CONTEXT BASED LEARNING IN THE HIGH SCHOOL CHEMISTRY CLASSROOM:
PROS, CONS & OBSTACLES

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Over a century ago, mathematician Alfred North Whitehead addressed the British Association, discussing the connection between mathematics and science. His plea was for the teaching of content in an applied manner, for “the mind untrained in that part of constructive logic which is relevant to the subject in hand will be ignorant of the sort of conclusions which follow from various sorts of assumptions” (Whitehead 1916).

I have been teaching secondary chemistry for 24 years and still struggle with the question that always come from at least one student, “why do I need to know this?” Some concepts are easy to apply to real life, but I still find myself answering, “If you take more chemistry in college, you will need to know this!” I feel like this is a copout and that I am wasting the majority of my students’ time drilling content that they may never need to understand. I want to empower my students with scientific literacy, not abstract chemistry facts that will only be relevant to students majoring in chemistry-heavy science. I want my future neighbors, business people, elementary teachers, construction workers, factory workers, and especially politicians to be scientifically literate. Citizens around the globe need to be educated in a way that helps them to understand environmental issues that affect us all. This understanding will then empower us to act in sustainable, environmentally friendly ways. As Alfred North Whitehead would say “Neither logic without observation, nor observation without logic, can move one step in the formation of science” (Whitehead 1916). Alfred would agree that people can’t truly fathom the implication of our environmental choices if they don’t understand them. What is the best way for me to equip students for real life, while still preparing some students for continuing chemistry coursework? That is my motivation for researching this topic.
Problems with Current Chemistry Education

There are many issues with the current first year high school chemistry curricula. In Indiana, where I teach, there are forty chemistry standards that are to be taught to first year students with very little science background. In addition to those forty standards, there are eight “science and engineering process standards”, and eighteen “literacy in science” standards that are to be completed. That is a total of 66 standards that a high school teacher is to educate her students about in 180 school days. Many of those 180 school days are taken by weather delays, field trips, absences, standardized testing, pep sessions, etc. High school teachers often teach more than one subject in a day as well, requiring the change of demonstration materials, lab materials, presentation materials, handouts, and brain waves every 50 minutes, six periods a day. Time is valuable and short in the high school chemistry classroom.

The chemistry content standards are not only numerous, but are also written as if all students were going to build on their high school chemistry course in the future. This is usually not the case. Thirty-five percent of the US population had completed four years or more of college in 2019. The most popular four-year degree awarded was in business (Bastrikin 2020). This tells me that over sixty-five percent of my students are unlikely to earn a four-year college degree, and even of those who do, only a small percentage will take one or more chemistry classes.

This trouble does not only lie within the walls of high school chemistry classroom. Colleges have been discussing the restructure of the general chemistry course for years. “It would be fair to say that most students and many faculty find the [general chemistry] course to be less than satisfactory, and there have been numerous calls for reform” (Cooper 2010). College chemistry attempts to cover too much material, ignores the fact that most students are
not chemistry majors, uses ineffective teaching approaches, overlooks the research on how students actually learn, disregards sound pedagogy, and does not engage student interest. In fact, some studies have found that students leave general college chemistry with less chemistry knowledge and lower satisfaction with chemistry than they started with (Cooper 2010). If this is happening with college students, we can induce that it is happening with high school students. I see this dissatisfaction regularly when I meet new people and they find out that I teach chemistry. The most common response is a wrinkled-up nose and “I hated chemistry”, or “that is so hard”. It makes me sad to hear these responses. I want my students to say “I loved chemistry” or “I learned so much in that class!” Even better would be “I use what I learned in that class in my daily life”.

While researching this topic, I was curious to see why students hate chemistry and found this “top 25 list” written by an undergraduate student who had taken a general chemistry course:

“While sitting in [chemistry] lecture halls full of self-loathing students, all anyone really learns is how much they hate drawing chemical compounds. The level of absolute impractically to everyday life of the information taught is comparable to learning how to solve a rubix [sic] cube. It's impressive if you know how to do it, but it's useless information to 99 percent of us. Quite simply, Chemistry is the worst thing to happen to general education courses and here's why…” (Georges 2015)

