

My development as a Biology educator who seeks to be engaging and authentic, and my thinking on how to help students make deep connections to themselves and the living world.

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A common question directed to teachers goes something like this: how did you know you wanted to do the same thing over and over every single year? The question reveals the misunderstanding of the most important work of an educator. I suppose that I should not blame anyone for this position given the formulaic image that is often applied to education. Students, the raw material, are shaped through tried and true teaching methods - guided by standards that point students toward the perceived best college. The true work and inspiration in teaching is the relationships that are forged during the sacred process of learning. The care of the individual child and the engagement in their development is the real work and it is never the same year to year. Biology is a wonderful context in order to guide this personal development.

I have come to wonder after 15 years of teaching high school chemistry and biology in 3 separate public school settings, what is it that I am preparing students for.? What are the important lessons of biological sciences and what are the important personal lessons that can be learned from biology? Sometime over the past 15 years I stopped thinking of myself as an expert of a broad high school level biology content and an expert on interaction and development of young people. A teacher colleague of mine, often in referring to John Dewey and to teaching will say, with his most profound inflection: “This thing we do, it is a human enterprise.” It does not matter what I teach; it matters that a genuine and authentic learning experience is fostered through the relationships that are built in the classroom. Nevertheless, I am a teacher of biology. It remains the discipline that inspires me personally. I come to this project with the desire to explore how in my teaching of biology I can better engage students in authentic learning that helps them relate to their biological world.

But truly, how can they not? They have blood coursing in their veins and why is it blue sometimes and red other times? Is that even true? Some carry genes that predispose them to condition X and what does elevated risk even mean? They eat corn, it is in everything, why is there so much damn corn? The questions to be explored with biological contexts are endless and every question intersects with our humanity in some way. The questions listed above are ones that inspire classrooms. It is what kids are actually wondering about. This is the energy into which I would like to tap as I explore the kind of teacher I want to be in the future and the type of learning experiences that I want to provide for my students.

The most memorable moments in any learning settings are ones that create meaningful and personal connections. The learning should be experiential and exciting. Reeve (2012) describes the self-determinism theory (SDT) and the specific aspect of student-teacher relationship as it relates to engagement and motivation. His work describes the complex inner motivational recourses that orient them in the learning environment. Additionally the learning environment has aspects that support or impede these resources. (Reeve, 2012). I see the students interests wax and wane in a non-uniform way over the course of the year. The trend that I see is toward students taking classes that are content heavy and have diluted experiential learning. Reeve's emphasis on the unique collection of interests and motivations of each student is reinforced in my observations of my students. I seek to become better at recognizing and being prepared to engage these students. The current paradigm captures many students but not everyone and not all the time. I believe that, generally, teachers worry too much about every student learning the exact same collection of material instead of following their own line

of inquiry. One explanation that I have experienced is that teachers are worried about trying out new ideas because of the uncertainty that comes with the process. Teachers are generally very busy and having well defined plans is a mechanism to bring order to chaos, leaving less room for creativity in the curriculum and creativity in the learning. I wonder, is it more important that every student has the exact same experience or is it more important that they have a personal and meaningful experience?

The process of research undertaken has the purpose of exploring a potential alternative path to my teaching. I have always considered my classes to trend toward student-centered learning. I am confident that my ability to build relationships with students is strong. The traditional teaching model that still exists in my class does not play to my strengths as an educator. I aim to have a more nimble teaching curriculum that can follow threads of inquiry. I envision students having the freedom to explore the areas of biology that they are curious about but with the understanding that their curiosity is the wedge that opens up a wider world of biology. The work in the report is an exploration of curricular methods that lend themselves toward self-exploration. In this future curriculum, students have choice in what they pursue but within the context of an overarching theme. The students are selecting lines of inquiry that are challenging but interesting to them. The student's work involves engagement with the wider community. The students learn from each other and are invested in topics that are not their own because they are also engaged in a personal inquiry. The students engage in a review process that scrutinizes the validity of each other's work.

The sections that follow outline my exploration of different teaching models. The goal of the research was to help me envision ways to bring more engagement and

authenticity to my classroom. The engagement I hope to achieve is student engagement in the material, peer-to-peer engagement, and my personal engagement with my students as individuals and their personal interests. The authenticity relates to my personal orientation toward the meaning of my work and teaching in a way that is best for students learning and growth. The research can be broken into two primary sections. The first being interviews with teachers that use alternative classroom models and the adjoining research that those interviews inspired. The second section is an exploration of alternative teaching methods that maximize student engagement. Some of these methods I have used in my classroom and served as a starting point for my thinking and my research.

