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**ED 12X: In the Classroom Reflection #1**

For my first in-the-classroom reflection, I asked my peers to think about two broad, overarching questions that I had been trying to wrap my mind around myself. At the time, I was finishing a unit on Forces with my 9th graders and was starting to consider the next series of units on Work, Energy, and Momentum. In my own reflections, I had been noting that I have a difficult time getting started with lesson planning because I kept getting stuck on the question of "so what?". As Wiggins and McTighe phrased it, I was trying to find a way for my lessons to have an "enduring value outside of the classroom" and to be meaningful beyond the physics classroom. I was spending hours thinking about this question for each topic, even before outlining and detailing out the lessons. As I looked at the upcoming units, I knew that I would only continue to struggle with this given Work, Energy, and Momentum in their physics sense were specifically created to look at physics problems. I saw their value for the future studies of physics, but I could not come up with how these would be useful beyond the classroom. This was the first challenge I provided for my peers. I first wanted to see if my peers could help me with thinking about the "enduring value" in the topics of Work, Energy, and Momentum. Second, knowing how important these topics are in the physics, I wanted help in thinking about how to make these abstract concepts more assessable to my students.

What does it mean for a lesson to have "enduring value"? One of the history teachers at school asked me one day, "What is the goal of teaching? Does it really have meaning if it only is for further the knowledge on that discipline versus having things they can take away into their daily lives"? In talking to him, he really strives to teach history in a way that students are able to use the past to think about themselves, their identity, their actions, and the present world around them. He does not believe in teaching history for just history. In a similar way, I want my

students to see physics as meaningful to their everyday lives. Physics helps give more depth and insight to my students' interest, but I struggle because they technically do not need to know physics. For example, a student who loves baseball can learn to hit homeruns without ever analyzing the trajectory of a baseball. Before having the class discussion, I was persuading myself that just bringing in an example or two using my students' interests was not... substantial enough. I wonder if this was in part from having studied engineering because I was not used to figuring out information just to figure it out as in physics. Instead, I was so used to taking information and figuring out how use it to build or create something that I sometimes forget that the beauty of physics is in trying to figure out how the world works, that the pursuit of knowledge by itself is something completely worthwhile. I am often lost in the "we know that, so now what?" This is why I believe I struggle with "meaningfulness" in my lessons.

When I asked my peers to help think about how topics such as Work, Energy, and Momentum are important outside of the physics classroom, a couple different ideas emerged. Some of the responses reframed what "meaningful" can mean, trickling back to the fact that these topics are at the heart of the discipline (Filter 2 in Wiggins and McTighe's "What is Backward Design"). Some raised that having a goal of students feeling more comfortable or knowing how to approach problems dealing with the topics in their next physics class was a fine goal. This brought up questions on how much of the material needed to be retained for the class to be meaningful? Do the students needed to retain equations or if it is okay just to retain activities that are associated to certain concepts?

The most salient point that came up for me was when someone mentioned that some students wonder about the connection physics concepts when things happen to them in their life. For example, asking what happened to the helmet when they fell off a bike and why the helmet

crushed the way it did. Reflecting on the discussion after the class, an a-ha moment came to me from this point. It was so simple, something I had thought many times before, but from the hustle and bustle of teaching, I had forgotten about it. My own fascination with physics occurred in my junior year of college, when my friends started conversations stemming from random questions they had about the world. How many balloons would it take to lift a house? How high can a person jump? They made me curious about the world and made me appreciate physics. From thinking about this, I realized that for physics to be meaningful for my students, they have to be the ones curious about exploring why things happen. The enduring value that I want my lessons to have is to instilling curiosity, interest, and amazement about how and why things happen. I am glad that my peers helped remind me to come back to this point and have my revelation.

The second question for my peers centered around making the upcoming topics more accessible and thinking of ways to help students understand the differences between the concepts. One of the most difficult part about learning about Work, Energy, Forces, and Momentum is that we use them in our everyday language without the specificity that they have in physics. For example, in our everyday language, we often say that if someone is applying a force, the person is doing work. However, in physics, if the person is not moving the object that they are pushing on, work has not been done. Coming to terms with the "physics" version takes time and thought.

