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Rationale

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Target Student Population: High School Physics

While “teaching” seems to many in contemporary American society to be a profession that a person does if they cannot succeed at anything else, great teaching is a very difficult accomplishment. To those who would disdain the importance of an excellent teacher, I would challenge them to take a group of 30 students--most of whom do not want to be there--and have them emerge after a year as having both a better understanding of the content and more intangible skills to succeed in the world. Those who are able to galvanize such a transition in students are great teachers, and set the bar highly for their colleagues and aspiring teachers. Great teaching requires a person with the right combination of attitude, people skills, work ethic, content knowledge, and artistry, and these are the traits for which I am striving. As a beginning on the road that leads toward excellent teaching, this paper will set forth my thoughts on curriculum--instruction and assessment--and explain how I will incorporate theory and observational experiences into my classroom. Both sections will begin with a guiding question and discuss the appropriate area.

The first guiding question is: what is my instructional framework in which to implement specific strategies? The answer to this question is that my framework will be the 5E strategy (Engage, Explore, Explain, Extend/Elaborate, Evaluate), which is an inquiry-based strategy focusing on the students performing activities before an explanation of the phenomena is given (Barufaldi, 2002). This model is student-centered rather than teacher-centered, and thus takes the emphasis off me to always perform and places it on me as more of a guide for the students. There still will be times for me to perform, especially during the Explain section of the 5E model. This section lends itself well to mini-lectures, but in an overall sense this model focuses on the students doing activities rather than simply sitting and listening to me talk.

Inquiry learning has its roots based on the work of Lev Vygotsky (1896-1934), and his psychology theory of learning is called the sociocultural theory of development. This theory emphasizes three aspects driving development of humans: social interaction, language, and culture. Social interactions result directly in development, and through these interactions the less knowledgeable person develops understanding they would not have otherwise from a more cognizant person. The new comprehension is generated in a process called internalization, in "which learners incorporate external, society-based activities into internal cognitive processes" (Eggen and Kauchak, 2010). Internalization is the primary mechanism for cognitive development, and creates a link between the external and internal worlds of the person.

Language is another aspect of development. It facilitates access to knowledge others already possess, and is a cognitive tool that allows learners to think about the world and solve problems. Language is also a way to regulate and reflect on our own thinking, as we "talk through" problems to logically reason to an acceptable solution and share with others (Eggen and Kauchak, 2010). As students share knowledge with each other to make sense of their experiences in an open discussion process, they are actively engaged in negotiating and building consensus within their peer groups (Lorsbach and Tobin, 1997). This is a step that helps with the internalization process, and should help reduce the number and strength of student misconceptions.

The final essential aspect of Vygotsky's theory is culture. It provides a context in which development occurs, and also a mechanism for both communication and thinking (Eggen and Kauchak, 2010). Therefore, I must create a context for each student to learn, and to do this I must activate the students' prior knowledge of a phenomenon. This is accomplished through the first two E's of the 5E strategy: Engage and Explore. By having the students perform activities that are relatively familiar to them but require more information than the students currently have to explain, this framework gives a context for learning further about a topic. To highlight the importance of background knowledge, I turn to this quote from Willingham (2009): "The processes we most hope to engender in our students--thinking critically and logically--are not possible without background knowledge."

Through the Engage and Explore steps--which may be combined into one step--students work cooperatively on activities to predict and explain observations. This observation experience is directly related to the nature of science, in that learning is a process rather than content to be memorized (Beisenherz, Dantonio, and Richardson, 2001). The nature of science is a large part of what I am teaching students, because understanding that science is not a completely rigid system in which everything is perfectly explained is important. Indeed, "although much science knowledge is quite durable, all scientific ideas are open to revision in light of new evidence and interpretations" (Clough, 2000). This contrasts greatly with the cookbook-style laboratory experiments most students receive in science classes. These labs provide very detailed, step-by-step instruction, which is necessary at first for students to become proficient with general scientific procedures. But, as the students understand more how the 'game' of science is played, I can change the labs to be more open-ended rather than giving exactly the steps to follow. By building from closed labs to more open labs, students will have further understanding of how scientific reasoning and knowledge are really collected. For professional scientists, "while some scientific work does involve the plodding, brick-by-brick accumulation of evidence, much of it requires leaps of imagination and daring speculation" (Judson, 2009). While I do not expect my students to perform in the same manner as professional scientists, having an understanding that true science requires imagination as well as knowledge will broaden their minds to more of the limitless possibilities that science offers.

