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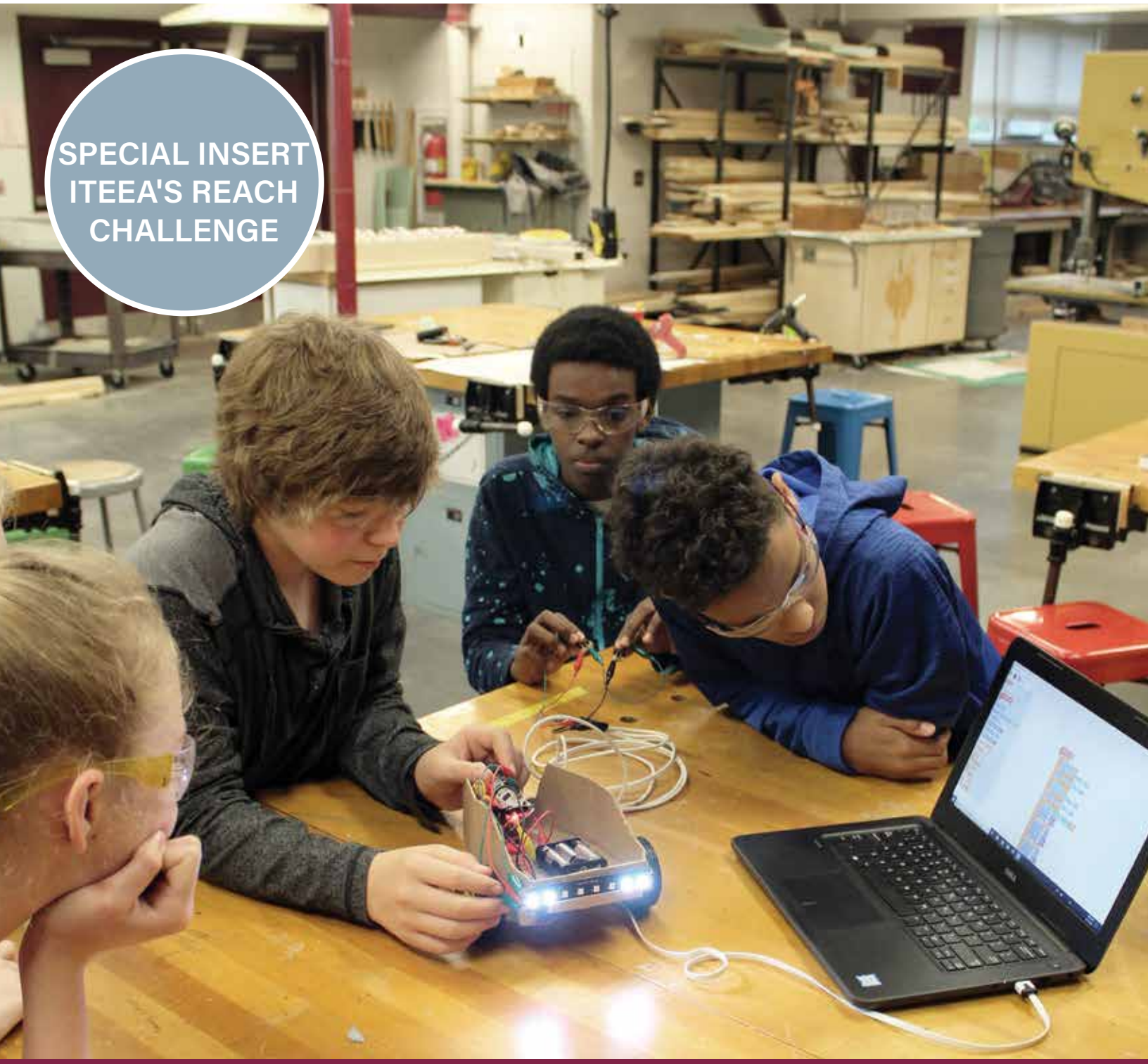

