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Fred Hawley

EDUC 452

Inquiry Project

Topic: Finding a balance of open and guided inquiry in stem projects.

During my practicum at John Oliver Secondary I taught a grade 9 STEM program. The STEM program is taught collaboratively by a technology education teacher and a math/science teacher (I was the tech. ed teacher). Students in the STEM class worked on hands-on projects that were connected to the math/science curriculum. This is a new program so most of the projects were being introduced for the first time. The teaching philosophy of the two teachers was to focus on inquiry-based learning and to aspire to open inquiry. Their goal was to only provide as much guidance as was absolutely necessary. As a result, we were evaluating how each project went so that we could adjust for future students. Some of our observations were of the logistics, i.e. use braided wire for the sumo-bot controllers because the solid wire connections kept breaking. But I am going to focus on observations of how the amount of guidance that students had on project work contributed to their level of success.

Inquiry-based learning is a method of education where students begin with a question, problem, or scenario that they need to solve with research and experimentation (Hammond, 1991). Students are asked to find their own answers and develop their own understanding of the subjects being taught. In the context of the STEM program that I was teaching, we used inquiry-based learning by encouraging experimentation, design, and independent research as students worked to make their projects as successful as possible. A goal of the program was for students to “learn how to learn”. According to Blessinger and Carfora, inquiry-based learning can contribute to an environment “where increasingly higher levels of self-directed learning is fostered – and where students grow in the three key areas of learning: affectively, behaviorally, and cognitively” (Blessinger & Carfora, 2015, page 4). A large part of learning how to learn, in the classroom/shop where I was teaching, was learning how to use the internet as a resource. The way that I chose to guide the class in this process was to provide a list of web-based resources for each project or topic. This brings me to the topic of my inquiry – my decision to provide a list of web-based resources was my best effort at finding a balance between open and guided inquiry. What are open and guided inquiry? In short, open inquiry has no prescribed results that students are expected to discover or achieve. Instead there is an emphasis on the individual’s experience, development, and growth. In open inquiry, students begin by defining a question, then designing and investigating, then communicating their results. Instead of focusing on the results, the focus is on the process and there is no “wrong” result. In guided inquiry, students are learning through investigation but instead of defining the question or problem themselves, they are investigating and responding to a pre-determined question or problem. Essentially, I wanted to make sure that students had the tools to succeed without the projects feeling like “paint-by-numbers”.

I will look at two of the projects from my practicum, one that was closer to guided-inquiry, and one that was more open-inquiry. First, the open-inquiry project: parachute egg-drop. For this project, students had to make a parachute that would slow the descent of an egg as it was dropped from a height of 5 meters. This was the first time that students in STEM had been required to find their own materials instead of using materials supplied for them. In terms of instruction, I delivered a lesson on the theory of how a parachute works, but did not give any instructions for how they should make theirs. I also had the class make prototypes with paper so that they would have an opportunity to experiment with different designs. The result of this project was on the whole very successful. Students timed the descents of their parachutes and some were difficult to time as the slightest gust of wind would carry them away, keeping them aloft for over a minute as they drifted off school property. The challenge for some students was that they didn’t bring in adequate, or any, materials and had to use whatever they could find at school. Also, some had a harder time researching designs so when it came time to build, they were directionless. This shows a challenge with open-inquiry, when a project is opened up and more responsibility is placed on the student, I found that some struggled with this newfound responsibility. A central tenet of open-inquiry is to not look at projects as successful or not, but as opportunities for learning, and from this perspectives, even the parachutes that didn’t prevent the eggs from breaking could be seen as “successful”, but for those students, it feels like failure.

Secondly, the guided-inquiry project: propellers. Students made propellers out of wood and tested them, using a device that I built to show how much lift each propeller could generate. They were to be used on tethered airplanes that the students would be building after I had finished my practicum. For this project, each student was provided with an identical piece of wood, a handout with step-by-step instructions, I demonstrated the steps, and provided an example. The “worked example” is one of the methods referred to by Kirschner, Sweller, and Clark as a means of guiding student inquiry through demonstration with examples (Kirschner, Sweller, Clark, 2006, page 80). This was the first time that students had worked with concepts like lift and drag, and shaping wood was also new to most of the class. According to Kirschner, Sweller, and Clark, a challenge with inquiry-based learning is when novice learners lack proper schemas to integrate the new information with their prior knowledge (ibid.). This was a complex project with new concepts so I wanted to scaffold the students’ work as much as possible. The benefit of using a worked example was first demonstrated by

Sweller and Cooper (1985) and Cooper and Sweller (1987), who found that algebra students learned more studying worked examples than solving the equivalent problems without that guidance. Another way of guiding instruction is the use of “process worksheets” (Van Merriënboer, 1997). Process worksheets provide a description of the phases one should go through when solving the problem and allow students to “consult the process worksheet while they are working on the learning tasks and use it to note intermediate results of the problem-solving process” (Kirschner, Sweller, Clark, 2006, page 81). The result of my application of these pedagogical tools was that all the students were able to produce successful projects. The downside was that they were all nearly identical. From my observation, the increased guidance ensured a level of success for all students but did not encourage the creativity of more open inquiry.

There are advantages to leaning towards both open and guided inquiry, and there are also disadvantages. The advantages of open inquiry in my observations were increased creativity, but that came with the possibility of some students being less successful. With guided inquiry it is possible to ensure a level of success but this came with the price of limiting creativity. Not to get too philosophical, but it could be argued that creativity is inseparable from a possibility of failure. The book “Shop Class as Soulcraft: An Inquiry into the Value of Work” referred to this idea as an issue within education as students shielding students from failure does them a disservice (Crawford, 2009). This belief would suggest that we as educators must decide whether we want to provide opportunity for the strongest students to prosper or ensure the success of ensure the success of the weaker students. I argue instead that we have an opportunity as teachers of electives, that we can decide on the meaning of “success” or “failure” through assessment. While a failed provincial exam is inarguably a failure, a broken egg can be a learning opportunity, and so can an ineffective propeller. During practicum, student assessment was based mainly on blog posts that students made for each project, with only minimal value placed on how long their parachute stayed aloft or how much lift their propeller could generate. Those blog posts included evaluation and reflection, where students were pushed to learn from their experience regardless of how well the product of their work compared to that of their peers.

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