Alternative models of classrooms at Brookline High School have offered a convenient and inspiring array of examples that reflect aspects of what is written above. There are three classes at BHS that have offered me some insight. The Experiential, Project-based, Innovative, capstone (EPIC) and School within a School (SWS) EPIC History classes and Social Justice Leadership Program are all non-traditional models of teaching and learning with elements that could be applied in a science classroom.

EPIC's problem-based teaching model is a good proof of concept within the walls of the high school. The planners of the course, Stephanie McAllister and Ben Berman, cite the desire to create a more authentic and meaningful capstone experience at BHS. The course was implemented as an alternative to the senior paper, which is a graduation requirement. The senior paper is completed in English classes and the flexibility in topic and format is largely related to the teacher with whom a student ends up. The EPIC course is still young, this being only the second year. Berman recounted the biggest

failing of the first year of the class was that too much freedom was given to the students and that many students floundered as they took on a big topic. The approach this year has been to develop mini research cycles to develop research, reflection and communication skills that can be transferred to a more independent inquiry in the second semester (Berman and McAllister, personal communication, November 2016). The EPIC course provides me valuable insight as I consider pedagogical frameworks that allow students more choice. The teachers of EPIC report that this year, the mini research cycles have allowed them to better “corral” the students in the first semester, providing more opportunity for formative assessment of skills that will be important later, the very skills that were missing in the previous year. The other insight that strikes me from visiting with the teachers of EPIC is the attitude toward continued development of the course. Berman and McAllister both understand the class is a work in process. Just as their students are undergoing a project of inquiry that is fluid and changing, so are the teachers. The idea of learning together is a strong classroom community value that allows the students and the teachers to take risks. They see their work on the course as an educational experiment and they have included the students by incorporating opportunities for them to give feedback and shape the way the course is taught. (Berman and McAllister, personal communication, November 2016).

The EPIC course is a good model and it is important to note the institutional support for doing a very different type of senior year capstone; however, the challenge of using this course as a model is that it is not a content standard-based course. The class is process-based and focused on teaching research, reflection and presentation skills. These

are aspects of what I hope to have in my classroom, but I still need to address the need for teaching specific biological content.

The SWS History classes are interesting to me based on various aspects, including their heavy reliance on technology, the class is paperless, there are no tests or quizzes, and students are selecting the content in many cases. History classes are content-based and there are topics that need to be covered in a year's time. The teacher who developed the course, Jen Martin, comments that students invariably get around to the major themes as long they respond to her guidance. It would appear that the sequential nature of history would provide a challenge, but Martin comments that student are more engaged when they have influence in determining the direction of the course. The course just covered Native American history from the time of Columbus landing all the way to the Dakota Access Pipeline. The inquiry led students along a path that moved past other historical events, such as the Vietnam War. She reports that in this process, student engagement is high and when students need to learn about other historical events, such as the connection between the Wounded Knee Incident and the Vietnam War, students could independently seek out this information (Martin, personal communication, December 2016). This anecdote is of particular interest because I have wondered about non-sequential teaching in biology.

There are a few variables at play when looking at this SWS History class. One is that this class is a part of an alternative program (SWS) that assumes an alternative approach to traditional education. This alternative setting allows for more teacher autonomy, and students opt into the program. The learning environment is challenging and engaging but I wonder if it is a class that could work for all students. Additionally,

there are several topics in biology in which sequence matters. However, the most promising lessons from observing Jen Martin's history classes was the opportunity to see the way students and teacher interact in a technology-based classroom. Linn (2003) described the essential and developing role of technology in the science classroom. Many of the curricular methods explored in this paper are enhanced by students' ability to have a wealth of information at their fingertips. Learning platforms are increasingly more customizable to the topic of interest. Teachers can use these platforms as a way to develop learning environments that are more individualized (Linn, 2003). The role of technology in my future classroom will certainly be significant and a mechanism to manage all aspects of learning. I see strong connections here to the work I did in Creative and Critical Thinking (CCT670): Thinking, Learning, and Computers. In that class, I worked on a project that attempted to use a technology platform to increase the quality and quantity of peer feedback on written work (<http://expertprojectcrcrth670.weebly.com/>). The method is now a regular part of my teaching and represents one of the ways that technology can be used.

The Social Justice Leadership (SJL) is a program that involves a classroom component. The program has limited school meetings and a more involved aspect of community engagement. Students learn in seminar settings about social justice issues and a process of exploring their own identity. The remainder of the time, students intern with Boston area social justice groups. The SJL program, upon discussion with its teacher Roger Grande (Grande, personal communication, November 2016) provides a good model for student engagement but is too far removed from the classroom to draw strong parallels. The desire to bring agency to my students is one of my hopes, especially

along the lines of the environment. The SLJ program does a small unit on environmental social justice, which could serve as an opportunity to do some powerful cross-curricular work. In the classroom I envision, students are empowered to pursue an educational path that is personally meaningful. Dimick (2012) investigated an environmental science classroom that was constructed around a social justice framework. In citing Buxton (2010), Dimick states (pg.993) that “using a social justice lens used to view class content raise the student awareness about environmental and sociopolitical issues through place based education and by building on students lived experience.” This framework speaks to several aspects of the classroom that I want to create for my students.