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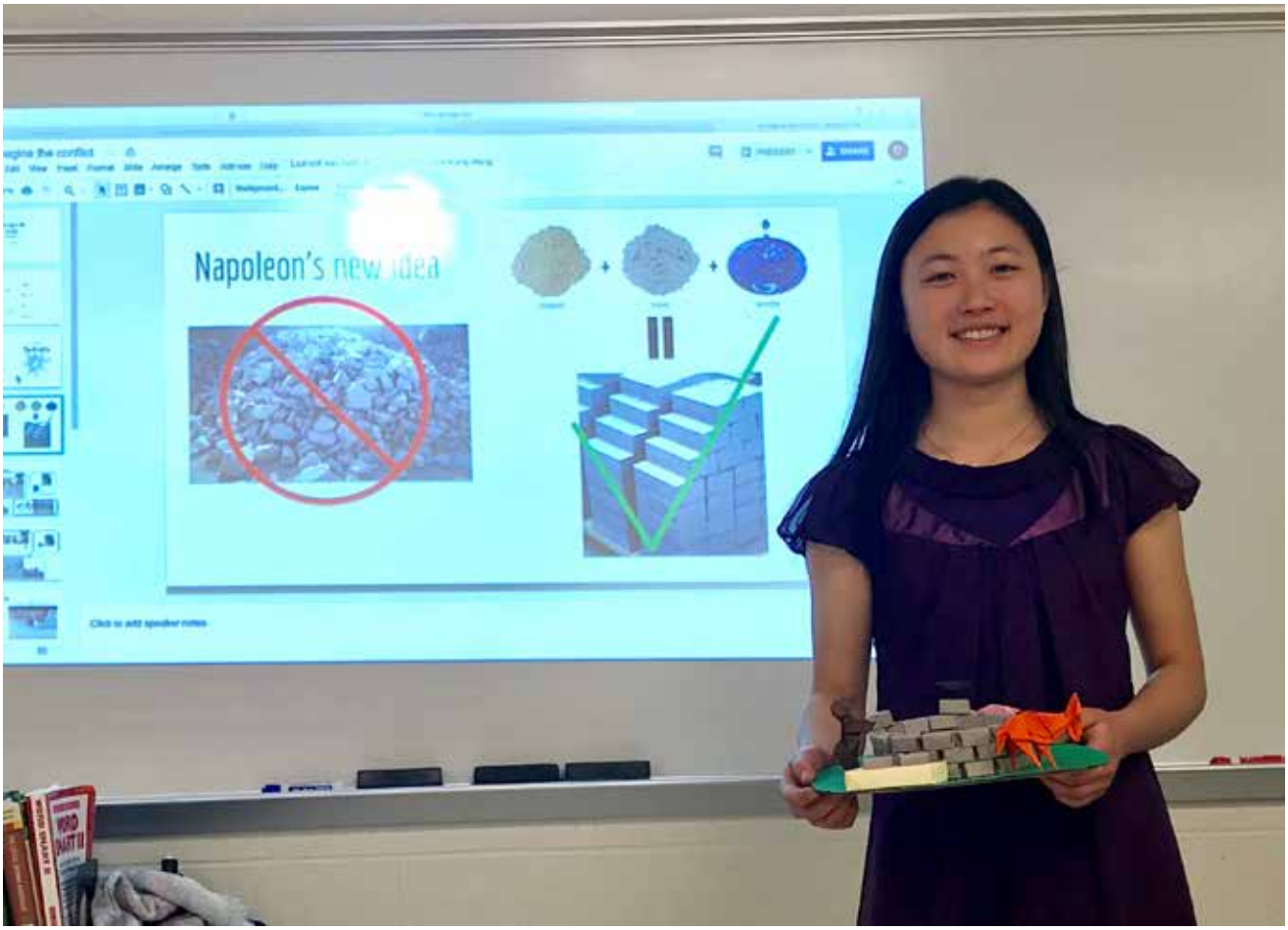

reengineering the conflict: STEM in the English classroom

The project is a humanities incorporation of STEM foundation concepts.

by Daniel Lipowitz and Michael Berkeihiser

Introduction

At Unionville High School in Kennett Square, PA, humanities teacher Daniel Lipowitz has partnered with engineering teacher Michael Berkeihiser and other STEM teachers to put the humanities (H) in "SHTEM." Sophomore English students were asked to re-engineer the conflict in common works of literature and then design a prototype solution to their new conflicts.

