Moderate Community building exercise</td>
<td>Problem/ lab that requires students use the George Polya method of problem solving</td>
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<td>Have students think of other applications of the George Polya Method</td>
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<td>Community</td>
<td>Culturally Applicable Problems</td>
<td>Problem Solving</td>
<td>Self Identity</td>
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<td>Have students link their</td>
<td>Lab or activity</td>
<td>Student</td>
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<td>Have students create and test</td>
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<td>Students pick</td>
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Classroom Integration

An important foundation of successful teaching is clear and understandable objectives for students. Often when teachers plan a lesson or unit they have a set of objectives in mind that they want the students to achieve. Along with the content knowledge there also needs to be a process objective. For example, a lesson on layers of the earth may have an objective of “Students will learn and understand the four layers of the earth and their composition.” In CPS there are over-arching objectives the help guide how the students will obtain that curricular information. In the previous example of learning about the layers of the earth are the students going to be working in community teams, analyzing theory, or applying a particular problem solving method. Another way to look at it is, does the lesson incorporate one or more aspects of CPS? Below is a sample lesson outline for teaching students about experimental error. Several CPS objectives have been integrated into the design. Note that students are asked to devise their own solution and that discussion will ensue afterward to reflect upon the effort.
Sample Lesson outline

1. **Lesson Title:** Experimental Error
2. **Central Task or Problem:** Measure the perimeter of a basketball court using meter-sticks in a way that minimizes error in measurement.
3. **Lesson Objective(s):** Students will plan, test and analyze a method of their choice that minimizes error in gathering data.
4. **Application:** Use of the Self Identity Worksheet (p.101) to help students apply the activity. Post lesson discussion.
5. **PBL Techniques:**
   a. George Polya
   b. Team work ability
   c.
6. **Community:** How will the learning community be structured (i.e. teams, pairs, whole class) Students will work in teams of 3. When all teams have finished results will be shared with the rest of the class and discussion as to why different results were obtained. If all experimental error was eliminated should there be any difference in the data?
7. **Self Identity (Roles):** What roles will be assigned within the community (every student needs a role) One data recorder and 2 in charge of measuring
8. **Deconstruction:**
   a. Post activity discussion on why accuracy and experimental error is important in science. Also how could groups or individuals seeking to either verify or discredit data use experiential error to their advantage?
9. **Praxis:**
   a. **Student:**
      i. Assessment:‘publication’of team data.
      ii. Students can restate the lesson objective.
      iii. Self reflection worksheet
      iv. Class discussion
      v. Written activity conclusion as homework (1-2 paragraphs)
   b. **Teacher:** Reflection on the effectiveness of the lesson
      i. Did the students relate to the topic?
      ii. How well did the communities work?
      iii. Where all individuals involved in the effort?
      iv. Were students able critically analyze the problem? Did they have the tools to do so?
      v. Did students make any connections to society?
APPENDIX B

Recommended Reading and Websites

A Collection of essays that help the reader understand the basic principles of
critical pedagogy.

Education inc.
An excellent resource for the beginning or veteran teacher. Provides descriptions
of various teaching methods in an easy to understand format. The authors give
examples and real world applications for applying a wide variety of strategies.

Company.
Paulo Freire's original pedagogy translated from Portuguese outlining and arguing
his definition critical pedagogy and what it is. This is perhaps one of the foremost
books concerning the subject.

Ginwright uses a real life classroom to apply an unconventional teaching format
in a very urban classroom in Chicago. This book illustrates how a classroom
community can work together to accomplish very large and multifaceted tasks.

Teachers College Press.
This is a comprehensive explanation of what Afrocentric Pedagogy is.

University of Chicago.
A collection of essays that can show an educator what critical pedagogy looks like
in action. Also this book does a good job of showing what hegemonic
deconstruction looks like from people who attempt to apply it.

http://www.AwesomeLibrary.org A great resource supporting multiple activities all are
researched, peer reviewed, and are of good quality.

http://www.readingquest.org/home.html. A fantastic website full of strategies designed
for reading comprehension in a social studies class. However, many of the ideas
can be easily applied to the science classroom.
REFERENCES


