Cultivating a Culture of Thinking

Cultural forces exist in all classrooms that can be leveraged to develop a culture of thinking. **Jeff Watson** and **Roger Winn** demonstrate how to harness these forces to develop students' thinking skills in secondary Maths and Chemistry classrooms.

The Cultures of Thinking (CoT) framework was developed by the Project Zero team at Harvard University. The framework focuses on eight cultural forces that exist in classrooms: expectations, language, time, opportunities, interactions, environment, routines and modeling. These forces, according to Dr. Ron Ritchhart, the Principal Researcher for the CoT project, exist in every classroom, whether they are given attention or not. The idea is to properly leverage these forces so that classrooms become places where thinking, collaboration, independence and deep-learning rule and become common-place, rather than teacher-centred places that are ruled through stress compliance and work.

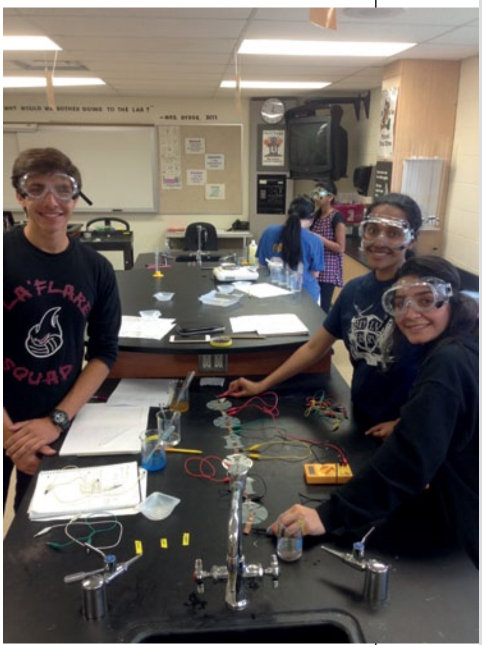
Harnessing meaningful **opportunities** is a crucial part to creating a Culture of Thinking in a classroom. As Ritchhart points out, "the opportunities that teachers create are the prime vehicles for propelling learning in classrooms" (p. 144). If planned properly, **opportunities** can be engaging, thought-provoking, and fun for students. This article will focus on the application of the forces of **opportunities** in the secondary classroom. Although many of the examples will focus on maths and science, the core principles that are drawn from these examples can be applied to any classroom.

In past years, when covering the concept of unit vectors in IB DP Math SL, the lesson would go something like this:

1. Tell the students that a unit vector is a vector of length one, and demonstrate the proper notation.
2. Show them the procedure, or 'recipe' to find a unit vector.
3. Have them work independently to find unit vectors given several vectors.
4. Show them how to use unit vectors to create parallel vectors that have the same directions, but different lengths.
5. Show the students the tie-in to motion of objects that have a constant velocity.

When covering voltaic cells in IB DP Chemistry 1, the lesson would go as follows:

1. Lecture about the parts of the voltaic cell, how to construct one, and give examples of voltaic cells used in their daily life.
2. Give a lab hand-out and go over the steps to construct a voltaic cell.
3. Have students perform the lab and compare their results to theoretical results.
4. Have students practice drawing voltaic cells, including labeling the parts of cells and predicting electron flow.



The maths lesson and the chemistry lessons both went well in terms of test performance. The students could do the maths problems as long as they were scripted exactly like they had been in class, and chemistry students were able to successfully construct voltaic cells.

As we began to have discussions about the CoT framework, we really started to think about these lessons and the impact that they had on student thinking. As we reflected on our teaching, we pondered the questions in Table 1 and realised that with a bit more planning, we could provide richer opportunities that provoked deeper thinking. As far as the **opportunities**, the students had to repeat back very cookbook-like tasks that they completed exactly the way they were shown, as though we were the sages who knew the content better than they did. The tie-in to real life applications in particle motion and batteries was prescribed and told to them. Their thinking was not stretched or pushed, and even though "it is what students are actually doing mentally that matters" (Ritchhart, p. 144), the students were mentally just doing surface-level learning. They demonstrated an ability to perform these skills, but only in familiar situations – and they were only assessed in familiar situations.

