During spring 2014, a high school science teacher shared with the teacher librarian the news of a great opportunity.

The school, Council Rock High School North, a large suburban high school in the Philadelphia area, would offer a new class that would be a scientific experimental research course. It would be the first fully integrated STEM class offered at the high school level in the district and one the science teacher had lobbied hard to bring to life. The nerdy librarian was jumping with joy!

What a great opportunity for the science teacher, the students, and of course the librarian! Students would be able to choose a research project based on personal interest from any field in STEM. They would engage in research on a single project for the entire school year. The science teacher could create a meaningful learning experience for her students with real-life applications. The students could move beyond a basic writing assignment to actually creating knowledge and communicating their research to the community. Through the process, the librarian would be able to help students hone their information literacy skills.

The science teacher and the librarian took a breath, jumped in, and, a year later, stood in amazement, not only at the work the students had accomplished but also at the many lessons learned by all. The intention of this article is to share what teachers and students learned about discovery and, maybe more importantly, about success, failure, and the element of time involved in the process.

RIGOR AND PROCESS

When given an assignment, students typically focus on the end product. They need to know what is due, when it is due, and how they will be graded. They are forced to move quickly, often without time to reflect on learning, because educators must maintain the pace of the curriculum. In many cases, students do not have the opportunity to repeat the process of creating or engaging in the ongoing, reiterative cycle of developing knowledge. One of the positive features of this STEM class would be time—time to experiment, fail, discover, and repeat the process in order to make the most of their learning opportunity while maintaining rigor.

The students participating in this first class were 14 honors and AP level seniors. Many of them had previous experience working with both the science teacher and the librarian. The science
GETTING STARTED

Initially, it was decided to give the members of this pioneering group a short survey on their previous search experiences and acquired information literacy skills. Brief information literacy lessons were tailored to their responses. These included lessons on advanced search tips, particularly those related to the school’s available databases that focused on their topics of interest. Also, use of RSS and email alerts, as well as use of the state's combined catalog for ILL books, was encouraged. Interestingly, the science teacher and librarian realized that it was necessary to differentiate the meaning of research as it looks to those in the field of science versus the more general use of the term for librarians and students—that is, scientific research relates to experiments, data, and conclusions, whereas library research often relates to literature searches on a variety of topics. Establishing that simple distinction between terms enabled all members of the learning group to communicate more effectively about needs, either scientific or reference, at any given time in the project.

In addition to establishing topics, students, teacher, and librarian brainstormed criteria for evaluating free websites. It was noted that students had already developed a good feel for determining legitimacy of resources. From this discussion, the following resource evaluation criteria were agreed on: authority, currency, accuracy, bias, and content. Students were required to use a criteria checklist and questions relating to those five essential measurements to evaluate articles found during their literature searches. The small class, and the very hands-on approach of both teacher and librarian, allowed teachers and librarians to tailor lessons to the students’ needs; students were expected to quickly move forward with their topic or literature searches as they began to gather information.

STUDENT CHALLENGES WITHIN THE PROCESS

Unfortunately, after providing students with the previously mentioned information literacy lessons and directing them to look for specific information on chosen topics, students still struggled. They attempted to use the databases, but they had not developed their project ideas to a point where they could use the databases effectively. They had failed to build adequate background information, thus they created questions/searches that were too narrow or far too broad. So their initial literature search attempts fell short. Students needed to slow the process, build a knowledge base, and embrace patience and persistence.

As an attempt to remedy some of the student frustration, the science teacher instituted "Google Days." The students literally spent the nearly hour-long class sessions on web-based literature searches for current science topics in the news, narrowing topics as they moved forward. For example, a news story about water contamination led to stories about clean drinking water contamination, which led to stories about clean water shortages, which led to questions on how to purify water. In this way, students began to clarify their understanding of topics, and in turn they were able to develop solid, well-defined questions.

