Use of Technology to Enrich and Problem Based Learning in the Sciences

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Abstract

Problem Based Learning (PBL) is an established tool that began at McMaster University in the medical college as a methodology for successful learning (Neuffeld & Barrows, 1974). PBL is a method of learning in which students first encounter a problem, and then go through a student centered inquiry process to solve it. PBL is a very useful framework for creating active learning events in which students can develop their cognitive skills and problem solving strategies (Boud & Feletti, 1997). Currently, PBL is popular and starting to be applied across many disciplines and being applied in many ways. The significance of PBL is that it emphasizes the contextual dimensions of knowledge – meaning is constructed within the physical and social context in which learning is situated. (Brown, Collins and Duguid, 1989). We have attempted to use PBL in the sciences for high school and university levels in a model that can be applied across many subjects by the help of technology. We established a well-defined program; it can result in a strong tool which, through the use of technology will provide peer assessment and feedback, collaboration, excitement and enduring understanding. Our main model involves a three stage problem that has, to date, been used for learning in chemistry and biology. Today, problem based learning (PBL) has become a valuable education tool enabling students to learn and explore while solving a problem. The use of this tool allows for increased student engagement, enduring understanding and most importantly, attention, retention and excitement in the classroom. In addition, technology is a powerful tool, when used in the classroom that extends student imagination and capabilities. In fact, the real challenge is to apply successful PBL. Ideas like trials and tribulations, for technological enrichment shall be presented here.

Keywords – Problem-Based Learning (PBL), wiki, enduring understanding

Figures:

<table>
<tr>
<td>Figure 1 – an Exemplar of a “Biology Busting” poster from Qatar</td>
<td>Figure 2 – an exemplar of a “Chem’myth’try” myth from Canada</td>
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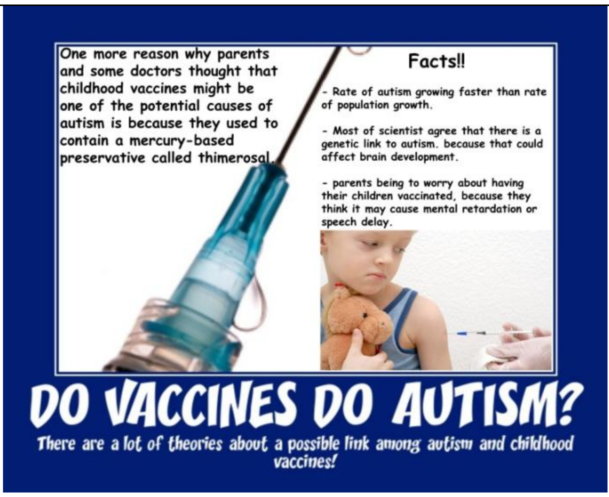

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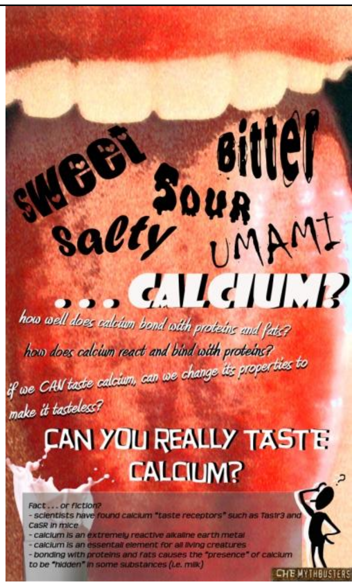

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1.1 - Introduction

Reflecting on one’s education, people tend to remember the major projects they worked on more than little bits of learning, particularly if it no longer relates to the world that surrounds them. As educators, we need to reflect on this, and work with what it is about projects that results in long term retention of knowledge and also the excitement that surrounds the project when they work out well. In terms of education, the problems that we work on can be addressed in classrooms by using Problem Based Learning (PBL) methodology. As scientists, we further thought about not only solving problems, but what intrigues people to the sciences. Science is about questioning the world around us, but what seems particularly interesting to people seems to be discussing whether myths and “old wives tales” are actually true.

Based on a play on the popular Discovery™ series, “Myth Busters™”, we created a project for students to do something similar in chemistry and biology which we termed “Chem’Myth’try Busting” or “Biology Busting”. The project involved three major stages. The three stages involved creative discovery and expression of a myth, then research on someone else’s myth and finally a debate to determine if the myth is in fact “Busted”, “Plausible” or “Confirmed” as a spin-off from the Myth Busters show.

1.2 Background

The set up and research for this project was performed in two continents, with two very different cultures. The project began in collaboration with the University of Toronto – OISE, with the research group of Professor Jim Slotta and in direct collaboration with Dr. Cheryl Madeira. While this project was being researched, Dr. Madeira regularly met with other instructors that shared and brainstormed ideas on using technology in incorporating technology. This particularly project was tried at the University of Toronto Schools, which is a highly academic institution for gifted students in Toronto, Canada. After this initial study, this work was presented in collaboration at the Science Teacher's Association of Ontario (STAO) conference in the fall of 2010.

The work was continued in the fall of 2010 until the present at the University of Calgary-Qatar in Doha, Qatar. The students involved in the study are Foundation program students heading for the nursing program, with diverse cultural backgrounds but generally only adequate levels of English. This continued study was then presented at the IICE conference in Ireland in October, 2011 and at the NASPA Gulf conference in Doha in February, 2012. The study is on-going with attempts to make it easily applicable and user friendly in various fields of study.