TABLE 1: KEY QUESTIONS RELATED TO THE OPPORTUNITIES FORCE

Opportunities key questions: 1. How did I ensure that rich thinking opportunities are woven into the fabric of my teaching and that students aren't just engaged in work or activity? 2. How did I provide students with opportunities to direct their own learning and become independent learners? 3. How did I take pains to select content and stimuli for class consideration in order to provoke thinking?

These questions are adapted from Creating Cultures of Thinking: The 8 Forces We Must Master to Truly Transform Our Schools, pp. 324-325

THINK-PUZZLE-EXPLORE:
What do you **think** you know about this topic?
What questions or **puzzles** do you have?
How can you **explore** this topic?

What can be changed? The answers to the questions in Table 1 are exciting because there are potentially infinite ways to accomplish deeper thinking. The beauty of implementing a Culture of Thinking in a secondary classroom is that you can decide how much to change at any one time. We decided to use the key questions in Table 1 in order to leverage the opportunities so that the students were doing the critical thinking and driving the lesson. After pondering these questions, and revising and revisiting them for several iterations, here are the 'new' lessons:

The new maths lesson:

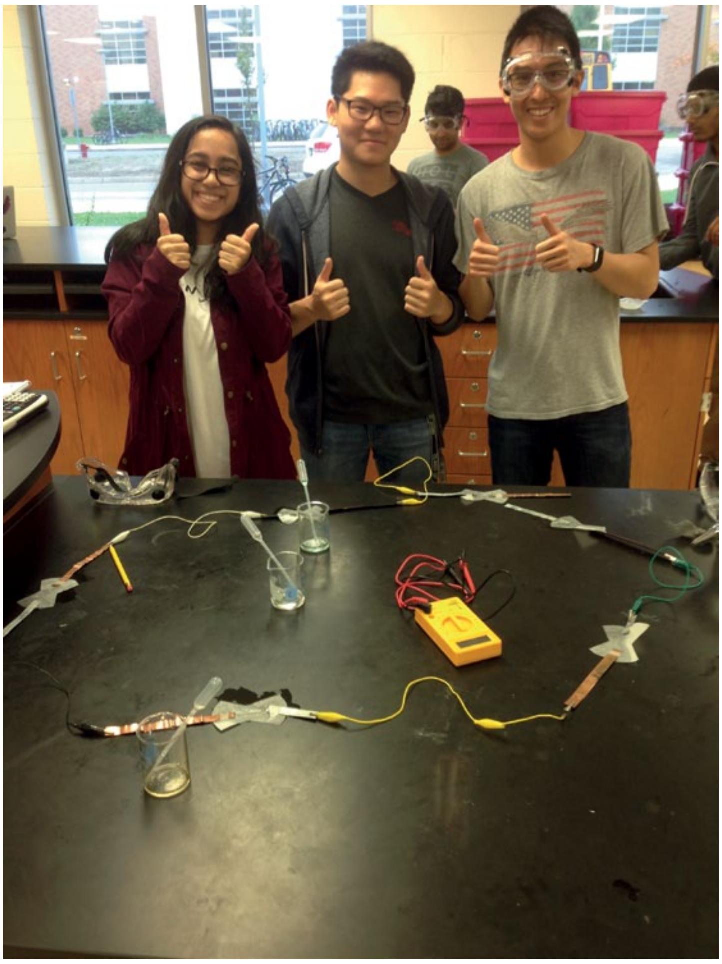
1. The students reflected quietly for 5 minutes using the the 'Think-Puzzle-Explore' routine to start their thinking on naming vectors and how to find the magnitude of vectors. During this time, students used their math resources – textbooks, phones, computers – to look up anything that they couldn't remember about vectors. Students know that using these resources is encouraged.

