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Perspective

When STEM Leads to the Rest: A Reflection on STEM as the Hub for Curriculum Integration

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Growing up, I experienced education as a world of silos. Language Arts (ELA) was where reading and writing occurred; Math held formulas and algorithms to solve equations; Drama served as an outlet for performance. Few overlaps existed in my mind: Science and Math spoke a shared language, and ELA held a leveled partnership with the Fine Arts. When I entered the field of education as a college student, the concept of interdisciplinary studies for K-12 education was scarcely discussed. It was not until my fourth year of teaching that the verbiage of STEM was specifically used in educational vernacular. I found it a fascinating idea and took to fine-tuning my craft; intentionally working to merge subject areas, causing them to crossover and intersect with one another.

Fast forward to my fifth year of teaching when I was presented an opportunity that seemed daring and innovative. I was asked to teach a class titled Core Connections (CC). The premise of the class is simple: the teacher of CC partners with the four core educators of a specific grade-level to create an intense interdisciplinary environment that forces students to dig deeper into content strands using Project-Based Learning (PBL) and STEM as the form of content delivery. I am now in my fifth year in CC and have seen how this pedagogical approach has challenged students. I have witnessed how students have come to understand that classes do not have to be separated into silos, but can be blended for deeper comprehension.

Although the specific projects and the content standards have varied from year-to-year, the learning that takes place consistently affirms that STEM is an effective hub for connecting other subjects. One might struggle to understand how ELA and Social Studies (SS) fit into the STEM mix but, in the following, I hope to demonstrate how these subjects logically intersect with each other and encourage educators to consider how their classes can contribute to, or derive from, STEM initiatives.

Using my own classroom setting — sixth grade Core Connections — I focus on three primary content areas: ELA, SS, and Fine Arts (i.e. music, dramatic arts, visual arts, etc.). I teach CC five times per day in 50-minute increments; and in this discussion, I reference the projects delivered in this specific setting. I will show how educators can move beyond rudimentary delivery of content to something more enriching for students.

LANGUAGE ARTS IN STEM

At the beginning of each school year, students embark upon one of two team-building projects: The Bridge Project and the Earthquake Project. In both instances, students divide into teams of three to five to build a structure: a bridge or a building. All teams have the same end goal — to build a durable structure that resists damage. A team's bridge should withstand more weight than those built by the other teams, and buildings should remain standing after a mock-earthquake. Materials for the two challenges are different, but the STEM programming remains the same.

In each project, students must explore the science behind each type of structure. Understanding concepts such as trusses, base isolators, or interactions between weight and mass forces them to take an in-depth look at the physics involved in each. Students typically accomplish this through reading assignments from informational texts, hands-on experiments, and open-class conversations. In addition, they must study the mathematical components of these structures, researching and experimenting with geometric figures to engineer the desired stability. Throughout these projects, students

utilize technology in a number of ways ranging from conducting research online, to using alternative materials in the development of their structures (i.e. Popsicle sticks, gummy savers). While research and note taking are indeed part of this work, students are also expected to move into more advanced ELA assignments.

Communication is at the heart of ELA and some of the most intensive work that students produce while working on their projects grows out of an authentic need to communicate. Each team of three to five is composed of students from across the five class periods that I teach. This creates an immediate "problem" for the students to address; "If I cannot physically see or speak to my partners in class, and my team has to accomplish a common goal, how do I communicate with my teammates?" The presentation of this problem forces students to contemplate what the ideal solution would be. Most students come to recognize that a live-journal — a working journal that uses an internet based storage system to store student daily entries (such as Google Docs) — is best for this purpose. For six weeks, students engage in written dialogue with their teammates by maintaining this journal. A series of daily questions guide students in the argumentative writing phase, allowing them to tap into their understanding of scientific and mathematical concepts to support their hypotheses about the next steps in the building process.

In a project later in the year, students participate in the narrative writing process, creating a fictional world based on scientific observations. The end goal is for students to develop a children's book based on a scientific concept that they are learning in science class. The subject one year was their community garden, in another year it was their study of space. In both, students were immersed in an extensive research process and encountered explicit informational or technical text that improved their scientific comprehension. The in-depth research helps them accurately reflect the fictional world they are seeking to create. Once they have developed a more accurate setting for their story, they then undertake the narrative structures of fiction in the writing process.

ELA educators seeking to develop a cross-disciplinary curriculum will appreciate the way in which STEM organically connects to the writing process. Students can create arguments related to their hypotheses, practice expository and explanatory writing, and research a problem they uncovered or establish a fictional narrative that uses science as a foundation for story development. When integrating subject areas in this way, it is important to consider the academic standards for those other disciplines, which can be a challenge when moving into unfamiliar content areas. These strategies that bring together ELA and STEM disciplines help students to become proficient in [interacting] with complex informational texts in a variety of content areas (DeBoer, et al, 2012).

