BACON's Origin Story

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About a month into teaching at my current school, the long-anticipated day had finally arrived. It was the day I would share with my students the thrilling news that each member of the class would be embarking on a year-long journey called the Science Fair Project. As a former engineer, this was the part of the curriculum about which I was the most excited. Some of my favorite college memories are of nights spent in the basement of the mechanical engineering building, wiring up a hand-built test rig with the hopes of teasing some obscure measurement out of the equipment. The Science Fair Project was probably the closest my students would come during their high school careers to experiencing that joy.

To my dismay, I was about two and a half syllables into the phrase "Science Fair Project," when the air began to fill with groans. It turns out that science fair projects are a mandatory part of the science curriculum for students in my school district, starting in grade six. Most of my students were juniors or seniors and had spent the better part of a decade learning to despise the exercise. I asked about the groaning and my students readily shared their common belief that science projects are tedious, pointless, overly time-consuming, and have no discernible benefit. I was incredulous. What about the process of scientific inquiry? What about the excitement of discovery? Not in high school, they said. In fact, a couple of students openly admitted that they would probably submit the same coat hanger solar system or plants-under-differently-colored-lights experiment that they had submitted last year. (I've never understood the need to investigate how plants function under lights found almost exclusively in party stores).

Clearly, I had made a miscalculation. The mere prospect of an individually driven scientific investigation was not going to ignite the passions of my students. Somehow, I needed to bridge the gap between their current state of apathy toward science and the mindset of curious and creative scientist. So, when my students entered the classroom the next day, a poster from the movie *Ocean's 11* dominated the front board. This requires some explanation.

Ocean's 11 is a classic Rat Pack movie originally released in 1960. The 2001 incarnation stars George Clooney as Danny Ocean, an ex-con who hatches a wild plan to steal $150 million from three Las Vegas casinos. The beginning of the movie follows a familiar plot structure:

faced with a seemingly impossible task, the protagonist cobbles together a ragtag crew of players, each selected because, despite their quirks and flaws, they possess a unique and indispensable expertise. These Hollywood plots usually involve talking a crusty old-timer out of retirement for "one last job," a diminutive Asian guy recruited for his computer and/or martial arts skills, and a clash of egos which goes back to either their last job or time spent together in the slammer. Once assembled, this crack squad of characters is able to blow up an asteroid before it hits the earth, overthrow a Latin American dictator, or knock over three super-secure casinos.

I explained the relevance of the *Ocean's 11* poster to my students: I had devised an extremely ambitious plan. And, like Danny Ocean, the only way I was going to pull it off was if I managed to recruit an unlikely crew of experts with wide-ranging talents. My plan was to send two cameras (one still camera and one high-definition video camera) twenty miles into space to take pictures and video and then find the cameras once they returned to earth. I had in mind one of those awe-inspiring views of our planet where the curved atmosphere glows against the stark blackness of space. This ambitious mission would require experts in space flight, meteorology, photography, and radio communication. The project would also need a math whiz, a fund-raising guru, and a community relations expert. And, while we were at it, we should probably have an artistic director, a webmaster, and a documentarian. And someone needed to be in charge of food. This was going to be a big project.

After selling the project, I offered my students a proposal: if they thought they could provide a meaningful contribution to the project, then that (along with a paper detailing their contributions and what they learned) would serve as their science fair project for the year. At the end of class, I asked each student to submit written answers to two questions: 1) Would you like to participate in the Super Space Adventure? and 2) What could you contribute? Of the thirty students in the class, twenty-nine opted to participate (one student was already well underway with an individual project).

That night, while reviewing the two-question response cards, I had my first realization that I might be stumbling into something special with this project. I am a physics teacher and experience tells me that, if you ask students to do physics problems, most students will oblige. Some will do well and enjoy the process and others will struggle. But, when you ask students what they want to do in physics or how they want to do it – an embarrassingly infrequent question – you find that approximately zero students will answer that they want to crank out solutions to a series decontextualized textbook problems. Just like the rest of us, students are motivated to participate in those modes of learning and working in which they are challenged, can express autonomy, and are likely to succeed. The question responses I received were as different and individual as the students themselves. Kurt wanted to write the soundtrack for the project, Brooke volunteered to be in charge of calling the FAA and FCC, Irene offered to be in charge of finances, John figured he could crunch the trajectory numbers, Claire wanted to take pictures and create a movie, Jared was excited about programming the microcontroller to collect pressure versus altitude data, and Lizzie wanted to manage the entire project.

These responses brought me back to grad school, and a book called *Starting from Scratch* (Levy, 1996) in which Steven Levy argues that each student has a unique genius, something that often requires leaving the traditional reading, writing, and arithmetic curriculum to discover. Educational experiences which nurture, challenge, and lift up the individual talents of students are destined to be engaging and memorable. As is shown powerfully through Levy's vignettes, reading, writing, and arithmetic content standards meld naturally with these rich educational experiences. But, it's the experiences that form the backbone of the curriculum which, once established, can support the standards. As Levy shows, when the standards are built on an authentic framework of rich experiences, they are imbued with meaning and are much more enduring.