While analysis and interpretation are vital skills for all levels and grades, the task facing the tenth graders was to discuss literature from a different perspective, shifting the sophomore students' approach upward on the critical-thinking hierarchy from analysis and interpretation to synthesis and evaluation. With the STEM tide rolling across the educational seascape, the students' objective was to offer a blend—a "SHTEM"—a concoction of STEM with just the right mix of Humanities, differentiated instruction, and critical thinking.

Zombie Inspiration

In the 2013 film, *World War Z*, a family led by former United Nations employee Gerry Lane (Brad Pitt) finds itself stuck in Philadelphia traffic when a zombie outbreak occurs (*World War Z* 2013).

Figure 5. Hannah presents her redesign of the windmill from Orwell's *Animal Farm*. Her reengineering explains that the windmill is impervious to destruction. Its success follows Snowball's objective: an electrical structure that powers the farm, enabling the animals to have more leisure time. *Photo credit: Jennifer Marmo.*

Figure 1.

Project Description: Choose a novel read in class during the school year. Create a new conflict and resolution using the engineering design process and a STEM concept.

Novel: ***Chronicle of a Death Foretold***
Main Conflict: The impending murder of Santiago Nasar (protagonist)
"Reimagined" uses the distance formulae to solve for time and shorten how long it takes word to travel throughout the town:

1. Break down how long it took Santiago to be killed. When he wakes up at five thirty, his murderers are already prepared to act, so the murder took less than 24 hours.
2. Choose what to solve: I chose to solve for time because if time were decreased, then the murder could be avoided.
3. Choose the size of the town. Our school district, a rural area, is 77 square miles, so I estimated that the small, Columbian coastal town would be around the same size. I chose 80 square miles as a hypothetical size of the town. The town would then decrease to 70 square miles in my equation.
4. Speed. I chose word to travel at a rate of .2 miles per minute in the original conflict and .4 miles per minute in the reimagined conflict.
5. Use the formula Time=Distance/speed.
6. Plug in the two equations for an answer of 400 minutes for the original conflict and 175 minutes for the reimagined conflict.

Resolution: Santiago can now be warned about his killers because word traveled in 175 minutes, and he is able to avoid being killed, which changes the main conflict.

Zombies and STEM? The unfolding plot inspired the creation of a classroom unit blending elements of language arts with engineering, calculus, biology, and/or physics.

The Unfolding Narrative

Later in the film, Mr. Lane, who has military training, works with other scientists to help resolve the growing worldwide problem. Two countries have prepared for and are handling the zombie outbreak—North Korea because its dictator orders all citizens to have their teeth pulled within 24 hours—no teeth, no bite; and Israel, which builds an extraordinarily high wall to stop the zombies from invading. Mr. Lane flies to South Korea to talk about strategies with a CIA outpost there that possibly possesses vital information.

On the flight over, a scientist tells Mr. Lane to pay attention to all details. A virus's strength may also reveal its weakness. In essence, to solve this problem, every detail counts. From South Korea, Mr. Lane travels to Israel to speak to a member of the Mossad, the Israeli equivalent of the CIA.

The agent recalls the 1967 Six Day War between Israel and the surrounding Arab states. He shares something to the effect of, "We vowed never to be caught unaware again. To be prepared for any scenario, we formed a group of 10 to discuss strategies and solutions. If all 10 agree, someone in the group *must* offer an alternative view, no matter how outlandish."

The "10th Person" Approach

The task for the sophomores involved a redesign of a conflict from any of the works they read during the school year. Students review the major conflict of the novel and reconfigure what happened. Their solution can be outlandish, but there must be a logical foundation to their outcome. Employing the Engineering Design Process, each student is challenged to devise a new way of viewing the resolution in the narrative. Essentially, the project is a humanities incorporation of STEM foundation concepts. Students implemented the engineering design process to identify their problem and generate solution concepts. Then they applied their math, science, and technology skills to create prototypes of their solutions.

