

Reimagining Teaching and Learning in the Science Classroom

Over the course of the past several years, The Baldwin-Whitehall School District has experienced a decline in state assessment scores, along with a noticeable difference in student achievement, specifically within the content area of middle school science. Because of these changes, a sense of urgency emerged; therefore, our district was faced with the challenge of improving the instruction of science. The question then arose, Where do we begin? We were well aware that curricular changes needed to be made, but that alone, was not going to impact student achievement. As we dug deeper, we also realized that we needed a shift in instructional practices, as “it’s no longer enough to simply transmit information that students memorize and store for future use” (Barron & Darling-Hammond, 2008). Today’s students need to be able to use the tools and knowledge that is available at their fingertips in order to learn how to solve problems. Our students’ future success will rely on their ability to compete with other students who have the same access to information that they have. The jobs of the future will require students to be able to use creative problem-solving skills, in conjunction with the ability to communicate effectively and in multiple formats. Furthermore, highly desired employees will be those who can network and use their resources to help answer the questions and problems that they face. A networked worker will be able to utilize the minds of many instead of only one. Finally, from the district’s most recent comprehensive plan, one of our overarching goals is to create a culture and environment built on trust and relationships that demand a concerted focus on the children to ensure that they realize their full potential.

We first looked at the recent success with our elementary science program. The rise in our elementary science scores was the result of a hard look at our elementary science curriculum. In order to provide our students with a more rigorous and inquiry-based approach to science education, our district opted to partner with ASSET STEM Education. ASSET STEM Education is a national education improvement non-profit, which believes in “a hands-on, mind-on formula” approach for success. The way in which we selected ASSET modules involved the science team looking at the PA Science Standards and expectations by grade levels, while maintaining an awareness of the Next Generation Science Standards. As a district, we chose modules that would best combine earth, life, and physical sciences in our K-5 classrooms and increased the number of modules that were taught in each grade level from three to four or five. Instructional time for science was increased from 40 minutes to 50 minutes daily. Additionally, the engineering design process, with extension kits in all grade levels, was added. For literacy instruction, the district purchased non-fiction reading materials to complement the science topics.

All elementary science teachers were then provided professional development on the new modules at ASSET. Our elementary teachers have had extensive training in notebooking and inquiry-based learning as well. Teachers have been provided professional development time at the district-level to collaborate on these science initiatives. As Wiliam (2011) asserts, “Pedagogy trumps curriculum. Or more precisely, pedagogy is curriculum, because what matters is how things are taught, rather than what is taught” (p. 13). As such, high quality instruction by educators who are provided with high-quality, embedded professional development is perhaps the most significant factor in students’ learning. As Guskey noted, “Educators at all levels value opportunities to work together, reflect on their practices, exchange

ideas, and share strategies and expertise (p. 10). When examining all elements of effective professional development together, Kennedy (1999) referred to noticeable improvements in student learning outcomes as the ultimate benefit of professional development including, but not limited to, assessment results.

The rise in 8th grade science scores can be attributed to our new integrated approach. The administration decided to move from teaching earth, life, and physical sciences in isolation to an integrated approach throughout the 6-8 middle school experience. Our middle school teachers worked tirelessly for the past two years on writing curriculum that contains a vertical and horizontal storyline and have combined classroom-based instruction with field experiences. Our district has also implemented a pre-biology component in the second semester of 8th grade. The high school and middle school teachers developed this component based on the needs from the Keystone data. This past year, we saw a dramatic increase in Biology Keystone scores at the high school, which we attribute to this curricular change in 8th grade. As a result of these efforts, a fully threaded, inquiry-based, science curriculum has been created for students in grades 6-8.

Now, having both the need and desire to change instructional practices within our middle school science courses, the goal became to engage students in more authentic learning, including projects and activities that would require them to employ subject-specific knowledge to solve real-world problems. Gone are the days of continuously implementing teacher-directed instruction from a textbook. This type of a traditional academic approach, which emphasizes memorization, does not develop students who are critical thinkers and who can retain their knowledge. For students to develop these higher-order thinking skills, they need to take part in complex, meaningful projects that require sustained engagement, collaboration, research, management of resources, and the development of an ambitious performance or product (Barron & Darling-Hammond, 2008). As we realigned our curriculum, we also explored ideas on how to better engage students in their learning and to make the content of science both meaningful and relevant. After countless committee meetings with various stakeholders, it was decided to create “a space,” where students could continue their journey of exploring science beyond the traditional classroom.

During the 2013-2014 school year, a team wrote a grant, which ultimately funded the construction of the IKS Highlander, an immersive, interactive simulator, reminiscent of The Magic School Bus. This project was made possible through a grant from The Grable Foundation and Dream Flight Adventures, in addition to matching funds from the district and in-kind labor. The IKS Highlander allows students to be involved in an interactive story by engaging them in open-ended scenarios. Dream Flight Adventures operates from the notion that “the experience transforms a room into a themed environment simulating a ship that can travel through time and space where students accomplish educational missions.” Each mission involves 16 crew members who are responsible for different functions of the ship. Teamwork will enable them to either be successful or fail the mission.