In developing these projects for my students, I am reminded of my 10th grade Biology class when I was asked to create and maintain an ecosystem for nine weeks. In this project, we kept a journal twice a week, marking any changes we saw, along with our hypothesis. I vividly remember the project. My partner and I included several types of lifeforms within the ecosystem, such as tadpoles and small fish. The journal I also remember, because we only had the first five minutes of class to write our observations. In challenging myself as an educator to implement an interdisciplinary curriculum, I have to wonder how authentic that ecosystem journal could have become had my teacher been more thoughtful about the writing component. The only effort that I gave to my journal was just enough to get the grade. In comparison, the writing assignments in the journals that my students keep for their bridge/earthquake projects has a specific intent. Our class spends the first week looking at a cost analysis of what happens when someone does not pull their weight in their journal entries. We hypothesize and discuss multiple issues: What happens when I skip my journal entry? What happens when I do not use the correct terminologies? What happens when I am not specific enough in my writing? The integration of ELA with STEM gives an added weight to assignments that helps students see the value in their work and connect it to real-world concepts.

SOCIAL STUDIES IN STEM

In my eight years of teaching, I have come to realize there is no core content area more overlooked than SS. It is dramatically underplayed in the interdisciplinary work of PBL even though, as Blanchette points out, it belongs on the same level with literacy and STEM (2012). SS plays a vital role in developing well-rounded students and employs history as a backdrop for demonstrating how citizenship shapes our world. History can inform students in ways that help them become empowered, active citizens. In an interview conducted by a team led by Dr. Brad Maguth of the University of Akron, a teacher named Mark Jones states: "[SS] is really the glue that holds all the individual STEMs together." He goes on to say that there are a lot of ethical and critical questions that need to be asked about [STEM]...It's dangerous to have discreet knowledge without the critical thinking or decision making skills established through the study of SS" (Maguth, 2012).

Toward the end of the school year, my students complete a project in which they hypothetically colonize an area of space. Students use scientific research and data to inform their decisions about where to colonize, and how to engineer a new piece of technology that is vital to their planet. They also utilize mathematical graphs and statistics to give their consumers an easy guide for understanding how resources are broken down in the new colony. As a part of the colony project, students reflect upon previous ancient history lessons about developing societies and consider what type of government they will enact in this new colony. They must then justify their choice of government to the potential constituents. SS and its significance to a fast-paced society has never been more critical than it is now in the 21st Century. SS, perhaps more than any other of the K-12 content areas, addresses the moral responsibilities of citizens and can provide the social contexts that help students understand STEM issues.

THE ARTS IN STEM

I would be remiss if I did not address the essential role that the Arts play in STEM-based education delivery models. It is time to move beyond the idea of visual art as just a dance or an illustration on canvas. I propose we begin to look at the Arts as a Science. Similar to Science, the Arts allow students the benefit of exploration, creation, failure, and success while, as Hendricks points out, giving them the independence to stretch their creativity (2016). Although it might be easy to say that a student who draws up a blueprint and engineers a building is showing how STEM connects with the Arts, there is far more to the Arts than pencil on graph paper (Schwartz, 2015).

To illustrate, another assignment that I have my students complete is entitled the "Play Project." In this project, students take on a topic that they have discussed in science class and work to answer an essential question related to that topic. Students address these questions through plays that they write and perform. In doing so, they come to see the importance of knowing and understanding the information. The process of writing the play requires that they comprehend the relevant scientific issues. The students employ math and engineering skills as they become their own theatrical troupe and create the different materials they will need (sets, costumes, props, etc.) all in the interest of enhancing the delivery of their plays.

The Arts also hold sway in one area that most other content areas may not, that of emotional investment (Hendricks, 2016). The Play Project demonstrates this in the way that it elicits emotional buy-in on the part of the students. As they do the research, participate in the writing and editing process, and build their comprehension of the STEM content, they recognize that the emotional connection they have for the subject is a result of personal investment in the work.

The Arts also have the capacity to inspire curiosity in math and science among students who typically shy away from STEM. When we forego including the Arts in an educational delivery model for STEM initiatives, we unintentionally segregate those students whose academic leanings are not toward science or math, ultimately leaving it to the student to determine whether they love or hate math and science practices (Edutopia, 2015).

CONCLUSION

STEM can be a natural integrator and motivator of all school subjects, and serve to eliminate the disciplinary silos that have been part of our educational tradition. It can also be a catalyst for the kind of deep intellectual engagement that leads to academic success. I urge us as educators to use STEM as an integrating hub that helps students see the connections between subjects, and recognize how they are relevant to the world we live in.

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