The student goes on to list 25 reasons why they hate chemistry, including that the professor speaks in alien code, realizing nothing you learn will be useful in your adult life, and just not caring if something is ionic or not. Many studies show that when students see school science as non-practical, they quickly lose any interest that they may have had. One study in Sweden surveyed students to determine what suggestion they have for improving chemistry education. The most frequently chosen idea was to increase the connection to life outside the chemistry classroom. The second proposal was to increase the quantity (and quality) of laboratory work, and the third was to make learning more student-centered (Broman and Simon 2010).
Goldenburg interviewed 48 high school biology students in eight different teacher classrooms to determine what helped them learn science. The results closely matched best practices in science instruction. They most valued meaningful instruction that includes active learning. Teachers who are interested in them as individuals rather than recipients of information received the most positive comments. Students agreed that learning is more engaging when it incorporates their “personal lives into topics”. Group work and discussion was also preferred by students because it helped keep them on topic. One student said that she gets off task more if she works alone (Goldenburg 2011).

The use of direct lecture-based instruction and drill-style practice is still common in secondary science classrooms because it is the way most of us were taught, it is seen as most efficient, and it is how our readily available curriculum materials are set up. Despite the fact that for the past two decades, cognitive science has discouraged “teaching as telling”, teachers often fall back into the habit of lecture-based teaching (ACS 2012). When time starts to pressure us, teaching by telling seems like the only way to get through the content. We teachers must remember, however that getting through content does not mean that a student is learning that content.

The majority of students today do not learn through persistent, traditional instruction. According to the American Association for the Advancement of Science, in 1988, only 10% of the American population was considered to be “scientifically literate”. By 2007, that number increased to 28% which shows progress (Duncan 2007). However, when you consider that 72% of the general population cannot read and understand a simple science article from the New York Times, even this improved number is alarming. In a society so dependent and immersed in technology and science, it may be downright dangerous. As Duncan (2007) says, “It conjures
the specter of a society in which a cadre of elites knows and understands the essentials of the science that underpins our civilization, while everyone else uses and depends on that science without having a clue.” We must make changes to how we educate our citizens about science.

What is Context-Based Learning?

Enter context-based teaching. While there have been many suggestions on how to incorporate more application, visual learning, modeling, and other best management practices into chemistry teaching, the one that really flips chemistry education on its head is context-based learning (CBL). Rather than putting band-aids on the current methods of chemistry instruction, CBL takes a whole different approach. “The context-based approach aims to develop and sustain a sense of wonder and curiosity of young people about the natural world” (Ültay and Çalik 2011).

Donna King has done several studies on the effectiveness of context-based teaching and learning. She explains that the word context is used to describe a situation with meaning and connection to other words, phrases, or examples. When applied to chemistry education, the “chemistry becomes meaningful to students...and connects to an aspect of students’ lives” (King 2012). The framework of CBL must present information on a “need to know” basis determined by the real-world situation being investigated. In this method, students see the reason for learning the chemistry content because they need it to further understand what is being studied (King 2012).

Fifteen years ago, there was little research to investigate how, and whether, students really learned in a context-based setting. In the past ten to fifteen years, several studies have been done. One such study was performed in Queensland, Australia, involving an 11th grade chemistry classroom. The researcher and teacher met four times to design the water unit. They
focused on keeping the context central, which was the water pollution of the local creek. The final assessment was determined to be a written report in the form of an Extended Response Task.

The classroom work was done in three phases. First, students worked in groups to research water quality tests, including pH, dissolved oxygen, nitrates, phosphates, turbidity, total dissolved solids, biological oxygen demand, fecal coliform, and water hardness. Each measurement had to be explained from a chemistry perspective. The students then tested samples that had been collected from three different locations along the creek. The groups were then tasked with analyzing and interpreting this data. During this investigation, chemistry was applied on a need-to-know basis as student groups worked through the meaning of the data. At the end of the unit, students were required to write a letter to the area environmental protection group summarizing the investigation, results, and conclusion. This letter had to explain their interpretation of the results, compare their data with water quality tests in available local or state literature, and provide recommendations for improving the water quality of the local creek. The students also had to include sources of experimental error, limitations to their testing methods, and future research suggestions (King 2009).

King observed classroom interactions, read student lab journal entries, interviewed the students and teacher, and analyzed final reports. Of special interest in the findings of this study was the ability of students to make fluid transitions between real-world context and chemistry content. Students were able to discuss connections between the chemical measurements and what may have transpired in the creek to cause such results. For example, when one student was asked to explain a test result of high turbidity, the student was able to offer a sound definition and explain factors that may have contributed to the test result. The student suggested that
“something was stopping the current like a tree…that would slow down the current and ore solids would build up instead of flowing through the river” (King 2009). The link from the definition to an out-of-classroom explanation is one of the things that is often missing in more traditional teaching.