Additionally, an adjoining Mission Ops lab was constructed. The purpose of the Mission Ops lab is to enhance the simulator missions so that students participate in a full-scale experience that both extends and enriches the content area curriculum that they are studying. This space empowers middle-school aged students to be critical thinkers and enthusiastic learners, while

integrating the curriculum to include the full range of literacy skills (information, media, visual, digital, and technological) necessary to meet content standards and to encourage lifelong learning. Our teachers have become facilitators as our students take charge of their own learning. The lab is a sandbox for creative instruction. It encompasses inquiry-based and project-based learning skills that our students will need to thrive in college, careers, and life beyond the walls of our schools. At the conclusion of the first mission, for this school year, *Pandemic*, a 6th grade student was overheard saying, “I feel like an adult with adult responsibilities.”

While the district acquired access to the nine Dream Flight Adventures cross-curricular missions, it was critical that the mission designed for the middle school align to our curricular efforts and enhance the standards-based classroom instruction. Blending STEM topics with historical content, literature, the humanities, and social and ethical issues, missions are designed to create distinct memories and to instill a lasting emotional impact on all students. Working from this perspective, the mission, *Contaminant*, was born. In *Contaminant*, students are presented with a scenario in which an unexplained outbreak of a virus has infected 1,000 children, many of whom have died. Fish have disappeared, causing a food shortage and the underlying cause is believed to be associated with a river, located on private property owned by a corporation whose fertilizer factory sits along its shore. The corporation is forbidding access to its land; cue our students, the Infinity Knights. Tasked by the governor, our students must find a way to investigate the source of the plague before it is too late!

Among the topics addressed in this mission and aligned to our science curriculum are: aquatic ecosystems and food chains, the interconnectedness of living things, contamination and purification, social responsibility of organizations, recycling, waste disposal, and the impact on the environment, acidity and alkalinity, making scientific measurements and observations, and the characteristics of aquatic life. Students are presented with questions such as: What can individual citizens do to ensure a safer environment? What are the responsibilities of businesses and other organizations for protecting the environment?

There are many noted benefits to using problem-based learning (PBL) in all disciplines. Some of the benefits include:

- Providing opportunities to practice skills such as collaboration, communication, and creative critical thinking that are necessary for today’s workplace.
- Providing opportunities to create authentic products and presentations, and then to present their work to audiences beyond the classroom.
- Gaining a deeper understanding of academic concepts and fostering lifelong habits of learning.
- Motivating students who might otherwise find school boring or meaningless.
- Providing opportunities to explore careers, social issues, community issues, use technology, and interact with adult mentors.

The role of the teacher also changes when using PBL to guide his or her instruction. “Problem-based learning turns instruction topsy-turvy. Students meet an ill-structured problem before they receive any instruction. In place of covering the curriculum, learners probe deeply into issues searching for connections, grappling with complexity, and using knowledge to fashion solutions” (Stepien & Gallagher, 1993, p. 26). Teachers must

carefully plan rigorous problems based in realistic scenarios that allows students to realize learning objectives. Teachers must identify engaging problems and appropriate resources, and manage and assess students' learning. During this process, they must support, coach, and mentor students as they gather information while also supporting students' reflections on their own learning outcomes and processes (Arends & Kilcher, 2010). Specific to the middle school student, PBL can help to "sustain and promote students' developmental advances and bridge developmental gaps that are typical of students during these years." PBL requires students to work together, to problem solve both independently and as a team, and to create products utilizing their strengths.

As we move forward, our district will continue to look for opportunities to collaborate with organizations and business that will help support the authentic learning experiences for our students. During the 2015-2016 school year, the Carnegie Science Center has supported our 6th grade health curriculum, coupling their Science on the Road's program, Anatomy Adventure, with the *Pandemic* mission. Additionally, the Mission Ops lab has been used to extend lessons about ecosystems, biomes, and food chains, using box kits of owl taxidermy mounts on loan from the Carnegie Museum of Natural History. Finally, 7th grade students studying *The Call of the Wild* in their English Language Arts' classes, learned firsthand from members of the Pennsylvania Dog Sled Club about: the rich history of dog sledding, the differences between modern day equipment and the type that was used in *The Call of the Wild*, the demands of dog sledding (on both humans and dogs), training for competitions, the history of Alaska, and cartography. Students were able to examine various pieces of equipment that are actually used when dog mushing. Most memorable, however, was the opportunity for the students to meet four seasoned sled dogs who are all experienced runners having competed in the Iditarod! By the end of the week, curricular concepts were brought to life and memories and friends were made, which will last for many years to come. This summer, our hope is to include the IKS Highlander and Mission Ops lab as a component of our summer STEAM camps and enlist the help of high school students to serve as student docents and mentors for our elementary and middle school students.

For more information about the IKS Highlander and the Mission Ops lab, please visit: ikshighlander.weebly.com or follow us on Twitter @IKSHighlander.

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