Final Report

Secondary Cycle 2 Science Tools of IBL

1. Description

The goal was to create Inquiry-based Learning (IBL) activities for each of the four worlds in the Science & Technology C2Y1 program: living, material, technology and earth & space. 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. It took longer than expected to develop each lesson and activity. By the end of the third day, we had only completed the Earth & Space and Technology lessons. We realized that it would not be possible to complete four lessons in the amount of time we had left for the grant. The decision was made to produce three complete inquiry lessons and get them validated rather than rush to try to create a fourth inquiry lesson. We decided to forego the development of the Living World lesson as teachers are most comfortable with this world. There is a greater need in the teaching of the Material World. We specifically focused on the characteristics of waves and electromagnetic waves as our students have difficulty with understanding these topics.

A second challenge, related to the above, was the allocation of teacher release days. Although we were 3 teachers who required substitution, we came to realize that each of us played a different role and would require a different number of days. Unfortunately, the constraints of the PDIG application requires that participating teachers be allocated the same number of days. It would have been beneficial if the days allocated to the teacher who validated the lessons were re-distributed to the two teachers who produced the lessons. We believe we would have then be able to complete the Living World lessons as well.

2. Goal

The first IBL activity developed was for the *Earth & Space World* and focused on the geological timeline and fossils.

Exploration activities: Students create a geological timeline with the major events (first appearances of organisms and extinctions.) Students colour coded their timeline to learn that different eras occurred over different lengths of time.

Concept Development: The students and teacher discuss the main divisions of the geological time scale, their order, and the appearance of living organisms and extinctions. Then students sort cards and place them under the correct era.

Application: Students analyze 4 'Core Sample' activities. They determine the order in which the fossil cores formed (oldest to youngest) using reasoning from the activities in the exploration and concept development activities.

The second IBL activity developed was for the *Technology World* and focused on motion transmission mechanisms.

Exploration activities: Students learn the concepts of motion transmission by analyzing a variety of mechanisms and then answering questions for each mechanism.

Concept Development: Students build a motion transmission mechanism mixer. Students apply their knowledge by building a tower using a mechanism from the first day.

Application: Once the students have built their tower with their mechanism, they must modify their mixer. They test it under two different speeds by changing the size of the driver or the driven gear. They perform three trials and take the average of their results. Students also do an analysis of their project.

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

Exploration activities: Students learn about the characteristics of sound and electromagnetic waves. Students manipulate the amplitude, frequency, energy, and wavelength and see how the shape of the wave is affected for each characteristic.

Concept Development: Students manipulate cards to produce an electromagnetic spectrum based on the characteristics of waves, thereby identifying relationships between wavelength, frequency, and energy.

Application: Students answer situational problems by applying the knowledge acquired during the exploration and concept development phases.

3. Outcomes

Surveys:

An evaluation survey was created for the participating PDIG members, including the member who validated the documents.

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. Upon reviewing the survey results, we realised that although the teachers felt the materials were easy to understand and the activities were well laid out, the biggest area of concern was the ability to differentiate said materials. Thus, in future, we would like to provide more suggestions and guidance vis-à-vis activities that can be used for different types of learners.

In addition, 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.

These surveys were important. 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.

Validation process:

A teacher from another EMSB school, who did not work on producing the lessons, spent a day validating the lessons. She liked the activities that we created. She commented that they were easily reproduced in her classroom, could be done with recyclable material, and were great lessons that folded into the practical side of the program. She provided suggestions on how to present the teacher material and instructions so that teachers who had no prior knowledge of our PDIG would have an easier time to implement the lessons. This information was extremely important to us, as we want to make these lessons accessible to any teacher in the educational community at large who would like to try an IBL approach in science.

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.

At the beginning of the project neither teacher had ever led a true inquiry lesson. The hands-on activities that we usually performed with our classes were only done after the teacher explained the content to the students. This is a far cry from the IBL approach which requires teachers to guide students through their exploration of concepts and then apply them. This paradigm shift took some time to get accustomed to as our natural instinct asked that we do the very opposite.

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.

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 use the developed IBL lessons for all three worlds. 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 3 level. It definitely requires more attention and we believe that through IBL activities our students will be better prepared at the secondary 4 level, especially in the technology section. In this light we have put in a proposal for a 2nd PDIG grant. We hope to use all we've learned through this first process to better develop further IBL lessons.