Baran and Sozbilir investigated the use of a combination of context- and project-based learning (C-PBL) through a thermodynamics unit with a small group of associate degree students in Turkey. In this study, context-based learning involved a group approach of working together on a real-world situation through discourse focusing on a solution. Problem-based learning “invites students to search, to think critical, to work in a team and to find solutions to the problems that are given in scenarios” (Baran and Sozbilir 2018). Putting the two strategies together provides a real-life problem that must be solved and gives students an opportunity to learn chemistry on a need-to-know basis.

The first scenario included an indoor coal stove causing carbon monoxide poisoning. Students were given a short reading about a mother who had started an indoor coal stove to prepare tea. The mother then left to do some other work. When the daughter comes home from school, she warms herself by the stove and falls asleep. She becomes cold, wakes up, and adds more coal to the stove, then falls back to sleep. The mother returns and tries to wake the girl but the girl is unresponsive and is taken to the emergency room. The students in the class are then given a set of questions to work through in small groups. They are told to make use of the internet, course books, and any other resources available to make thorough explanations of the questions. One of the questions was, “What is the reason for [the girl’s] poisoning and how does this poisoning happen?” Also, “How does heating take place? What kind of energy transfers and how does this transfer take place between the stove and its surroundings?” Another question was
“Other than coal what alternative fossil energy sources can be used for heating, and what are the reactions…during their burning? What is the enthalpy change accompanying 1 kg of these fuels [compared] with the coal?” Students had to search for the chemistry information necessary to explain several aspects surrounding the thermodynamics involved with the coal stove scenario.

The Baran and Sozbilir study was not large enough to compare an experimental C-PBL group with a control group, but extensive analysis of the students’ experiences led to some interesting conclusions. The C-PBL increased the students’ achievement and curiosity in thermodynamics, enhanced the students’ communication skills through reporting research findings, and improved their ability to make quality presentations. Positive attitudes toward the C-PBL lessons increased their ability to associate chemistry with every day life and made them more confident in their ability to learn chemistry (Baran and Sozbilir 2018). The results of the small but thorough study supports that it would be beneficial to use C-PBL in the chemistry classroom.

In another implementation of CBL in chemistry, first-year engineering students in Madrid were assigned a series of context-based stoichiometry problems. Students worked in groups of three, primarily outside of class time on these problems. This professor designed these challenges in an attempt to show engineering students that chemistry was relevant to real-world situations that they would see in their future engineering work. One example surrounded the composition of bottled mineral water. Students were challenged to determine what the total dissolved solids (TDS) were in their bottles of water. They then had to apply the law of conservation of mass and stoichiometry to determine if the label information was correct. The questions linked to the bottled water example were:

1. Determine the total concentration in mg/L of cations, anions, and silica. Does it match the concentration of TDS?
2. From the contents, can you suggest a reason for the discrepancy (if any) found in the previous question?
3. Discuss with your fellow students and inform the instructor about your explanations.
4. Which ingredient do you think will decompose easily at 180 degrees Celsius?
5. Calculate again the total concentration in mg/L of ions and silica, this time taking into account the loss of gases during the decomposition of the bicarbonate ion. How does this number compare to the reported TDS?
6. Compare the concentration of positive versus negative charges. Do you need to convert units of mg/L to mmol/L to make this comparison? Do they match? What does this result imply? (Pinto 2013)

Clearly, these questions are academically challenging. The link to the real world is not a simple one, but involves complex chemistry. In the past, these engineering students did not see chemistry as a pertinent course to their future studies. Through observations and interviews, researchers saw an increase in students’ interest and motivation in chemistry. Students “gained an appreciation for the necessity to study chemistry as an introductory science for their specializations” (Pinto 2013).

King (2015) studied the impact of context-based teaching on middle school student learning with a unit centered around a creek that ambles through the school property. Researchers and the teacher worked together to design the unit prior to its implementation. The teacher led students to the creek nine different times over an eleven-week period. These trips alone revealed great opportunities to teach students a great assortment of science content, including habitats, biotic and abiotic factors, adaptations of animals and plants, native and non-native species, creek bank erosion, plastics pollution, water pollution, and environmental sustainability. The teacher would often stop along their walk and ask spontaneous questions, like “Okay guys, what do we notice about this whole area? Have we found much in the way of
bugs?” These questions led students to notice certain things and to link observations with the content being learned.