To ensure that there were sound principles in an area outside sophomore English, students had to meet with a STEM teacher, explain their plan, and get the teacher to confirm in writing that there was, indeed, a creative structure embedded in the conflict reimagining, no matter how fantastic the concept was. Assignments that integrate past readings to present day expectations establish a clearer sense of purpose for the students. They understand that everything we do counts (Reynolds). Moving on to a new task does not mean we leave the earlier work behind.

Students needed to approach the task from the perspective of the "10th person" (*World War Z*), an approach that would indirectly act as a review for the final exam, because each student had to think about the works read and discussed in class this year.

Once a student selected a work, the reimagining process began. The conflict in the novel should be reassessed and reengineered. The first due date simply required an idea written on a 3x5 card, stating the literary work and the purported STEM resolution. Each student developed a unique approach, with logic and creativity aligned together. After students discussed their

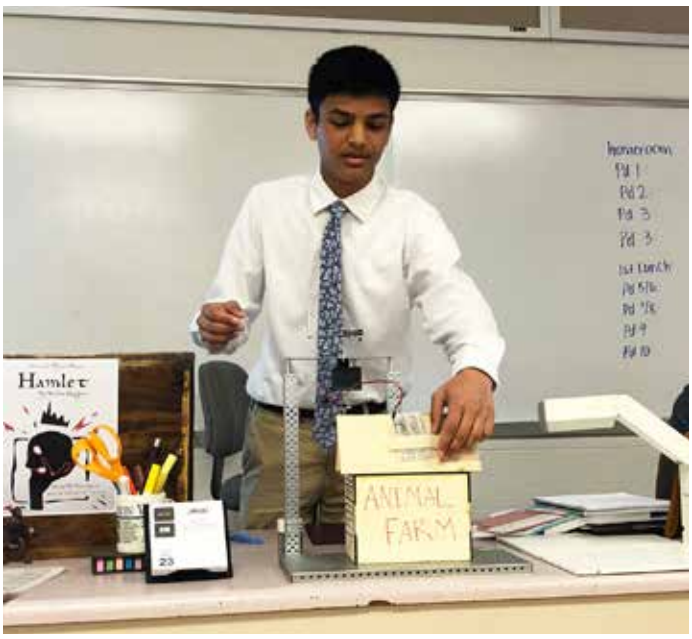

Figure 2. Adarsh demonstrates the working prototype he designed and built. His design calls for putting solar panels on the roof of the barn in Animal Farm. *Photo credit: Josie Liu.*

concept with a STEM teacher, the process shifted from concept to prototype.

Employing the six steps of the Engineering Design Process, for example, one student's reengineering process looked at creating a rail system that transports Luo and Ma in Dai Sijie's *Balzac and The Little Chinese Seamstress* from the country to the city to visit the Seamstress, who leaves the countryside for the big city. In her reengineering, the student changed the ending by having the Seamstress maintain contact with the boys while she remains in the city. The engineering design involved a trolley that navigated the treacherous mountain path.

Problem Definition

Using their skills in science, technology, engineering, and math (STEM), students identify and define a problem from the novel's major conflict that can be solved with an engineered solution. They learn as much as possible about the problem while defining its constraints (Brown, et al, p. 40). In addition, they compose a problem statement describing the objective; that is, the literary conflict, in a concrete and measurable manner. For example, many projects included a new conflict approach involving the following works: *1984, Animal Farm, Brave New World, The Chosen, Lord of the Flies, Chronicle of a Death Foretold, Escape from Camp 14, Behind the Beautiful Forevers, The Kite Runner,* and *Purple Hibiscus*.