1.3- How the project is set up

1.3.1 - Stage 1

The various stages highlight different aspects of learning. The first stage is individual work that drives student interest in the project. The second stage requires research skill and collaborative work. The final product also requires collaborative work, advanced application of knowledge and group learning. What is common through all stages is the open-ended problem created for the students and the use of technology as a key tool.

Instead of being given a problem, this process allows students to create their own problem to solve. The first stage involved students finding myths of their choice and expressing the concept of the myth by creating a newspaper article, a video or a poster. They had to find a common myth they had heard or researched in chemistry/biology and present the idea without solving the myth. This can have clear connections to material being learned in the course with scaffolding from the instructor to set the pace for students. Students work independently, and they are individually graded at this stage

The use of technology comes not only in the presentation of the myth, but also in the presentation itself. The whole thing is done on a wiki, where work is shared. Once a myth is used, other students can either be instructed to find a different (contradicting?) myth, or give a feedback by performing the detective work in order to know if something is being plagiarized. They choose topics of real interest that bring the connection of the subject matter to real life. This project was first executed in Canada, where some examples that students chose were “Does eating turkey really make you tired”, “Can the ingredients of lipstick cause cancer”. “Do contaminants in plastic really leak into the water in water bottles” and “Can you really taste Calcium?” (Figure 2). The Biology busting was executed in Qatar, and the topics were sometimes similar such as “Does reading by candle light really destroy your eyes?”. “Do Vaccines cause Autism?” (Figure 1) And more cultural (in Qatar) “Is praying the Fajr prayer (dawn or Morning Prayer) more physically healthy compared to other times of the day?” This stage really sets the curiosity and excitement for the project and also guarantees that the topics being chosen are exciting and relevant to the student. Because they post it on the wiki, the instructor, in addition to peers, can give on-going feedback.

Overall, this stage can be applied for any subject as an innovative project with peer assessment in ANY discipline, or catered to be done for more specific disciplines; combines artistic and creative skills and also really encourages understanding of how knowledge is applied to real world.

1.3.2 - Stage 2

At the second stage, the myths are then reduced in number by selecting what the instructor chooses as valuable or educationally strong Myths, and separated into Myths – arguments, for and against. For example, if there are eight myths, there will be sixteen cards to draw, with the myth appearing in both the positive and negative form. The students will not choose from the myth that they worked on in Stage 1. From a hat, they draw the myths. Some will choose the positive and some will choose the negative. In a wiki forum, they post their research from reputable papers arguing *for* the myth, and a different group or person will argue *against* the myth. By the end, on the wiki page, the eight myths are posted with students posting their "for" and "against" arguments in different areas with their references. Students are also asked to give feedback to each other on the wiki forum, which is another form of peer evaluation.

By doing the research at this stage, students are forced to work collaboratively and look more deeply into the myth and the science behind it. Students use and apply their research skills, the ability to critically analyze and understand the topic and scientific publishing and the thought process that goes into scientific understanding. This also draws out a lot of critical thinking because students can easily observe that valid journal articles seem to be proving opposing hypotheses. Once again, the use of the wiki allows everyone to see each other’s work, including the opposing argument groups. What has been found is that this only enhances the strength of the arguments on both sides because of this peer assessment. The opposing arguments are a nice set up for the final stage, which is an actual debate.

1.3.3 - Stage 3

In the third stage a formal debate is set with the "*for*" and "*against*" groups going against each other to present their cases on the myth. Once again there is an opportunity for technological enhancement at this stage. Pictures, videos or references to articles can be presented by groups at this stage. Following the presentation, students vote, using clickers, for the myth to reach a consensus on whether they are convinced the myth is Busted, Plausible or Confirmed. This is immediate feedback and also forces complete class engagement because everyone is involved with the process at each step of the way.

1.4 - Benefits and Problems of the Project

The project involved peer evaluation, peer collaboration, individual work, critical thinking and problem solving, use of wiki, online collaboration, technological projects, and research. They also had a good understanding the science involved with the myth not by learning in the classroom, but by problem solving. The benefits of PBL appear to be drawn out by what this project highlights. We believe this project can be applied to many different types of subject matter, including geography, history, and even math.

The project appeared to stir equal amount of excitement in the two nations where the study was performed, with the varying levels of English and knowledge base. What seems to be the biggest benefit of the project is that students solve problems that they themselves created, and thus there is no doubt they are topics of interest.

Focusing on subjects related to the subject of focus requires on-going creativity from the instructor. For example, as opposed to simply learning about chemical equilibrium, if this was being approached in this problem-based projects, related topics would need to be given to students or scaffolding to lead students to these types of topics.

To plan the project does, however, take a great deal of work, but once it is in place it becomes more systematic. As in any open-ended project, at an early stage if a student goes in a wrong direction, it is very easy for them to get lost and lose interest in the project. For that reason, instructors are required to check on the flow of work appearing on the wiki and give feedback. Making this accessible to students also, however, decreases work for the instructor and also increases peer collaboration. If, however, a random group appeared not to be driven or uninspired, this must be monitored by the instructor. To date this has not happened in the studies in both Canada and Qatar.

1.5 - Final Reflections and Continued Work on this project

This project was designed upon recognizing that students particularly remember projects in their education, more than anything else like regular course work or concepts learnt, to seek enduring understanding. The project showed great success, with student engagement, the knowledge that was introduced and many aspects of critical thinking.

Continued work is being done to make this easily applicable for instructors to use and across varying disciplines.

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