The planned study had students work in cooperative groups to do six main activities: collect water samples, test water samples, count and identify animal populations, count and identify plant populations, analyze the environment surrounding the sample site, and count litter at each sample site. Students used Flip cameras to record their observations. Classroom lessons that provided canonical knowledge supported the creek visits throughout the unit. The final assessment was a written report to government officials on the health of the creek. In this particular study, it is relevant to note that every student completed this assessment task to a satisfactory standard or higher (King 2015).

While this study was not specific to chemistry, the results show that when students get to DO science, it is much more exciting for them. In this case, students physically entered the creek in waders and collected their own samples. This takes time, but is a rich educational experience that students remember. One student expressed that it helped when “you get to actually do it yourself, so you remember what you are doing” (King 2015).

Washington College professor Anne Marteel-Parrish developed a full semester course titled “Art in the Anthropocene: greener art through greener chemistry” after incorporating a context-based lab combining green chemistry and art in her general chemistry and inorganic chemistry courses. Feedback from students in the chemistry courses showed that the combination of art and chemistry was “unpredictably attractive” to the science students. Science majors requested to perform more cross-disciplinary hands-on learning activities, while art-focused students showed great interest in the science of the materials that they used (Marteel-
Parrish and Harvey 2019). While no study was done on this experience, it demonstrates the desire of students to connect content to context.

One last example of CBL involves a young lady who took two years of chemistry with the same instructor, but had to repeat the second year. The first two years, this instructor taught a lecture-based course with traditional lab work. At this point in time, the State had required a change to a context-based curriculum, so the third (repeat) year was taught using this new pedagogy, but by the same instructor. This young lady’s misfortune was an opportunity for Donna King to do more research on the efficacy of CBL.

The traditional teaching years included weekly “cookbook” lab practicals where students were given procedures and the instructor knew the expected outcome. During the CBL year, three context-based units were taught. One unit wrapped around the restoration of archaeologically significant metal artifacts, another involved the water quality of the local creek, and the third investigated the chemistry of a healthy human body (King 2008). The CBL units did not use “cookbook” labs but instead used projects that were planned by each student group with the guidance of the teacher. Students had to research and figure out what tests to perform in order to answer the questions they had about the topic being studied.

When the student was asked about which approach to lab work she preferred, she said “I think the one we used this [CBL] year is better. You find you are [covering] more the other way (i.e., concept-based approach) when you don’t have to do the research behind it it’s a lot faster. You can do things faster but you don’t learn as much in the process” (King 2008). The student was also able to identify real-life connections as a positive part of the new teaching method. The interviews revealed 16 different occasions where she mentioned a benefit of the context-based
approach over the concept-based approach. These comments often involved statements like, “You can see the real-life aspect to it…” (King 2008).

**Summarizing the Benefits of Context-Based Learning**

Study after study shows that CBL has benefits that should not be ignored. Researchers Ültay and Çalik (2012) performed a large review of the efficacy of the use of context-based curricula in chemistry. One recurring theme from this review is that CBL in chemistry motivated students and made them more enthusiastic about studying chemistry. They were not making top 25 lists of why chemistry is the devil, but were looking forward to going to class and doing science.

Studies related to the students’ abilities to understand the chemistry content have shown one of two things: an increase in conceptual knowledge of chemistry concepts or an equal level of comprehension compared to traditional teaching methods (Ültay and Çalik 2012). Either of these should be seen as a success when accompanied by an increase in desire to learn and an excitement for chemistry. Perhaps of even more interest was a study that showed that students who started with the lowest chemistry scores showed the greatest increase in all variables of learning quality as compared with students who started with higher chemistry scores (Ültay and Çalik 2012). This hints that students who are not “good at playing school” will benefit, while students who are already good at the school game will succeed with nearly any method.

Final implications of the Ültay and Çalik study are that “teachers should energetically make changes to their teaching styles” and that more guidance should be provided to clarify the CBL approach to teachers. Best teaching practices including scenario-based designs, cooperative learning, hands-on activities, authentic news media-based learning activities, student-centered and project-based laboratory activities should all be used within CBL (Ültay
and Çalik 2012). Narratives to provide the context should be employed to wrap the rest of these practices around in a neat spiral. Sound simple? This could make a first-year, or even a 24th-year teacher anxious. To do all of this with all of the content needed to be presented, is a daunting task.