The next step in the 5E framework is Explain, and this is concerned with deepening background knowledge and developing a further explanation of the phenomena in the activities. This section is the main content section, and is focused on taking the background knowledge acquired through the first two steps and applying concepts to explain the activities in a more rigorous manner. From the development of this explanation, the concepts are generalized in an attempt to link specific topics to a main idea in physics--e.g., conservation of energy, conservation of momentum, etc. This is the section in which I will perform, because I need all students to converge their thinking on a correct understanding of the concept. Part of this section will be me leading a mini-lecture on the topic, along with some discussion of the concept. Another aspect of the Explain section is the inclusion of reading and writing strategies, which help the students continue their reading development through scientific reading, organize their thoughts on the topic, and have resources that they may reference when studying. I will mainly employ the textbook for the readings and note-taking, but other articles will be included as well. These articles will help familiarize students with current research topics and trends, and again connect to the nature of science in that each article is a continuation of a process and not a stand-alone event. A further aspect of the Explain section is the basic mathematical equations and relevant theory, which are useful for modeling physical phenomena. The inclusion of mathematics will need proper scaffolding, because in the same case as reading level, students will possess a range of mathematical abilities.

The fourth step in the 5E framework is Extend, and this section provides an opportunity to take the generalized concept and apply it in new ways. This is accomplished through revisiting the same type of lab as in the Engage/Explore section except in a deeper fashion, or having a novel experience that connects to the labs in the first section and the generalization of concepts in the Explain section. The nature of science is again apparent in this section, because the lab experiences should be more open-ended and require a thorough understanding of the concept to develop and explain the phenomena. The students should also be engaging in higher levels of thought, according to Bloom's taxonomy, because their thinking must connect their previous labs and the explanation of the concept to form a new way of thinking about a topic. Besides more activities, the Extend section is a good place to move beyond the basic mathematical equations and into a deeper understanding of how the mathematics fits with the physical phenomena. Here, the extension is focusing on taking a phenomena and turning that into a mathematical model, so that the students may make a prediction from the mathematics.

The last section of the 5E framework is Evaluate, which is directly associated with assessment. Therefore, this guiding question is: how will I determine what the students have learned? Assessment includes many factors, all of which coalesce into a continual evaluative process. Traditional classroom tests, standardized tests, quizzes, and homework are one part, as are so-called performance assessments--direct examinations on tasks relevant to life outside of school. Assessment also contains informal evaluations of student learning in the first four E's, and decisions about whether to reteach and how to assign grades. All of these parts sum to employing assessment *for* learning, defined as a process designed to support and increase student learning, instead of assessment *of* learning, defined as simply determining the amount a student has learned at the end of a unit or course. Because assessing for learning is a process, it provides information about the students in four areas: their existing understanding, motivation to learn, extent of taking responsibility for their own learning, and if they have reached my learning objectives (Eggen and Kauchak, 2010). With these four areas, I will give continual feedback to the students and reinforce the process of learning through internalization rather than rote memorization.

This assessing for learning as a process is accomplished in several ways. One way is by embedding assessment in performance tasks that are genuine, rather than artificial, I may understand the students' knowledge and reasoning about a particular concept as they are learning about the concept. This will allow me to make adjustments for teaching in response to learning needs, instead of assessing at the end of the teaching and (worst-case scenario) realizing that no student understands the concept (Gallagher, et al., 2003). Another way is to employ effective questioning strategies during whole-class discussion to help students develop an ability to verbalize their thoughts about the concepts they have seen during the other four E's. This ability to verbalize allows the students to develop logical structures about a particular concept and to explicitly see the step-by-step logic of these structures (Bonnstetter, Crow, and Penick, 1996). A further way to embed assessments is to train myself to wait after questions I ask and student responses. These two wait times are critical for many reasons, all of which are positive for both the students and me. One reason is to have longer (than 3 seconds) wait times is that it increases the length and complexity of student responses, because the students have more time to process the question that was asked and other responses that have been stated. Another reason is the student-to-student exchange increases, which reduces the amount of 'show and tell' I have to perform during a discussion. Finally, disciplinary moves decrease, because students are allowed the time to think of an answer for themselves, rather than thinking of what I would want them to say (Rowe, 1986). All of the above strategies, along with other such as journaling and exit slips, comprise the formative part of assessment, but there is also the summative part of assessment.

Because of the nature of high-stakes testing the students will face, modeling part of the unit tests in the same manner as the high-states tests will give the students practice for these tests. This will help the students' comfort level when they take the high-stakes tests, so that they will perform in a manner in which I know they are capable. Again, all of these assessment strategies comprise assessing for learning, which will help both the students and me as we move through the content.

The final aspect to the curriculum is the issue of safety. Whereas physics laboratory experiments do not contain harmful chemicals, there is still a variety of safety hazards present. Therefore, creating a good basis at the beginning of the year for safety is essential, and something that I will continually emphasize throughout the year. By having the students document what safety rules are applicable on each activity and doing the same myself, I will create a trail of documentation for myself and the administration showing proper safety practices.

To tie together the parts of my curriculum philosophy, simply employ the 5E method: Engage, Explore, Explain, Extend, and Evaluate. This inquiry-based method of teaching science focuses on science as a process, in which students learn such skills as observing, inferring, and experimenting. Students also describe objects and events, ask questions, construct explanations, test those explanations against current scientific knowledge, and communicate their ideas to others. By identifying their assumptions, using critical and logical thinking, and considering alternative explanations, students actively develop their understanding of science (NRC, 2008). This is what I hope to bring to and out of my students, and if I can achieve this then I will be well on my way to becoming a great science teacher.

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