Idea Generation

The next step involves the development of a wide variety of possible solutions to the problem through brainstorming or other ideation techniques (Brown, et al, p. 47). This action is important because the engineering field has proven that there is a direct correlation between the number of ideas generated at this juncture and the quality of the final solution. As students develop their ideas, they are recorded in the form of notes or simple thumbnail sketches. Delaying gratification may give students time to look at their work, process their strategies, assess and then reassess their outcome prior to the teacher evaluation (Kohn 24-26). Slowing the process a bit becomes more purposeful when students understand that a reward, i.e., peer recognition and, perhaps, better grades, will be forthcoming if their approach is deliberative. If students do not understand the overall purpose of the assignment, then they may want to complete the work as quickly as possible. Thoughtful, reasoned discussion, the means, becomes more important than the quick answer. "A key purpose as English teachers is to focus students to think critically about literature and to reflect and respond to the works in our varied curricula" (Lipowitz and Conley 106).

After completing this process, students composed a contract that detailed the specific objective. Then the students made a sequenced design brief (proposal) and shared it with a STEM teacher. In the example shown in Figure 1, Melanie met with her Math teacher to determine the accuracy of her Time/Distance/Speed formula. In the next step of the process, she established the parameters of the resolution regarding Santiago Nasar's death in *Chronicle of a Death Foretold*. Because this project centers on a novel, the STEM teachers' time must be respected. The student work is front-loaded. The STEM educator's signature indicates that a meeting took place and that the proposal is structurally sound (Figure 1).

Solution Creation

In the solution-creation step, students evaluate all suggestions from the idea-generation step. They first eliminate approaches that fail to solve their problem. Finally, they choose the best of their ideas or include parts of numerous concepts to develop a new objective.

It can be difficult for students to determine the best solution to their problem. One way to add structure to the process is to use a decision matrix (Brown, et al., p. 68). Students can develop charts and list criteria down one side and ideas across the top, assigning a numeric score for how well each idea meets each criterion. Then they just have to add up the numbers to determine the best solution (Brown, et al.).

Once students select their final solution, they communicate their ideas using detailed sketches with notes. Students whose solutions involve a designed physical product create working prototypes (Figure 2) of their solutions. Students build physical models, create 3-D drawings and 3-D prints, and much more. A key construct in cross-curricular activities is that an "essential, high-structure core is present," and that students are aware of the expectations (Glatthorn, p. 39).

Testing/Analysis

The goal in the testing/analysis step is to determine whether the final solution actually solves the literary conflict stated previously (Brown, et al, p. 99). Because the engineering design process is iterative, if, at any step in the process, students determine that the solution does not achieve the key objective, they must go back to previous steps in the process and change their design so that it does solve the problem.

Final Solution or Output

In the final solution or output step, students create models and drawings to communicate their ideas so that others may understand their solution in detail (Brown, et al, p. 94). A 6- to 7-minute oral presentation includes the literary work, its conflict, the new approach, and the accompanying 3-D model, drawing, or photograph. The step-by-step process helps build confidence, particularly with more introverted students. Experiencing success at each checkpoint helps the quieter student build confidence while encouraging risk taking (Cain 2012) (Figure 3).

Design Improvement

Because engineering design is a never-ending process, students make recommendations about their design that needs improvement if further attempts are made. This step is a valuable part of the engineering design process and serves as an opportunity for student reflection; that is, evaluation (Brown et al 106).

A few days before the Prototype deadline, students meet in small groups to discuss their proposal. This time offers an opportunity to test the logic of the proposal and to get peer feedback and other concrete suggestions to strengthen the project. In addition, a review of the prototype permitted students two weeks to make adjustments before the due date (Figure 4).

Speaking and Listening Standard

The state of Pennsylvania requires each district's Language Arts curriculum to meet a set of standards in reading, writing, speaking, and listening. Two Speaking and Listening standards for tenth grade students include:

- Integrate multiple sources of information presented in diverse media or formats (e.g., visually, quantitatively, orally) evaluating the credibility and accuracy of each source.
- Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning; ensure that the presentation is appropriate to purpose, audience, and task.