Challenges with CBL

The benefits of CBL are obvious and many teachers truly want to implement it into their classrooms. The actual execution of CBL, however, is a challenge to most secondary chemistry teachers. The idea of reforming the science curriculum in the United States has been brewing since the Soviet Union launched the Sputnik satellite, beating the United States in the science and technology game. Efforts were made to change from fact-overloaded curricula to understanding basic chemistry concepts and rules. However, contexts were not included in this effort and it was largely a failure (Jong 2006).

The mid 1980’s saw the rise of projects like “Chemistry in the Community” in the United States and the Salters’ Chemistry project in Great Britain. These ventures implemented student-oriented and active learning approaches. The situations were taken from topics believed to be of interest to students to encourage both a better understanding of science in life and a more positive attitude toward learning science. These changes were also largely unsuccessful. Enrollment in first year science at the universities dropped and students still did not connect the context provided to the concepts and rules being taught (Jong 2006). The turn of the century saw another attempt to create a mass curriculum for CBL, Chemistry in Context in the United States and ‘Chemie im Kontext’ in Germany. The context in these programs was thought to be truly relevant to students and is regularly updated to remain current.
An overview of the Chemistry in Context program discussed some of the challenges to implementing the program in non-major undergraduate chemistry courses. The first hurdle is that this program does not teach chemistry the way we were taught chemistry. Instructors may know little about some of the main contextual settings, such as stratospheric ozone depletion or nuclear waste. Therefore, instructors may have a learning curve nearly equal to their students (Middlecamp 2008). This can be very uncomfortable for some teachers.

The Chemistry in Context curriculum presents chemical content on a need-to-know basis. Some content that is near and dear to an instructor’s heart may not be included. This can be difficult for a teacher to accept, and they may have to let go of some topics or teach them in much less detail. The time required to fully invest in the Chemistry in Context curriculum can also be of concern. Learning new content and keeping current on the contextual issues can be a challenge. End-of-course goals may also need to be reinvented to align with a context-based curriculum (Middlecamp 2008).

Today, we have a shortage of licensed science teachers across the United States which presents yet another challenge to using CBL in classrooms across the country. Many schools are finding that they will have few, or even no, qualified candidates for several open teaching positions. Winchester Community High School has found it very challenging to fill science positions with quality candidates. In the past ten years, we have had six teachers go through one biology teaching position. One of those “teachers” was a chiropractor who had moved back home to Winchester, had not yet reestablished a practice, and was willing to fill in for one year. He had no desire to get his teaching degree and left after the one year that he promised. Another teacher really struggled to get along with teenagers. She hated them and they hated her. She resigned under some pressure after only eight weeks of school. A third person who filled the
position in the science department was a climate change denier, among other things. How can we expect CBL to be used in the classroom when we can’t even place qualified teachers in those classrooms? Our nation must decide to prioritize education and make the teaching career more highly respected, and financially rewarding.

**Training the Teachers**

A study by Overman et al. (2018) evaluated the differences between two instructors who attempted to implement a CBL approach but who did not have equal success. One instructor succeeded with the approach, but the second one struggled. The researchers recorded each teacher presenting a lesson, watched the video with that teacher, and discussed how to activate students to engage in learning. Three additional in-depth interviews were conducted to determine what interactions were useful to engage students in context-based learning (Overman 2018).

During this study, three main themes emerged concerning the day-to-day negotiations that occurred between teacher and students; “agency of learning”, “vulnerability”, and “care”. Agency of learning refers to the shift from “the teacher being the one who tells the students what to do and how to learn” to students regulating their own learning process (Overman 2018). The teacher who had more success considered his students to be “knowledge owners” and often told his students how much he learned from them and their group conversations. The other teacher thought of his students as “passive learners” who were dependent on the teacher and would not take the initiative to learn on their own (Overman 2018).

Overman describes the CBL “vulnerability” as the simple fact that with context-based learning, the teacher may not always know the answer. CBL raises unanticipated questions which should be seen as part of the learning process, for both student and teacher. The more
successful teacher in Overman’s study intentionally demonstrated and even embraced his vulnerability whereas the less successful teacher did not want his students to take advantage of him and was less willing to show his vulnerability (Overman 2018).

