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Reading and Writing in the Science Classroom
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# Reading and Writing in the 21st Century

As a science educator at the middle and high school level I have found that it is imperative for students to be able to understand and engage in scientific texts in meaningful ways. Being scientifically literate allows students to be successful in their current role as a student but it will also allow them to be successful adults participating in everyday life whether that be personal, job related, or in their civic duty. (Siebert et. al 2016) Today's world is one that is always changing, to be able to move forward successfully and make the right decisions adults will have to consume information, process it, and be able to know what to do with it. While those skills are needed to be a successful citizen and participant in our modern world, those skills are also needed to be a scientist. What better way to prepare our youth for the future than to do it through science classes where students can act out and try out that role.

In order to develop critical thinking skills described above, students must be scientifically literate. This includes interacting with, reading, making sense of, and applying texts in a meaningful and authentic way. This can be a challenging task for teachers, as it may require them to change from their traditional learning practices that focus heavily on providing students with the facts and concepts that then need to be recalled for exams. As educational reform is underway there is a push to have students participate in the discipline in communities of practice rather than interact with scientific expository texts which depict science as a static body of knowledge. (Siebert et. al 2016) A great first step to making a change towards this 21st Century literacy is to choose reading materials with purpose. This means that it is at a lexile level appropriate to your students, is authentic to your discipline, and will engage your students. If students feel that they can easily access the text without being frustrated by difficult vocabulary, abstract concepts, or judgement from their peers then they will be more motivated to participate and engage in classroom activities (McGlynn and Kozlowski 2016) As students engage in the social and cognitive aspects of learning, student motivation increases. When students are engaged in authentic tasks where they social, emotional, and learning needs are met they have a strong foundation for self-esteem, leading to increased motivation and academic success. (Wentzel 1998)

Once an appropriate text has been selected, the next step is to have the students engage with it in a deeper way to elicit content learning and understanding. This requires science teachers to implement Content Area Literacy (CAL) instruction. Content area literacy instruction focuses on helping students learn content by reading information texts and fosters a classroom culture of knowledge consumption. Content Area Literacy can fall into two categories; disciplinary CAL instruction and general CAL instruction. (Siebert et. al 2016) Disciplinary CAL instruction creates classroom activities "where they can exercise the creative practices of imagine, investigate, construct, and reflect as unique beings committed to giving meaning to their experiences." (National Core Arts Standards 2012) These types of activities can easily fall under Project Based Instruction (PBI) or Project Based Learning (PBL). Problem Based Learning (PBL) which is a type of instructional method in an inquiry science curriculum. Problem Based learning is a method of teaching through authentic multi-layered problems that have students act and think like scientists. Students in PBL classrooms have shown to make more sustained and long-term academic gains than non PBL classrooms. (Dolmans et. al., 2005) A main feature of PBL classrooms is that students are partaking in Peer Assisted Learning where rich student dialogue, questioning, and evaluating allow for the instruction of their peers. In order for students to participate in these rich dialogues students would need to have gathered meaning and understanding from classroom texts. This is where disciplinary CAL instruction comes into play.

Disciplinary CAL instruction explicitly teaches students the skills necessary to participate and engage in the practices of that discipline, in this case science. Science CAL instruction can be tricky in that science relies heavily on multimodal texts usually in the form of flowcharts, graphs, data tables, and pictures. Multimodal texts are not always used in the general literacy setting, so even “good” readers may struggle in this new and challenging area. Therefore direct instruction and modeling will be needed for students to feel successful. Although direct instruction is needed, it should be done within the context of authentic learning. In a science classroom this includes creating experimental designs, making and writing predictions, drawing scientific models, recording observations, developing conclusions, and finally sharing these ideas in a public format. (Siebert et. al 2016)

There are specific instructional strategies that can be used to forster in scientific participation and engagement. One skill is to teach students how to develop and ask a compelling question. A compelling questions should be one that is not a yes or no answer, allows for multiple answers and and perspectives, and is interesting to the researcher. This can be a daunting task for a middle or high school student, therefore teacher modelling is essential. (Spires, Kerkhoff, and Graham 2016) As a practitioner, I have found that using question webs to expand thinking has been extremely helpful to aid students in this process. Question webs add information to the the main question by using smaller sub questions to add bits of information in some related way. The goal at the end is for students to use the web wholistically to answer the driving questions. (Harvey and Goudvis 2007) Question webs can also be used for students to develop a testable research question. Question webs can come in a variety of formats, however the driving or essential question is in the center of the page with sub questions branching off. When I model webs I will explain my thinking process outloud starting with what I already know and then what I want to find out. This is what becomes the sub questions. Once students have enough information gathered, they can sift through what they know and don't know to create a research questions that will be innovative and add to the scientific body of knowledge. To introduce this practice to students I will start them off in groups and provide some already written sub questions that they can use with the understanding that they too must generate their own questions. As students become more comfortable they will no longer need the question prompts and can start to do this independently.

In order for students to add information to their question web and complete the research after they experimental question has been created, they need to be able to find and understand credible research. This is a another disciplinary CAL skill that needs to be taught explicitly. Text annotation is one way to do this. Text annotation is a coding system students use to track their thinking and understanding as they read scientific texts. The process inherently forces students to slow down and engage their thinking with the text in a more meaningful way. If done correctly it can provide a lens for students to make self to text connections, and undergo a metacognitive process where they express what they already do know and do not know. (Harvey and Goudvis 2007)

Another CAL strategy that can be used in authentic science instruction is to teach students how to move among and understand the tables, figures, and diagrams often found in scientific journal articles. (Spires, Kerkhoff, and Graham 2016) Interpreting multimodal text can be hard for students especially when the tables, figures, and diagrams include mathematical and scientific language students are not familiar with. Using the CREATE method as developed by Hoskins 2007, is a concrete and approachable way for students to engage in authentic scientific research. CREATE stands for consider, read, elucidate hypotheses, analyze and interpret the data, and think of the next experiment. (Hoskins et. al 2007)  I use a series of specific graphic organizers to guide students through the create method. Not only do the graphic organizers teach students what information they should be looking for as they read it also provides them a scaffold and model of how they should express themselves when it comes to the last portion of scientific inquiry which is to write about and share their ideas.

These are just a few of the disciplinary CAL strategies that can be used in the science classroom in an authentic way. There are many more out there however the trick to is to pick what is most appropriate for your specific group of learners. Think about the ages of the learners, their current capabilities, and the goals and enduring understandings that you are trying to move your students towards. This framework can help you choose what instructional strategies are appropriate to use. No matter what the strategy, I always try to instill to my students that these strategies although they may seem specific to science can be transferred and modified to fit any text or problem that they may come across as a student or later in life. If students feel confident in their capabilities as a learner, then they will be able to see the applications and importance of literacy elsewhere.

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