Getting to know our neighbors: the Oral Microbes

Action Proposal

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Abstract

Course schedule and mandatory standardized testing has created huge time constraint in the classroom, which has altered how science is taught in most classrooms. Even though inquiry-based learning has been shown to increase student motivation for learning science and improve attitude in science classes, the two factors mentioned earlier has prevented its implementation in most classrooms as teachers race to prepare their students for mandatory tests. My action proposal is to investigate how the inclusion of inquiry-based activities in the cell biology, genetics and biotechnology sections of my IB biology classes will influence my students' motivation and their performance on the individual scientific investigation component of the IB biology course. The effect of these interventions will be assessed using personal meaning mapping, and reflection and survey questionnaire.

Rationale

Incorporating active learning and inquiry-based learning activities in biology courses has been shown to increase motivation, improve attitude and performance (Madhuri and Broussard, 2008), Armbruster et al., 2009), Freeman et al., 2007). Although these studies were based on college-level biology courses, the findings should be applicable to college-level biology taught in high school like IB Biology. The active learning activities include group activities, discussions, clicker and inquiry-based activities. Inquiry-based science has been shown to increase student motivation and attitude towards science in high school (Wang et al., 2015). American Association for the Advancement of Science (AAAS) in its Benchmarks recommended that for students to develop science literacy, the teaching of the nature of science should include the knowledge of scientific inquiry, which is described as scientific investigations that allow students to explore different concepts associated with their content materials. Scientific inquiry-based learning would not only improve motivation in science classes but would help student develop science literacy that is essential for an informed citizenry.

I have been teaching standard level IB biology for two years. The IB Biology course had a curriculum and schedule change from being a two-year course to one-year with a new individual scientific investigation (open inquiry) component added, which is 20% of the final IB biology grade. These changes made the course very fast paced with limited active learning. With the time limitation, students were unable to reach the proficiency level to design and complete an open inquiry investigation. Open inquiry activities that are not preceded by adequate practice to create strong foundational knowledge has been shown to be less effective in helping student gain mastery of content knowledge (Kirschner , et al., 2006). While the overall course pass rate was

relative high in both years (89% and 76%, respectively), the pass rate on the individual scientific investigation was very low with the students exhibiting frustration, some anxiety and lowered motivation. After evaluating the feedback from teachers and students, the school administration changed the course schedule back to a two-year track. This change will eliminate the time constraint of the past two years, and most importantly, provide the opportunity for more active and inquiry-based learning which will help the students acquire the science skills for completing the individual scientific investigation. Secondly, it will hopefully remove the frustration and anxiety of the students over the completion of the individual scientific investigation and increase their motivation for mastering important biological concepts and science skills.

Incorporating inquiry-based learning in my regular biology classes should also have a positive effect on student motivation and achievement. My regular biology students are lower performing and struggling readers compared to the IB biology students with less motivation and commitment to mastering the concepts. The regular biology classes have an end of course (EOC) exam at the end of the school year, which is based on a plethora of standards that places time constraints on implementing more student-centered learning activities. Understanding the nature of science is a significant component of the EOC exam that students struggle to comprehend. Implementing more inquiry-based learning activities will enable my students to practice how science is actually done, understand the process that scientists use in their studies to eventually formulate the content knowledge being taught in the class.

My action proposal is to determine the effect of incorporating inquiry-based activities into my IB and regular Biology on student motivation, attitude and performance. My hypothesis is that these activities will increase student motivation, improve their attitude in class and performance on assessments, as students are able to engage more with the materials as active learners.

Intervention

Inquiry-based activities based on oral microorganisms will be implemented through the school year (see Table 1). Through these activities, students will learning how to use micropipettes, culture microorganisms on nutrient media and identify morphology of different colonies, and prepare wet mount and use microscope. Students enjoy learning about relatable issues like their oral microorganisms. This intervention will allow the introduction of an inquiry-based study of microorganisms into my cell biology curriculum, which was based mainly on lab sessions on plant and animal cells. This study of microorganisms will be a common thread in the curriculum that will be linked into topics in genetics and biotechnology. Although genetics and

biotechnology make up a significant proportion of the curriculum with cutting edge information, I have had no opportunity to introduce my students to important lab skills like using micropipettes, gel electrophoresis, polymerase chain reaction and using DNA sequences generated from students' samples for bioinformatics analyses. Having lab sessions using these techniques will not only make these concepts easier to master but will also make my students relate better to biotechnological information that they come across. Most importantly, these structured and guided inquiry-based activities will enable my students to formulate related research questions that they can investigate to meet the individual scientific investigation requirement of IB biology.

Table 1: Inquiry-Based Activities for 2017/2018 School year IB, AP and Regular Biology Classes

Topic	**Inquiry-based activity**	**Schedule/Course** IB Biology (11th grade) Regular Biology (10th grade)
Biochemistry	Learn pipetting	Fall 2017/IB and Regular Biology
Cell Biology	Culturing oral bacteria on agar plates	Fall 2017/IB and Regular Biology
	Describing morphology of bacterial colonies	Fall 2017/IB and Regular Biology
	Microscopic observation of bacteria colonies	Fall 2017/IB and Regular Biology
Genetics	DNA Extraction from bacteria colony cells	Fall-Spring 2017-18/IB Biology
	DNA amplification using PCR	Fall-Spring 2017-18/IB Biology
	Observation of PCR DNA products with gel electrophoresis and cleaning up PCR product	Fall-Spring 2017-18/IB Biology
	Sequencing oral bacteria DNA	Fall-Spring 2017-18/IB Biology
	Identification of oral bacteria using BLAST	Fall-Spring 2017-18/IB Biology

Data Collection and Analysis

The effectiveness of these interventions will be assessed using personal meaning mapping, reflections and survey questionnaire, performance on the individual scientific investigation component of IB Biology. Implementation of these inquiry-based activities should enable students to be more engaged in the learning process, which should improve their motivation and attitude. With the exposure to new lab techniques and guidance during these guided inquiry-based activities, my IB students should experience less anxiety and frustration completing the open inquiry of the individual scientific investigation.

Words and phrases for Personal Meaning Mapping: Cells, Microorganisms, DNA, DNA technology, Bioinformatics/BLAST
Reflection and survey questionnaire: Attached

Connections to CATALySES summer institute

The oral microorganisms-based inquiry activities are based on the "A Mouthful of Microbes" lab sessions offered during the 2017 CATALySES summer institute. This was a lab protocol that was modified from Strain and Vang (2014). The reuseable equipment required for completing these lab sessions will be obtained on loan from CPET. I would also like to invite CPET staff to assist with the set up of some of these lab sessions.

Literature cited

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