Final Report

Secondary 3 Science Inquiry Activities

1. Description

The goal was to create Inquiry-based Learning (IBL) activities for two of the four worlds in the Science & Technology C2Y1 program: material and technology. A teacher guide and student material would also be created for each lesson.

It was decided that each inquiry lesson would have three phases:

1) Exploration – where students experience a concept to gain familiarity;
2) Concept Development – students' understanding is examined and further processed and terminology is explored;
3) Application – the concept is practiced and applied in a new way.

One of the challenges we encountered was time, or the lack there of. The days provided to create the lessons was more or less sufficient. However, the time required to create the visual aids for pre-inquiry activities took longer than expected. There were also some modifications that needed to be made to the objects once they were developed.

As for the Technological lesson, when tested, the students needed more time to create their model. They had to come to Recuperation periods outside of classroom hours to complete their project.

Despite these few issues, the students were deeply engaged and were able to demonstrate their acquired knowledge while make connections and inferences.

A third challenge was that the teacher assigned to validate the three activities was unavailable for validation. It would have been beneficial to have a member that did not develop the activities, provide feedback and suggestions on how to improve them.

2. Goal

The first IBL activity developed was for the ***Technological World*** and focused on Motion Transformation Systems.

Exploration activities: The students are paired in teams and fill out *Worksheet 1* whilst exploring the cam/follower and crank/rod/slide models of motion transformation systems by rotating through 7 stations. (Each station has a model that they examine.) Teacher reviews answers with class.

Concept Development: Teacher reviews answers from previous day and elicits answers from students (so that it is student-led) regarding the following points:

Crank and slide

- The larger the crank the further the slider will translate
- The position of the axis on a crank and slide must be off centered for a straight connecting rod to function properly
- The axis on a crank and slide can be centered or off-centered for a bent connecting rod to function properly

Cam and follower

- The shape of the cam and where its axis is located affects the height the follower will translate

Application: Building & testing of Model (Motion Transformation Systems).

The second IBL activity developed was for the *Material World* and focused on Concentration.

Exploration activities: Students explore their understanding of concentration by working in teams of two on a 'Folder Activity'. Each team is given three folders: one for each big idea (i.e. volume, mass, and concentration). The students are handed a sheet of 15 exercises to be worked on in conjunction with the 'Folder Activity'. Answers are corrected as a class. (Picked up and used as diagnostic tool by the teacher.)

Concept Development: Students are introduced to idea of 'solution' and as a class discuss the concept. Basic ideas of concentration are reviewed vis-a-vis a PowerPoint presentation (includes examples of concentration, unit conversions and ppm). Students work through unit conversions ('Concentration Worksheet Units')

Application: Students work through concentration problems and apply in a practical lab i.e. Energy Drink Lab.

The third IBL activity developed was for the *Material World* on Fluids.

In the proposal, a lesson on the Living World had been planned, however when brainstorming for ideas, it was decided that it was more beneficial to create a lesson on *Fluids* instead. The reason for this is that, since there are various systems in the body that are based on the movement of fluids, it was important that students understand the concept of fluids prior to learning about these systems. Students must first understand how fluids move in order to understand how to apply it to each system in the body.

Exploration activities: Students explore their understanding of compressible and incompressible fluids by working in teams of two on the 'Marshmallow Activity'. Each team is given syringes filled with 1) air, 2) water, and 3) marshmallow. The students fill in their hypotheses of what will happen and why in each case. Then fill in their observations.

Teams of two get together and work with another team to decide on their final reasoning re: what happened. Class discussion ensues ensuring the use of proper scientific terminology. PowerPoint of main points is presented and worked through.

Concept Development: Students sit in teams of two / three and must work through one of two examples (water bottles and graduated beakers) to come up with a definition of their specific example using the terms compressible / incompressible fluid.

Application: Students in teams of two or three each receive an identical set of hydraulic models (one with syringe filled with air and one filled with water). Students compare / contrast the movement of their model. Wrap up by teacher. (Show and tell by each of the three different models.)

3. Outcomes

Surveys:

An evaluation survey was created for the participating PDIG members, as well as a survey for the supervisor.