The process of visiting these classrooms and talking with the teachers helped me think further about my development. The work they are doing is innovative and provides examples of how non-traditional methods can be implemented, supported by the school and embraced by the students. The classes all give students a larger role in deciding the curriculum. But, the lessons learned from my practitioner colleagues, while valuable, is not science specific. The practitioner examples help me understand the classroom structure and culture, but not the teaching of science. In effort to explore my development as a biology teacher, I extracted several examples from the education literature that have helped me to think about what a non-traditional biology class might look like. Alternative classroom models and pedagogical frameworks are, of course, not new inventions. Educational literature has much to say on the effectiveness of several models. The subsequent section addresses my research on large-scale classroom framework approaches and individual curricular methods.

Problem based learning (PBL) is a well-established framework that has been

extensively researched, but still remains controversial. De Witte and Rogge (2014) write, “The main reason for the controversy is that, in spite of being the subject [PBL] of extensive research, several aspects and influences of PBL remain unclear.” (pg. 59) The authors of the paper are attempting to fill in a gap in the research on PBL in high school classrooms. One clear challenge was simply defining the method because it is implemented in so many different ways. In this study, the researchers showed significant improvement of student motivation, higher classroom environment satisfaction, and improved content knowledge as measured by test scores, when the method was defined as, “PBL is an active learning method that starts from a concrete problem. Through group discussion, individual study and collaboration in small groups, students discover their own knowledge, try to understand the underlying mechanisms of the problem and solve the problem together. The teacher acts as a tutor that guides the students and supports the students’ initiatives.” (De Witte, and Rogge, 2014). De Witte and Rogge point to several other examples of the effectiveness of PBL in secondary classrooms in the course of laying out their argument. Geier et al (2008) showed a connection between PBL methods, increased content understanding and performance on state-wide testing.

The PBL method is of great interest and has a foundational component to my future classroom. I am especially interested in the potential of teaching environment-based lessons using PBL. Savery (2006) outlined several aspects of PBL that fit well with teaching environmental issues, including sentiments such as, “problem simulation must be ill-structured and allow for free inquiry”, “learning should be integrated from a wide range of disciplines” and “the activities carried out must be those valued in the real world.” Lewinsohn et al (2015) propose that PBL can improve student ability to apply

ecological knowledge when faced with ecological problems. The authors layout starting points for curricular and classroom structure shifts that teach ecological content through PBL and experience based learning. The authors suggest using technology in an inverted classroom model, field courses and excursions (Lewinsohn et al, 2015). This perspective ties into not just to PBL, but other areas of interest around place-based learning.

Smith and Williams (1999) described place-based learning or outdoor education as, “the practice of ecological education requires viewing human beings as one part of the natural world and human cultures as an outgrowth of interactions between species and particular places.”(pg. 3) Place-based education is an important part of bringing engagement and authenticity to my students’ learning. Time in nature has wide-ranging impacts that extend past the teaching and learning goals. Scott and Boyd (2013) report on teacher and student perceptions of teaching and learning out-of-doors. Teachers initially nervous about leaving their comfort zones reported improved behavior and engagement. The students reported positive impacts on peer-to-peer and teacher-to-student relationship building. Place-based or outdoor learning emphasizes and reinforces many of the same principles of PBL in the areas of free inquiry (Savery, 2006). Another important aspect of the PBL method stated by Savery (2006) was, “collaboration is essential.”

Wolfensberger and colleagues (2015) studied a cooperative learning technique with 10th to 11th graders around a specific History of Science lesson. The cooperative learning technique is connected to my goals in that I want my classroom to be a collaborative and supportive learning environment and flow from the concept of PBL. I want to create an environment in which students learn from each other just as they would

learn from me. This study also incorporated two other attractive methods. Case-based learning and a reflection on the nature of science. The case is based on the history of the discovery of the Archaeopteryx. In another History of Science case on sickle cell anemia, students are learning the content of the central dogma of biology in addition to the complexities of the social contexts of a disease (Howe, 2003). The case-based method has lots of potential to provide the students with examples of science playing out in the real world. Using cases as a teaching tool provides a wealth of techniques and topics that cover virtually all areas of Biology content. Clyde Freeman Herreid (2005) has written widely on using case studies to develop critical thinking and to engage students in learning in the contexts of stories. This is an area of my research that requires further digestion given the volume of work that has been done. The National Center for Case Study Teaching in Science

(<http://sciencecases.lib.buffalo.edu/cs/teaching/publications/>) is a resource I have written about in the past and is already a regular tool in my curriculum. My development in this area is around digestion of the teaching resources that are provided on this site, including references to PBL and design thinking, and a more thematic approach to using the cases in my classroom. I need to determine how to weave cases into a choice based curriculum. One area that I have used cases in the past is in the teaching of bioethics.