2. After the reflection time, we moved the desks in pairs, and the students then did the MicroLab protocol to discuss their findings from think-puzzle-explore. The MicroLab protocol has one student talk for a set time while the other student listens, then after the set time the roles flip. After both students had a chance to talk, they had a few minutes for open discussion about any remaining questions or ideas.

3. This led to the guiding question for the rest of the class period: "Given the vector <a, -b>, how can I create a new vector with the same direction, but with magnitude $\sqrt{c}$." Each table (there are 8 of them) received a specific example of this guiding question.

4. Lessons need to adapt to where the class is in the moment. As discussion progressed and questions surfaced, the students needed more direction; the goal was to keep spoon-feeding to a minimum, but the students needed to be kept from going too far into the weeds. Jeff then said, "I can see that all of the groups are in a bit of a different place – if you need a bit more direction, you may want to consider how to take a vector and shrink it down to magnitude 1. Then, create a vector with the same direction using that new vector. If this doesn't fit with what you are doing, then keep going with your current path and let me know how you do."

5. After observing, listening and interacting for several more minutes, Jeff thought about what type of learning would be best for the students to do outside of class. Several options were given that included answering the key question, writing down the path and method they chose and a more detailed particle application problem.



In chemistry the new lesson looked as follows:

1. Students are presented with a challenge to construct a battery that produces enough voltage to charge a cell phone. They are given a handout with the guidelines for the challenge. In addition, to encourage deep and innovative thinking, bonus points are given to the group that builds a successful battery at the cheapest cost, connecting to the real-world, as industry always looks to minimise costs.

2. Students have a class period to research the parts of the voltaic cell, create a schematic for a cell, make all necessary calculations, and create a procedure for how they will construct their cell in the lab.

3. Student groups then check-in with the teacher to receive feedback on their plans. If students have an appropriate cell, they are approved to go to the lab.

4. During the next class, students have the opportunity to build and troubleshoot their voltaic cells. All groups are allowed to interact with each other. With 15 minutes left in class, the batteries' voltages are tested.

5. Groups explain their batteries to each other after they have been tested.

6. Students then created some class notes about voltaic cells and then practiced with IB-style problems.

The 8 Forces of the Cultures of Thinking Framework

The four pillars, or characteristics, of challenging opportunities that promote learning are novel application, meaningful inquiry, effective communication and perceived worth. Let's look at each of these in turn:

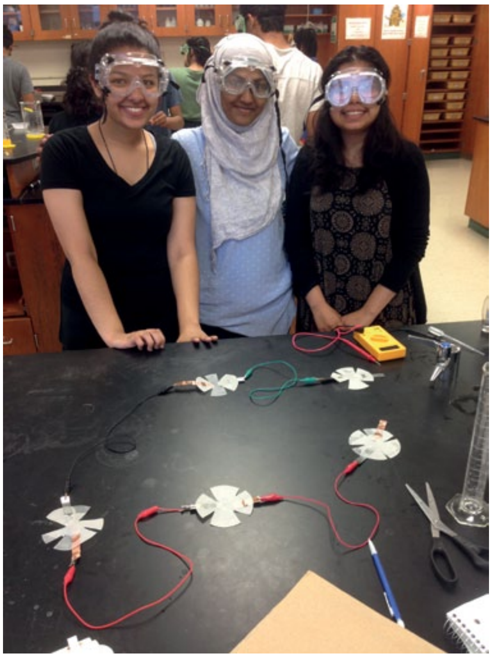
Novel Application

The idea of applying one's knowledge in novel situations is all about the transfer of that knowledge as "transfer is the holy grail when it comes to teaching skills and knowledge" (p. 163). Ideally you would want students "organizing, interpreting, evaluating, or synthesizing one's knowledge to create something new" (p. 163). In the maths lesson, students took their knowledge of vector notation and length and transferred it to a novel situation which required them to apply those ideas to create new parallel vectors with differing lengths. Furthermore, the students applied these ideas to particle motion, which at first glance, didn't appear to have a connection. In the chemistry lesson, students took their knowledge of oxidation-reduction reactions and applied it to a new context in that they are now constructing the reactions in a way to control electron flow. When designing lessons to contain new applications, we ask ourselves the following: How are students applying what they already know to the task at hand? How are they applying their learning to a new context that pushes their thinking in new directions?