Figure 3. Julia postulated that the boys in *Lord of the Flies* would have an improved chance of rescue if they utilize the resources available to them on the island. Keeping their age and skill level in mind, she determined that Jarrah Wood, a resource indigenous to a Pacific island, burns brighter and longer, enabling a passing ship to see the flame and smoke. *Photo credit: Josie Liu.*

The students know that the rubric requires a logical, sequential line of reasoning. Each literary conflict is re-engineered with a rationale that meets the state standard and the classroom rubric (PA English Language Arts Standards 28) (Figure 5, page 28).

Writing

Because this unit encompasses multiple standards, after the brainstorming process students compose their rationale in one

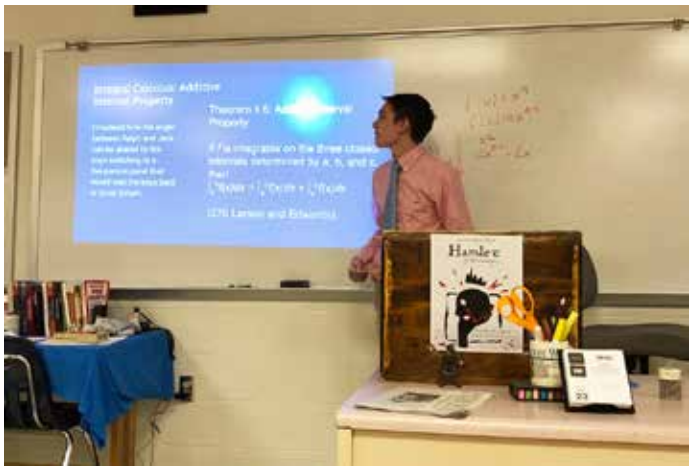

Figure 4. Hunter employs Calculus in his reimagining of the conflict resolution to the seething anger that builds between Ralph and Jack in Golding's *Lord of the Flies*. *Photo credit: Josie Liu.*

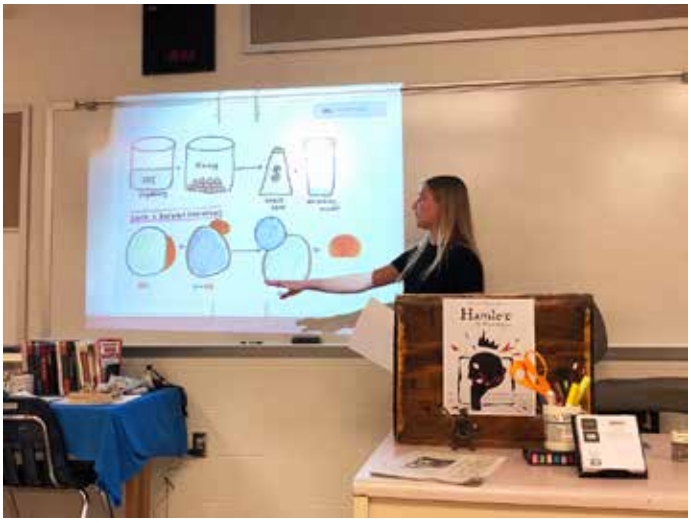

Figure 6. Julia C. demonstrates her fresh water solution as a means of conflict resolution in *Lord of the Flies*. *Photo credit: Josie Liu.*

paragraph, laying out the sequence for the reconfiguration of the novel's conflict. This requirement includes the necessary vocabulary, a mix of sentence types, and the mandatory transitional expressions that link sentence to sentence and paragraph to paragraph.

- Write with a sharp, distinct focus identifying topic, task, and audience.
- Distinguish the claim(s) from alternate or opposing claims; develop claim(s) fairly, supplying evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level and concerns (PA English Language Arts Standards 17).

Presentation Day

Having read the novels, each classroom member is aware of the key conflict in every work. Speakers understand that the listeners, their classmates, are cognizant of the conflict and the factors that cause the discord. Rubric on their desk, the sophomores listen, assessing their peers according to the assignment's criteria. Because each presentation has a unique resolution, the listeners expect to observe synthesis in a sequential, logical manner. This process reinforces the ongoing assessment process (Burke 2013). Again, STEM evidence must be intertwined with the literary work. While the outcome may be fantastic, the solution must be sound.