This survey was extremely helpful to us as it is our hope to continue to work on materials not only for our students but those of the English educational community. We hope to work on future PDIGs and wanted to try and avoid pitfalls.

The survey results of last year's PDIG identified differentiation as an issue with the materials developed. Hence, this year we inputted more open-ended scenarios in order to allow for 1) flexibility and 2) greater higher-order thinking on the part of students.

Given that last year's survey results greatly informed our work this year, we felt it was a must to get even more data from teachers vis-à-vis the proposed activities to inform our future work.

Surveys for each world were produced for the teachers who used the IBL lessons. The two teachers that participated in the development of the IBL's had the chance to test two of the inquiry lessons in their own classes. Coincidentally, the other secondary 3 science teachers also tested the first lesson of the Material World. It would have been ideal to test all of the lessons; it was simply impossible due to the aforementioned time constraints.

The surveys allowed us to fine tune the materials that were developed and make certain that our target population (I.e. the education science community) would be able to access and use the materials easily.

It would have been helpful to outsource the surveys so that a non-PDIG member could provide feedback and suggestions.

Validation process:

Unfortunately, due to unforeseen circumstances, we were unable to undergo the validation process.

It would have been helpful to outsource the surveys so that another member who did not develop the lessons could provide feedback and suggestions.

Gains of PDIG

The core members of the team (two teachers, lab technician and consultant) have learned a great deal by participating in this PDIG. The core team members worked well as a team; each bringing different skills to the table.

Previous experience in the development of inquiry activities was very helpful in the creation of new ones. There was more of an ease at implementing inquiry activities as professionals because of previous knowledge of the IBL approach.

In carrying out the lessons in class, we also learned that our students had some difficulty with problem solving. It was at this point that our teaching (i.e. guiding) had to jump into place. We realised that our students' skills in this area were poor. Perhaps we have not provided enough opportunities in the past for them to develop said skills? This was clearly evident during the lesson where the students had to build their own mixture mechanism. They struggled with the pulley-gear not rotating when the rod was rotating and did not know the next steps they might attempt. This trial and error method, crucial in technology design, was severely lacking. Most students are not comfortable with trying something new because they have a fear of failing. This further shows us the importance of developing more of these inquiry activities. Students need to become more comfortable with discovering activities where they do not know the answer. With some help our students were engaged in their learning and enjoyed these IBL lessons.

In department meetings it was also expressed by Secondary 4 teachers that it was their observation that many of the secondary four students who were exposed to inquiry activities last year, were able to better navigate through other critical thinking-based activities compared to students who weren't exposed.

As teachers became more comfortable with allowing the students to create their own notes from their findings, they realized that not only were the students more engaged in these topics (from previous years) but they also seemed to understand the concepts more thoroughly. After seeing the positive results in both the teachers and students, we would like to continue to develop more IBL lessons. As such, we have submitted a new proposal for another PDIG to continue our work.

4. Reinvestment

It is important to us that this work be shared with other teachers. It is our belief that such work is needed not only in our schools, but the system at large. When we analyzed the results of the Technology section of the secondary 4 MEES exam, the need for such work was quite evident. Both at our school and provincially, this section (section C) on the exam has consistently been the weakest, in terms of student success.

In order to work on a proactive solution, we believe working at an earlier grade, to develop a stronger foundation in problem solving and technology design, is necessary. Moving forward, all secondary 3 science teachers at Laurier Macdonald High School will make use of these developed IBL lessons. In addition, the science consultant for EMSB will be promoting the materials and sharing them on the username-password protected portal to which all EMSB science teachers are a part. In addition, we will be applying to LCEEQ to share our work at the next LCEEQ workshop so that we can provide a hands-on experience of the work on a larger scale.

Finally, given that we have seen how IBL lessons enriched students' overall comprehension of the various topics of the Technological World, we would like to continue working on IBL at the secondary 5 level. We would like for our students to further develop their critical thinking skills in the hope that they are better prepared for CEGEP. In this light we have put in a proposal for a 3rd PDIG grant.

We hope to use all we’ve learned through this process to better develop further IBL lessons.