The third theme of “care” in Overman’s study shows that both teachers care deeply about their students as individuals, but the more successful teacher also demonstrated care about his students as learners. The teacher who struggled said, “I still like to teach, because the interpersonal interaction with my students is something fun…[but] it is hard to “seduce” these students to engage in self-study. That takes so much energy.” On the other hand, the other teacher shared “a mistake I made in the beginning [was] that I asked them to write down personal qualities without relation to the subject. I want them explicitly to think about how they can contribute in the classroom” (Overman 2018). Meaning, he changed his question strategy to ask about personal qualities with relation to learning. The latter demonstrates small ways that this teacher constantly related things back to the student as a learner.

Professional development of teachers is a requirement of any successful curriculum reform. "Excellent teachers are the key to exciting and sustaining interest in science in schools". The challenge for all science educators is to discover the most effective methods in their classroom environment to capture the imagination of all students to ensure quality science learning (King 2007). Broman and Simon (2015) also emphasize that the key influence to students’ interest in science is teacher quality. As a nation, we must prioritize education as an attractive, rewarding profession in order to draw in the highest quality candidates, and then we must train them to use best teaching practices available while incorporating the real world into their classrooms.
How do we accomplish this? Past experience has shown that for reform to be successful and endure, teachers need to be involved in the design and implementation of the curricula (Stolk et al. 2012). This leads to increased teacher confidence in creating new units on their own. Teacher development courses should connect CBL with course activities, provide pre-teachers the chance to complete half-finished context-based units and then allow opportunities to implement the completed CBL units into a classroom experience (Jong 2006). Professors, secondary teachers and pre-service teachers should all discuss and reflect on teaching successes and challenges within the CBL classroom.

In my experience, the best professional development is that in which you get to model what your students will need to do in the classroom, while being able to troubleshoot and problem solve with peers. My personal suggestion is to offer annual training where teachers are the students in a context-based unit. This could be done in one intensive week. Each year, a new cohort of teachers could become the students while the previous year’s cohort become the instructors of the professional development. A new unit could be created each year by the “graduated” teachers and eventually a full curriculum of units could be taught in a cycle. I would love to have that opportunity! CBL could be introduced into the secondary teacher’s classroom slowly, trying one or two units per year.

The Push to Continue Trying

The need for a scientifically literate society has never been more obvious than it is today. As COVID-19 permeates every aspect of life across the globe, we see the struggle for people to understand. Climate change is happening, yet we have a large population who don’t understand science enough to make sound judgments on global warming and other environmental issues. Our river waters are tainted with excess nutrients, leading to a dead zone in the Gulf. Drinking
water becomes too acidic and ionizes lead, making our community ill. According to the National Research Council, “science literacy means the capacity to understand, at least at an elementary and inquisitive level, the phenomena of nature and the products of human technological endeavor,” (National Resource Council 1996). Dr. Jean Mayer, former President of Tufts University says, “It is not a measure of what you know. Rather, science literacy is a measure of your ability to gather information and to discern credible from non-credible sources,” (Herring 2013). Stephan Lewandowsky, a cognitive scientist at the University of Bristol in the UK puts the need for scientific literacy into perspective: “On page one of any political science textbook it will say that democracy relies on people being informed about the issues so they can have a debate and make a decision. Having a large number of people in a society who are misinformed and have their own set of facts is absolutely devastating and extremely difficult to cope with,” (Gray 2017).

Despite the great challenges facing education in general, and the hurdles that will need to be overcome to implement CBL in all science classrooms, my research shows that it is worth it. Bennet et al. (2003) performed a meta-analysis of 66 studies on CBL and evidence to support the claims that CBL motivates students and leads to more positive attitudes toward science. Further, evidence supports the claim that CBL does not adversely affect students’ understanding of scientific ideas.

After investigating the pros, cons, and obstacles of context-based learning, I plan to find and/or develop at least one context-based unit per semester for my first-year chemistry course. Careful attention will have to be paid to the state standards, and some standards will have to be taught in less depth than I am used to. I will search the schools around me to see if there are other chemistry teachers already doing CBL, or who are interested in joining forces to incorporate it along with me. The current limitations with COVID-19 may make this even more
challenging, but I fully believe that developing a community of people who enjoy science, find it relevant, and are more scientifically literate, will benefit us all. Alfred Whitehead’s two educational commandments are: “Do not teach too many subjects”, and “What you teach, teach thoroughly” as it applies to life (Whitehead 1916). This will be my new mantra for the remainder of my teaching career.

Works Cited