For over three months, I dedicated one full class each week to our Super Space Adventure. With minimal directing from me, my students dove fully into the project and immediately began learning exciting lessons well beyond anything in the planned curriculum. As the project took shape, students realized that they needed to know more about the jet stream, helium, buoyancy, and atmospheric conditions at various altitudes. So, of their own accord, they conducted the necessary research. They figured out how to make ascent and descent rate calculations and became experts in GPS satellites, radio antennae, and navigation. They researched FAA regulations for unmanned aircraft, and FCC regulations for long-range radio transmission. When the students asked if they could meet on Saturday morning to test parachute designs, I knew this project had legs. It was about that time when I had important pedagogical realization number two: the teacher did not need to be an expert in meteorology and satellite communication to lead a class of students through this experience. From the project's inception, my role – and I was explicit about this – was facilitator and director much more than it was traditional deliverer of content.

Teamwork and communication quickly assumed a central role in this project. Coordinating the ideas and efforts of thirty students (John eventually joined in) took careful planning. With the help of the two-question response cards, I divided the class into teams, each with a team leader. Team leaders *assigned themselves* the responsibility of updating a wiki (an easily editable website) each day to keep everyone apprised of progress, plans, problems, and questions. I monitored the wiki and gave input when necessary. Also, each Monday, we held a brief "staff meeting" during class where we made sure that the teams were well-coordinated.

It was during the first staff meeting when I remembered another book from grad school, *The Parallel Curriculum* (Tomlinson et al., 2002). This was realization number three. In the book, the authors describe a model of curriculum development where the core content of a class is just one strand which runs parallel to and is dependent upon other curricular strands. These parallels serve to enrich the core curriculum, draw connections between it and the students, and give the content meaning. One of those parallels, the Curriculum of Practice, has students working as expert practitioners in authentic activities, employing lessons from the core content in the service of worthwhile objectives. I saw the Curriculum of Practice work powerfully in that first staff meeting. I had pushed the student tables together to form a large conference table. Students sat around the perimeter, each angling in their chair to face the projector screen at the head of the table. I sat at the end opposite the screen and called the meeting to order as two boxes of donuts and a pitcher of water circulated. I doubt many students had participated in actual staff meetings prior to this one, but the scene was easily recognizable from any movie where big business is portrayed. The scene from *Elf* with Will Ferrell comes to mind, where different writers are pitching their children's book ideas to the big boss. In our staff meeting, students playing the role of idea generators and experts as we developed a device to take pictures from space.

The Curriculum of Practice is a powerful answer to the question "Why do we have to know this stuff?" In the balloon project, I watched as the need to know the buoyant force of a cubic foot of helium at various altitudes drove students to research and review chemistry. Students wanted to learn more physics because their classmates were counting on them to properly design an antenna to transmit 144.39 MHz radio signals over twenty miles. And students taught themselves computer programming (seriously) in order to program the cameras and data collection equipment.

The scale of the project taught us another important lesson, community involvement. Early in the project, the Retrieval Team realized that tracking the balloon would require some very expensive equipment. The Finance Team informed them that the requested $600 radio transceiver was not in the budget. So, the Public Relations Team made some phone calls and found that our town supports an active amateur radio club that was willing to offer their expertise, equipment, and even some money.

On launch day, a cold Saturday morning in January, a Styrofoam box originally meant to transport human organs was carried out to the launch site. It now contained two cameras, a GPS antenna, a battery pack, atmospheric data collection equipment, and a radio transmitter. Half a dozen members of the amateur radio club sat in their cars, ready to receive signals from the balloon and aid in the chase. A student's father who is a pilot made one final check with the FAA, and a handful of students began to fill the huge latex balloon with helium while others made last minute flight path calculations and a gaggle of parents and teachers sat on a hill to watch. This had clearly become a community event.

We counted down from ten, let go of the payload and watched as it gracefully rose into the sky at, according to the calculations, 1,040 feet per second. Immediately, its transmissions began showing up on the laptops inside the amateur radio members' cars. As predicted, it was heading east-southeast with a groundspeed of about 30 mph. Brimming with excitement, we piled into vehicles and began the chase.

The balloon transmitted its location and altitude reliably for nearly an hour, but mysteriously stopped once the balloon climbed over 60,000 feet above the earth. We waited by the radio for further transmissions, but it remained silent. Hopeful, we drove to the projected landing spot and spent an afternoon walking through fields and farmland in search of the downed payload. We never found it. Later, we would learn that, due to government regulation, some GPS receivers (ours included) are designed to turn off above a 60,000 foot altitude limit.

That heartbreaking error taught the class one of the project's most enduring lessons. Real exploration and experimentation involves stepping into the messy world of uncertainty and risk. As the authors of The Parallel Curriculum put it, working as expert practitioners on real-world problems means "escaping the rut of certainty about knowledge." This new mindset requires developing a comfort with uncertainty, and a willingness to fail. And it requires learning from mistakes, refining your methods, and giving it another go.

And give it another go they did. It was the following year, when they were no longer in my class and no longer had a science fair project to complete that a group of students launched their second balloon. They chose to tackle the project again on their own time because they had ownership of the mission, were committed to its success, and wanted to see it through to completion.

On a brilliant June morning, with the amateur radio club again in attendance, as well as some graduated students who had returned for the launch, we once again watched a huge white sphere of helium tug our payload up into space. This time, we got it back. And from it we retrieved over two hours of exhilarating video footage and nearly one thousand breathtaking photos.

Since that first balloon project, interest in science, technology, engineering, and math has blossomed at our school. Last year, we founded an official science club called BACON, the Best All-around Club of Nerds and filled our calendar with science-related events. By the end of the year, the club had traveled Europe to see the Large Hadron Collider at CERN, Florida to watch a Space Shuttle launch, and several locations around the country for science competitions. Our next balloon launch is planned for the spring. Some students think that this one should feature live streaming video. That's up to them.

References

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