Even amongst ourselves in ED12X, it was difficult for us to say what we thought each of the terms meant and what their differences were. I think that the exercise was so difficult for us because in the class, we knew there was a "physics" answer. This depicted for me how important it is to ask for my students ideas up front, before any hint of physics, to hear their genuine thoughts as to what these words hold for them. My typical introduction to concepts this year

(Forces, acceleration, and Energy) have been to ask my students to write down of draw anything they can think of associated with the terms. I have tried this with both paper and on InterLACE, I found that on paper, the answers tended to be few and short, and on InterLACE, I would have a lot of Googled facts or pictures. While each gave me an idea of what students were thinking, I felt like I was not getting to the meat and details of what they thought. For Work, I tried a new approach. See Appendix A for the class activity handouts. Before introducing Work in the physics sense, I gave out four pictures. They were of a guy pushing a wall, a boy lifting a box, a person pushing another person on a rolly chair, and lastly a biker holding a bike overhead. For each one, I had my students write down if they thought there was work being done and why. They then talked to their table members and wrote down if they had the same or different ideas. If there were disagreements, they had to write down the different rationales. Overall, I felt like I got some really rich student thoughts from this activity, at least more than just having them write down a couple of ideas. The response I expected was that whenever someone uses their muscles, there would be work. This and many more that I had not thought of popped up. Some really thought about who might be making money with what they were doing (going to work) and others felt like the rolly chair one could not possibly be work because the people depicted were having too much fun. It was fascinating and the tables where there were disagreements had good conversations. Not only was I able to learn of my students ideas to keep in mind as I moved forward with the concept of work, they showed themselves how many meanings the word "work" took on. It made it feel a little more okay to say that the physics definition of work was specific. For this activity, I ended up telling my classes that the physics definition of work was specific and was depicted in only two of the four pictures. They then had to try to think of which ones would be "work" and why. Looking back, I feel that I could have made it more clear that

they were giving me different definitions of work, and questioning why were they not named different words before leading into the physics definition of work. One thing that I would still like more help in thinking about how to transition from student ideas to the "physics" idea.

Returning back to the ED12X discussion, there were a couple of ideas around how to have students engage in thinking about the different topics (Work, Energy, Momentum, Forces) all at once. The first idea was to have a problem where all the different concepts are involved so that the students can engage with it to think about what using each concept would help them find. Kathleen then brought up a specific problem that she has her students do. The problem has a family of squirrels doing pushups. She asks the students to calculate how much work each squirrel does, what sort of energy is in the situation, how much force a squirrel does in a push up, etc. This example led to discussion around letting the students build the problem, determine the variables needed themselves, and come up with reasonable measurements. I loved that with the collective group, we built up to a student centered activity - as Brian would say, make the students do the work! I have not been able to implement anything like this quite yet and am not sure that I will have the time this year, but I will definitely keep it in mind for the future. What I have done as my students learn more concepts is integrating video and activities that ask the students to think about multiple topics. For example, my mentor teacher and I had my students do an activity from CAST (Universal Design for Learning Curriculum) where they built mini Rube Goldberg devices to make a car move. After building it, the students created posters that showed the energy transformations, where there were forces, and where there work occurred. I have also been showing different videos, from Wiley Coyote to Pogoing, and asking about the various concepts. Something that Brian pointed out though during an observation was to be

careful not to go too fast. I agree that this is something I need to be careful of. Like I mentioned before, it takes time and some amount of struggle to have a better understanding of these topics.

The in-the-classroom reflection provided a wealth of ideas to reflect on. I will admit that at first, I was a bit overwhelmed with what to think of all the suggestions and ideas. I decided to put aside the conversation for a little bit and over time, random little nuggets would pop up in my mind which helped launch my reflection on the discussion. It was really valuable to have this interaction with my peers and for me, it sparked quite a few personal insights.

**Appendix A: Class Handouts, Work lesson activity**

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| **A: Pushing a wall**<br>  | **B: Lifting a box**<br>  |
| **C: Pushing a chair across the floor**<br>  | **D: Holding a bicycle over your head for 10 minutes**<br>  |

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| **A: Pushing a wall**<br>1. Do you think this is an example of work? Why?<br><br>2. Does your team think this is an example of work? Why or why not? What are the different arguments? | **B:**<br>1. Do you think this is an example of work? Why?<br><br>2. Does your team think this is an example of work? Why or why not? What are the different arguments? |
| **C:**<br>1. Do you think this is an example of work? Why?<br><br>2. Does your team think this is an example of work? Why or why not? What are the different arguments? | **D:**<br>1. Do you think this is an example of work? Why?<br><br>2. Does your team think this is an example of work? Why or why not? What are the different arguments? |