Bioethics is an area that touches several different topics in Biology. It provides a context in which to learn content. Siew and Dawson (2014) studied the use of ethical frameworks when teaching controversial issues in Biology. They discovered that giving students a process to evaluate a complex issue led to better developed and supported positions on that issue (Siew and Dawson, 2014). Ethics is one of the areas that has

seen students engage in passionate discussion and debate. Young peoples' concept of right and wrong is tapped into, yielding the potential for learning but also the danger of entrenchment. The article illustrates and encourages thinking about complex issues from the point of view of different stakeholders and through different ethical viewpoints. I think this empathy-building skill is important in fully understanding and engaging in a world in which we have increasingly more biomedical choices that relate to ethics and the consideration of an ethical orientation toward the environment.

As I consider the collection of observations, interviews, and readings, the challenges of integrating and distilling this information into a coherent connection to my professional practice swarms my thoughts. What strikes me most when I reflect on the interview I conducted, the fields of case-based learning and problem-based learning, and my own professional trajectory are the consistencies within all fields. For example, in the SWS History classes, I see learning that is technology-driven and problem-based, but Martin refers to it as project based. The class is clearly a cooperative learning environment, but this manifested as a reality of the planning and was not a central goal at the outset of rethinking Jen Martin's craft (Martin, personal communication, December 2016). In reflection, almost all the learning methods explored here are reflective and inclusive of other methods.

The integration and reflection of this research is playing out in the context balancing what is a practical vision versus what areas of my institution I choose to challenge. This is a personal evolution along with a professional evolution. I want to push myself into an area of slight discomfort as I try out new learning experiences. I expect that in this process, some failures will come with the implementation of a new

method. Drawing from the EPIC example, the teacher admits that last year the class allowed students to explore their interests, leading them to “spinning their wheels” or following a non productive path of research. (Berman and McAllister, personal communication, November 2016) The developers of the EPIC course had to teach this new class before they could learn that curricular lesson. Sufficient time is needed to allow the experiences to develop so they can be improved. I worry about this time being tolerated, but the existence of the classes I visited provides good models of support from administration. Additionally, the school recently hosted a design thinking workshop that illustrated a process of problem solving that can be applied in a wide range of subject areas. Design thinking, while not mentioned at length in this report, mirrors much of the student engagement goals from the methods above. The fact that the school sponsored such an event bodes well for the direction of innovative curriculum at BHS. Having said that, there is a limit to which I can stretch the system, especially within my department that values collaboration that errs on the side of group think. The acknowledgment that the program will not be perfect at its outset is necessary to the ultimate success of the program and many in my department take if it ‘ain’t broke don’t fix it’ mentality. This will need to be overcome.

Institutional challenges aside, there is a path forward to experiment with this type of classroom structure. I have the opportunity to teach in an alternative setting within Brookline High School. The SWS program is a democratic school program at BHS, and the same program that has supported Jen Martin in her development of her History curriculum. The students in this program are heavily involved in the development of the English classes that are taught. English teachers are given more control over the course

proposal process within the high school given that students are opting into the program. This model could be transferred to a Science class. The program is smaller and the administrative structure is very open to exploratory learning in all contexts. Relationships with students, staff and the wider community are values that are important to the program and mesh well with the type of classroom I envision. The SWS environment should allow me to incorporate alternative teaching methods into the classroom and experiment with different classroom structures. A different approach could be to create a second year elective Biology class focused on societal issues in biology. The class could employ the methods researched with less of an emphasis on achieving the content standards. This could be a proving ground for methods and will allow for the important step of collecting student feedback.

The process of reflection and research in this project has helped me create a view of the type of teacher I want to be. Authenticity as a teacher flows from the investment in the topics that I teach. It also relates to the investment in the topics my students choose to pursue. I have a view, but it is not clear. The work must become tangible. My current curriculum needs analysis and triage. Opportunities for student exploration needs to be identified and enriched based on the lessons learned and outlined in this report. Everything needs to be placed into a year-long arc of learning. My development as an educator is increasingly intertwined in this process. I wonder about my future in a profession that is devoted to content and assessment to the detriment of engagement and exploration. The potential changes I envision are not just about my students' meaningful connections with themselves and the living world, but about me staying engaged in an institution in which I believe. This report is a good start but there is work to be done.

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