As students focused their project goals and looked for prior research in their area of interest and experimental procedures to use for their own research experiments, it was discovered that individualized and unique types of searches became more important. Perhaps students were looking for an evaluation to use or a procedure to replace one that did not work, or to find other very specific information to enhance the success of their experiments. Both science teacher and librarian continued to work with the students by spending time talking to them, encouraging students to explain the searches they had done, both successful and unsuccessful. Depending on the situation, it was possible to suggest expanding their searches, narrowing their searches, or shifting to new key words or terms. Students were also helped with searches based on articles they had found that were
relevant to their topic. They searched both forward and backward, finding resources referenced by an article as well as sources that referenced an article. To provide “just-in-time” educational opportunities, students came to the library freely during their STEM class period to chase citations, search beyond article abstracts to find the full-text online or sometimes through ILLs (through the PA State Access Catalog), or to find contact information for authors of interest. When necessary, some students headed to local college libraries to use their resources. Additionally, the librarian frequently visited the science class to check on progress and assist with student searches.

EDUCATOR CHALLENGES WITHIN THE PROCESS

One of the challenges, both for the science teacher and the librarian, was the breadth of STEM areas that arose based on the research choices made by the students. In the first year, the biological sciences were represented with projects ranging from behavioral science (where a student was comparing methodologies of teaching the completion of tasks to students who had low functioning autism) to microbiology (where a student was attempting to develop resistance to high temperatures in an organism used to degrade lignocellulose for energy production). Other projects were in the field of engineering, where one student looked at refining the design of helicopter blades to reduce noise, and another sought to improve heat transfer in a device meant to utilize the energy stored in ocean water. Because no educator is an expert on this breadth of topics, it was critical to employ some of the personalized search strategies that were previously mentioned.

Additionally, it was necessary to help students search for subject matter experts—professional scientists and engineers who worked in their fields of interest. For example, in the first year, the school psychologist, who is involved in research in behavioral science, was an invaluable asset for the student doing research on autistic students. Each contact with a professional enriched students’ understanding of the chosen area of research, as well as provided additional leads to follow as they cultivated the approach to develop and address research questions. Each effort to go beyond an initial topic search, which may have yielded only a few article abstracts, provided students with real-life skills, like independence, flexibility, and persistence. This was truly a celebration of lifelong learning.

PRESENTATION PHASE

As the students wrapped up their scientific research for the year, they learned another essential aspect of scientific research: communication of their results. In order to expose the students to as many avenues of professional communication as possible, all students were required to present their results in several formats, each method presenting a unique learning experience.

The first method was one with which students are most familiar: development of a brief PowerPoint presentation. They were required to present their work to the class and at a local science fair. Happily, most of the members of this class qualified to move on to the state-level competition. The second method was the development
of a traditional science fair tri-fold poster presentation. For most of the students, this poster was presented at another science fair. The poster presentation was also part of a display held in the library in which all class members participated. Both the science fair and the presentation in the library provided opportunities for the students to describe their projects and answer questions from peers, scientists, faculty, and school and district administration who had been invited to the event. The final method was to write a scientific journal article in the format of one of the three currently available secondary science journals. In the first year, only a couple of the students actually chose to submit articles, but hopefully in future years this number will increase. Either way, the experience is invaluable.

FUTURE PHASE

The first year of the scientific experimental research course was very successful, with students commenting in a year-end survey that they felt “much more confident” in their ability to do research. Interestingly, many of them are already pursuing research opportunities as freshmen in college. Students also commented on redefining the meaning of “failure.” Previously, they thought of failure as something that meant they were somehow deficient. Instead, as the course progressed, they understood it meant that they simply needed to rethink and start again. It was clear from their reflections that through the research process they had learned to improve their ability to persevere as well as to utilize a variety of resources in order to overcome obstacles to their learning.

The students in the second year of the course are already benefiting from the lessons learned. At the beginning of the school year, lessons were presented to refresh student knowledge of terms and skills, as had been done during the initial year. This skill development was paired with a more significant amount of time for browsing the web. This change enabled the students to become more aware of current science news. This gave them time to develop ideas for research and greater topic understanding before jumping into the detailed work of developing their research plan and beginning their experiments. Along with the time spent browsing the web, there were current event reading/response assignments added to class activities and peer presentations on topics of interest. Also, because of the success and educational advantages of working with mentors, considerably more effort was placed on finding mentors outside the school for students the second year. Students from last year’s program were called on to return to the high school to work with the new class. Finally, a new book, titled STEM Student Research Handbook, by Darci J. Harland (2011), has been added as a resource. This book helps with all aspects of a scientific research project. It includes organizational tips for developing research questions and experimental plans. It also addresses literature searches, analyzing results, and writing and presenting results. These changes will better help all of those involved in this experience to celebrate this unique learning opportunity.

REFERENCE


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