

Using Science Journal Articles to Improve Independent Research Topic Selection

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As STEM initiatives gain popularity and the Next Generation Science Standards begin to roll out, the importance of instilling in students a strong foundation in the nature and practice of science maintains as high a priority in curricula as content. Previous editorials stress the importance of participation in independent research projects for students to gain these important science skills as they prepare for their post secondary careers. “Doing” science has been a critical component in my Biotechnology courses as each student is required to complete an independent research project and present it at our school’s science fair. There are few experiences for students with the potential reinforce as many skills and can challenge and inspire students the way that independent research projects can.

Over the years, I have grown increasingly “underwhelmed” with the topics that my students select for their research projects. As many teachers who supervise independent projects can attest, topic selection is the perhaps the hardest step for students who have limited experience in science and when faced with the entire body of scientific knowledge to pick from, often revert to topic selection websites or the like. More and more of my student’s projects started with a research question from a search engine, followed predetermined methods, achieved predetermined conclusions and wrote background papers to “flesh out” requisite knowledge about their topic. This “old model” of workflow fails to impart the intended lessons and leaves students and teachers frustrated (Figure 1).

Independent research projects should mirror the practices of “real” scientists. Topics for research should be derived from important issues being addressed in a field that a student has genuine curiosity. Like scientists do, students should arrive at novel questions for research topics after building a foundation of scientific knowledge in their topic area. Achieving this “critical mass” of knowledge is facilitated as scientists use the literature to keep abreast of advances in their fields. Through the literature, scientists evaluate the work of others, challenge claims, and integrate techniques into their own work. The ability to read and understand journal articles is the key to unlocking the true power of an independent research project. I proposed a “new model” for topic selection to my students that leverages the ability to read and understand journal articles to allow them to ask novel questions in an area of science they were curious about (Figure 2).

Implementation of the new model focused on two key areas; introducing students to the format and style of a journal article and creating classroom structures for practice reading those articles. It was important that any activities were designed to integrate seamlessly into my course curriculum, without competing against it.

Students were introduced to the format that many journals follow by highlighting similarities that the format shares with the parts of the scientific method¹, and given time to explore online resources for reading journal articles from Kenyon College² and Purdue University³. Those activities coupled with class discussions set the stage for students to begin reading papers.

Modeling an experience from a summer internship at Brown University, I instituted weekly “paper talks” into the flow of our course. Each week, students were assigned a new paper which they were expected to read and prepare for a discussion in class on Friday. Since students were still relatively inexperienced with reading

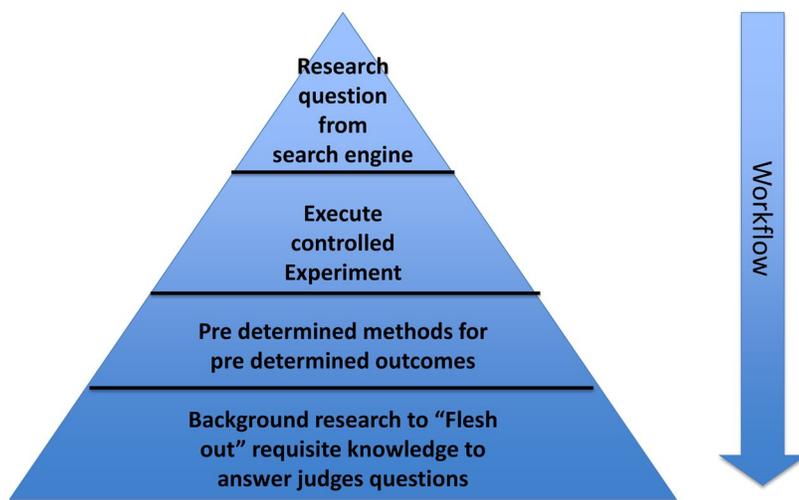


Figure 1. Old model of topic selection: “I want to do *that*”.

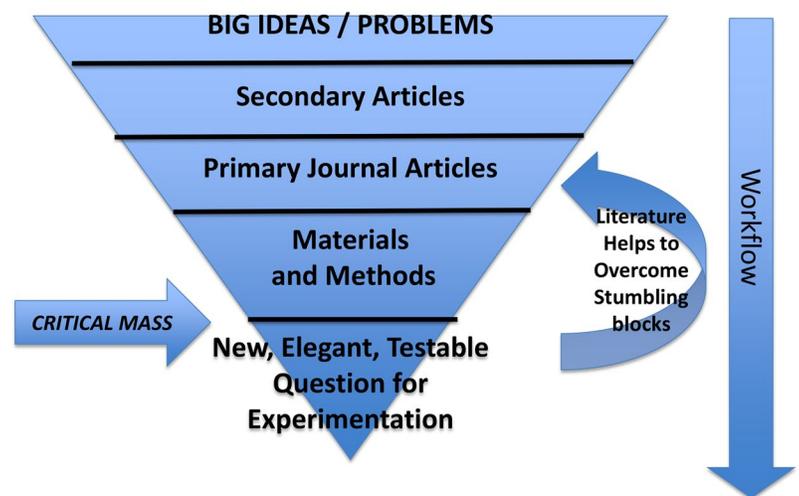


Figure 2. New model for topic selection.



articles, some important scaffolds were implemented to help ensure success.

To facilitate meaningful reading of journal articles and productive class discussion, I created a small set of questions to guide students thinking and asked students to turn their responses in a day before the paper talk took place⁴. Using peer reviewed guidelines for paper selection, I set out to find papers that could connect to course content, follow a straight forward experimental design with a limited number of steps in the sequence of logic, and provide a rigorous but accessible opportunity to students. The selection of appropriate articles presents an interesting challenge as the technical format of the journal collides with the nature of science, in the context of a specific academic field. The ideal introductory paper de-emphasizes the content, allowing students to follow the pattern of scientific thinking organized in the structure of the article⁵.

Discovering the first issue of the Journal of Experimental Secondary Science, July 2011 provided a bank of articles that met all of these criteria. The methods used and the data representations in the papers published in JESS are often comparable to those used in high school laboratory activities, allowing students to form a concrete mental image of how the data is produced. I was pleasantly surprised at how quickly my students developed a comfort and confidence reading and analyzing the JESS articles. The members of the class seemed to take pride in their ability to understand articles laden with technical jargon and could often be seen traveling the hallways with their weekly paper on top of their piles of books, like a badge of honor, inviting students and teachers alike to ask them about what they were reading. During the first quarter of the 2011 school year, my students read each of the articles in the first issue and one from the second before branching out to more complex articles.

Once empowered with experience reading research articles, the students began work on their independent research projects. With guidance in the “new model” for topic selection and encouragement to choose “hot button” issues in science, students embraced the opportunity to become experts and ask novel questions. I couldn’t have been happier with the results of their work. Rigorous and interesting, project topics included studies on the epigenetic effects of resveratrol on zebra fish cancer genes, the effects of competition on bacterial quorum sensing, an investigation of the use of gluten digesting enzymes from fungi to treat celiacs disease, the search for alternative antibiotics, and the bioremediation of selenium pollution from brown-fields by plants to name a few. These encouraging outcomes support a greater role for the use of journal articles in my teaching and I will continue to develop new activities and opportunities for students to interact with this type of media.

While the use of peer reviewed journal articles in the high school classroom present interesting challenges, their effects on the quality of research topics and ability to enhance student’s scientific literacy warrant consideration from teachers and curriculum directors. With the appropriate blend of scaffolding, practice and high expectations, high school students can make significant gains in their ability to read research articles and use them on their own to develop high quality independent projects that explore novel questions in science.

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