Meaningful Inquiry

The goal of the 'meaningful inquiry' pillar is that students, of all ability levels are "...building new understandings and developing personal insights" (p. 164). In my chemistry class, there is a wide range of student abilities. Therefore, the task assigned must be both low threshold and high ceiling. For the Creating a Battery Challenge, all students can use resources to find a way to construct a battery from the given material with the required voltage. In the three years I have done this revised lesson, all groups have come up with a valid theoretical method. However, the task also has a high ceiling. There is no guidance given for how the students construct their battery – any method they can think of is allowed. For higher achieving students this open-endedness provides the space for them to learn something new as they attempt to minimise the cost of the battery. When these students create a battery in a way different from the textbook, it further deepens their understanding by thinking about the parts of a voltaic cell in a new context. In the maths lesson, it was low threshold in that all students could name vectors and find magnitudes, but it was high ceiling because students were encouraged to come up with their own methods and approaches, and were encouraged to apply them to unfamiliar contexts. In both of these revised lessons and when designing lessons to contain meaningful inquiry, we find the the following questions useful: How many methods are possible to solve the problems or challenge in the lesson? To what extent am I giving the method and to what extent are students creating a method? Will all students be able to achieve the challenge? What space have I provided in the lessons for high achieving students to push their thinking?

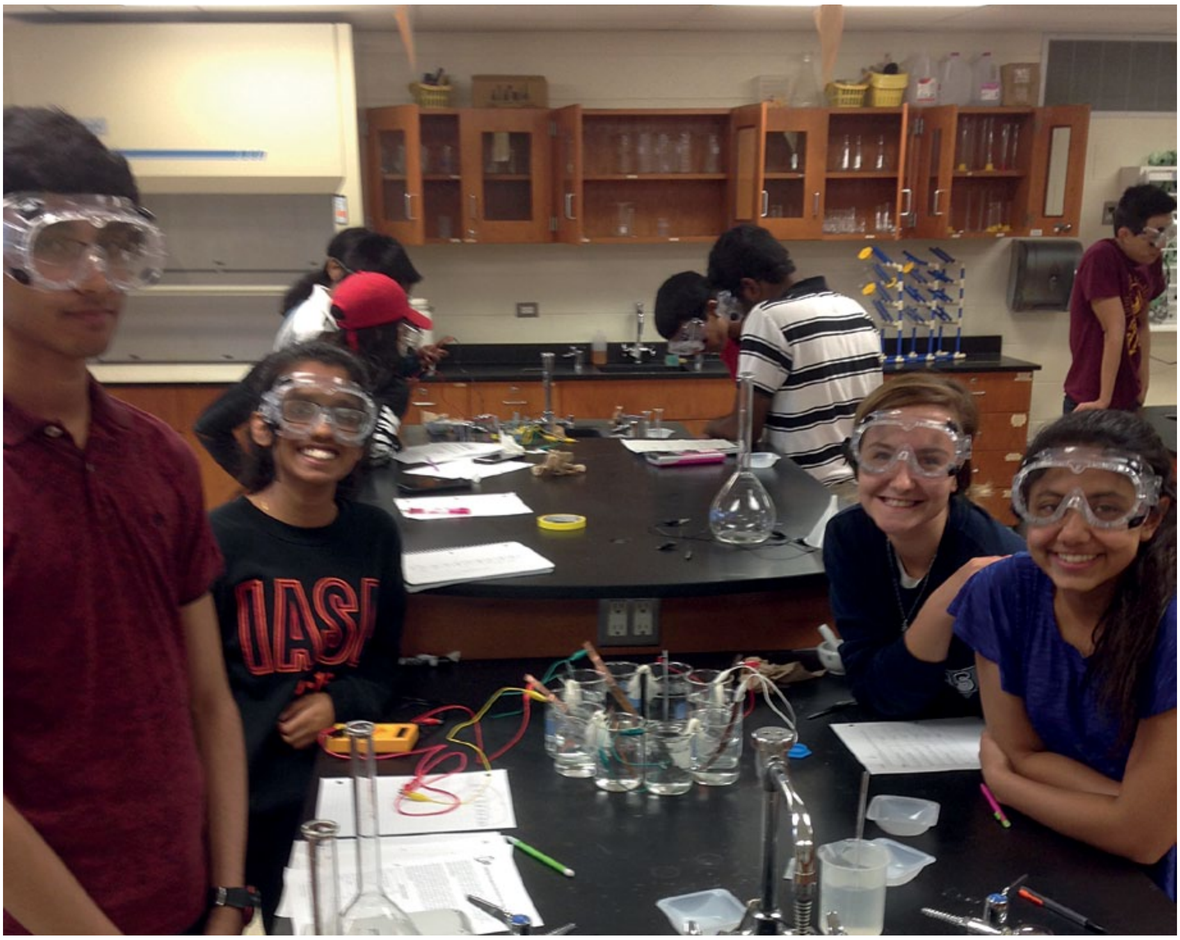
Effective Communication



In order to be mathematicians and chemists, students must be able to "use the language of the discipline to express, represent, justify, and communicate one's thinking and ideas" (p. 164). In the maths lesson, students had to use thinking routines to document what they already knew about vectors and then share, communicate and justify these ideas to each other. The MicroLab protocol is a great communication tool because it requires students to express their ideas to each other, and since each person has time to talk, those students who normally may not share an idea have an opportunity to express their ideas. Also, when exploring the new concepts, groups had to communicate their ideas to each other in order to answer the guiding question. In chemistry, groups presented their voltaic cells and explained how they work. By explaining their cells, especially the ones that do not look like those in the textbook, both the listeners and presenters are able to deepen their understanding of voltaic cells. When designing lessons that contain effective communication, we find the following questions useful: How much is the teacher talking? How much are the students talking? How are the students given time to share and communicate their ideas?