Figure 7. Julia W., using a parabola, envisions a world where John, in *Brave New World*, adapts to life in London. *Photo credit: Josie Liu.*

The sophomores shared their vision on presentation day, guiding the class through the reimagined and re-engineered outcome. Prepared for questions challenging their resolution, the presenters took the class on a tour of their work (Figure 6).

The projects involved:

- Solutions to avoid Santiago Nasar's death in *Chronicle of a Death Foretold*.
- Security cameras to show the animals that Squealer, in *Animal Farm*, changes the Commandments on the wall.
- Mountain path redesign to reduce the dangerous travel in *Balzac and the Little Chinese Seamstress*.
- Boat construction in *Lord of the Flies*. Constructive activities will diminish destructive tendencies among the boys.
- Acid/Base balance as a way to determine productive relationships in *Lord of the Flies*.
- Quadratic equations to help John the Savage adjust to his new environment in *Brave New World*.
- *Torah* verse conversion into numbers (Gematria) to overcome the silence in Potok's *The Chosen*.
- Chemical resolution to increase soil nutrients in *Animal Farm* (Figure 7).

Collaboration

Cross-curricular projects are challenging because teacher schedules tend to impede opportunities to share ideas outside one's content area. For the most part, schools are designed with same-subject hallways and/or similar-subject workrooms. This project breaks that physical and academic barrier and reconfigures a STEM cooperative, resulting in students approaching literature in a different way—S(H)TEM in the English classroom (Figure 8).

Cross-curricular work provides a practical component to the assignment. Breaking out of the walls of a specific content area promulgates a culture of shared expectations within a school. "Climate is to the organization what personality is to the individual" (Sanville, 32). In addition, when students get involved in an activity that challenges their imaginations in a manner that involves other content areas, not only do they see a curricular connection, they actually participate in it (Thiong'o, 41-42).

References

ALTEC at University of Kansas. (2000-2008). *Building a structure: Reimagining the literary conflict.* Rubistar: Create Rubrics for Your Project-Based Learning Activities. Retrieved from rubistar.4teachers.org/index.php

Brown, Ryan A., et al. (2016). *Engineering fundamentals: Design, principles, and careers* (2nd ed.). Goodheart-Willcox.

Burke, Jim. (2013). *The common core companion: The standards decoded.* Thousand Oaks, CA: Corwin Literacy.

Cain, Susan. (2012). *Quiet: The power of introverts in a world that can't stop talking.* New York: Crown.

Glatthorn, Allan A. (1993). *Teachers as agents of change: A new look at school improvement.* Washington DC: National Education Association, NEA School Structuring Series.

Kohn, Alfie. (Sept. 2014). The deferred gratification myth. *Education Week, 10*, pp. 24-26.

Lipowitz, Daniel G. & Conley, James M. (2009). *Advanced placement classroom: Macbeth* (Teaching Success Guides for the Advanced Placement Classroom). Waco, TX: Prufrock Press, Inc.

Paramount Pictures. (2013). *World War Z*. Directed by Marc Foster. Retrieved from imbd.com: www.imdb.com/title/tt0816711/?ref_=nv_sr_1

Pennsylvania Department of Education. (March 1, 2014). *Academic standards for English language arts, grades 6-12*. Retrieved from static.pdesas.org/content/documents/PA%20Core%20Standards%20ELA%206-12%20March%202014.pdf

Reynolds, Myra Cloer. (2016). *Ten strategies for creating a classroom culture of high expectations.* Atlanta, GA: Southern Regional Education Board. Retrieved from publications.sreb.org/2004/04V03_Ten_Strategies.pdf

Sanville, John. (n.d.). *The relationship between teacher perceptions of principal emotional intelligence and organizational health.* Proquest. Accessed 23 Nov. 2014.

Thiong'o, Ngugi Wa. (2013). A globalectical imagination. *World Literature Today*, May-June 2013, pp. 41-42.

Figure 8. Ben reimagines Clover's role in Orwell's Animal Farm. She sets up a camera recording Squealer changing the rules. *Photo credit: Josie Liu.*

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