Perceived Worth

In these lessons, students were asked to create a product, whether it is the solution to problems, the construction of a battery or a method to finding a vector. Ron Ritchhart notes, "Production is common in classrooms, but what is not so common is that what is produced is perceived by students to be of value and worth their time and investment" (p. 164). The revised chemistry and maths lessons worked to increase the perceived worth of the products required. In the old chemistry lesson, the required product was solutions to practice problems. These problems have little perceived worth – students understand that their



ability to accurately solve these problems will impact their grade, but these problems are largely disconnected from the 'real world'. In the new lesson, perceived worth was increased by relating the challenge to batteries in cell phones. Rather than just being able to solve problems related to voltaic cells, students are now using chemistry to understand an object they use every day. All the information and understanding that students discovered about voltaic cells related to this challenge, which is what is shown to create perceived worth the most, "....it [is] the ability of the teacher to *place the activity within the context of a larger goal or enterprise* that mattered" (p. 165). In the maths lesson, the larger goal was the use of unit vectors in particle motion. In the past, unit vectors were treated as a stand alone topic that students learned about because it was in the syllabus. Now, the use of vector notation and finding magnitude paved the way to find unit vectors which paved the way for the application to velocity and motion. Furthermore, by adapting the home thinking to each group's progress, it placed worth on the thinking and understanding they were doing during the class period. When thinking about increasing perceived worth, I ask myself the following questions: To what extent is this lesson connected to a larger goal or context? How have I made connections to this larger context or goal clear to the students?

As we continue to challenge the "..widely held misconception: that teaching is primarily the delivery of information and that learning is memorizing that information" (p. 151), creating powerful learning opportunities is crucial to ensure deep learning. Designing these opportunities is an art and is an iterative, exciting process that can only be improved with careful consideration, time and trial-and-error. Although the new lessons above are richer examples than their predecessors, these lessons will undergo continuous changes as our experiences grow.

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