

## CATALySES Action Research Proposal 2018

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A Study Investigating the Effect of Hands-on Biotechnology Activities and Technology-based Emerging Pathogens Activities on Student Mastery of the Pathology/Immunology Unit in a Regular Level Biology Course

### **Abstract:**

Regular level Biology students are expected to demonstrate mastery of bacteriology, virology, and immunology state standards on the Biology End-of-Course (EOC) exam. As with any course that is preparing students for high-stakes assessments, the curriculum should be continuously examined and modified in order to encourage positive student learning outcomes and improve student performance on the EOC exam. This action research will investigate the effect of hands-on biotechnology activities and technology-based emerging pathogens activities on student mastery of state standards for a regular level biology course. The efficacy of the research will be measured by state standard-based comprehension pre-assessments and post-assessments, and student familiarity with pipetting and biotechnology skills will be measured with a self-reporting survey.

### **Rationale:**

“As a result of the rapid development of the information and communication technology, the use of computers in education has become inevitable.” (Serin, 2011) Technology in the classroom is a powerful tool, and can have a profound effect on both student engagement and achievement. But like any tool, it is vital to use it appropriately, and to optimize the positive effect that it has on learning.

All Biology students are assessed by a high-stakes Biology End-of-Course (EOC) exam, but examination of these schools at the district or even school-level reveals a clear achievement gap. Students in a regular level Biology course often find themselves at a disadvantage when compared to their Honors level or AP level peers; they are more likely to face challenges presented by factors such as learning disabilities, socioeconomic status, community safety, and parent involvement. (Christenson, 1992) Evidence has shown the impact that individual teachers can have on student achievement (Rockoff, 2004), but how can teachers best close this gap? Computer-Based Instruction (CBI) “...is more effective on less successful children. The reason for this is that the computer-based instruction enables the children to progress at their own pace and provides them with appropriate alternative ways of learning by individualizing the learning process.” (Serin, 2011)

Traditional instructional strategies can also present a challenge to students according to their individual learning styles. Evidence suggests “...that the majority of our high school students are Tactile/Kinesthetic and Global learners.” (Snyder, 2000) Ironically, these learning styles are best served by hands-on and inquiry-based laboratory activities, though regular level students are less likely to be offered as many of these opportunities than their Honors level or AP level peers due to classroom management or behavioral issues during these types of activities.

With those considerations in mind, the planned intervention for this study will include traditional instruction, supplemented with both hands-on biotechnology activities and technology-based emerging pathogens activities. The expected impact of this intervention is a statistically significant difference in student performance between the control group receiving traditional instruction, and the experimental group receiving traditional instruction as well as hands-on and technology-based activities.

### **Intervention:**

The control group of students will receive the “traditional instruction” for the Pathology/Immunology unit, which follows last year’s curriculum and consists of guided PowerPoint notes, as well as three laboratory activities (i.e. “the Virus Lab”, “the Wild Bacteria Lab”, and “the Flu Outbreak Game”). The experimental group of students will receive the “traditional instruction”, as well as “Pipetting by Design”, followed by the Web-based Inquiry Science Environment (WISE) platform version of “The Dengue Dilemma”, and finally the hands-on version of the student ELISA procedure from “The Dengue Dilemma” (though this time it will be “tailored” to pair with “The Virus Lab” from earlier in the unit and the students will believe that they are testing for the presence of HIV).

The students are anticipated to be regular level Biology students, and a significant percentage of the students may have IEPs or 504 plans, and/or be enrolled in a Reading course or a Learning Strategies course. If possible, the groups will be as follows: a control group will be randomly chosen from the class periods before lunch, and another control group will be randomly chosen from the class periods after lunch; an experimental group will be randomly chosen from the class periods before lunch, and another experimental group will be chosen from the class periods after lunch. If only two class periods of regular Biology are available during the upcoming school year, one will be randomly chosen as the control group, and the other will be the experimental group.

The Pathology/Immunology unit will be taught in the 2<sup>nd</sup> Semester, during the 3<sup>rd</sup> Quarter of the school year. The “Pipetting by Design” activity is a hands-on laboratory activity that will allow the students to familiarize themselves with basic micropipetting skills, and will provide an opportunity to have a class discussion about biotechnology careers. “The Dengue Dilemma” activity is a technology-based inquiry activity that will allow the students to explore topics such as emerging pathogens in Florida, basic medical testing, epidemiology, the Central Dogma of Biology, ELISA assays, PCR and gel electrophoresis, and immunology. This activity will be adjusted to suit the reading level and needs of regular level Biology students. The student ELISA procedure is a hands-on laboratory activity that will help the students review and reinforce their understanding of the ELISA assay and pipetting skills, and will also help them review the concepts from “The Virus Lab” (such as asymptomatic infections and the importance of HIV testing and safe sex practices).

### **Data collection and analysis:**

Quantitative Analysis: A multiple-choice assessment will be given as a pre-assessment at the beginning of the Pathology/Immunology unit, and then again at the end of the unit as a post-assessment. In order to control for variations in student ability between class periods, the pre-assessment data will be compared between all classes using ANCOVA (analysis of covariance). This will evaluate whether the means of the dependent variable are equal across all class periods (i.e. whether all of the students are beginning the unit with similar background knowledge; or, in other words, whether there is a “level playing field” amongst classes). The pre-

assessment and post-assessment scores for each student will be compared using a paired samples t-test to determine whether the students displayed statistically significant learning gains.

**Qualitative Analysis:** Students will also participate in self-reporting Likert scale questionnaires in order to gauge their engagement/enjoyment of the intervention activities, familiarity with the laboratory techniques that they have practiced, whether they felt that the intervention was valuable for their learning process, etc.

**Summative Assessment:** Ultimately, all students will also be required to demonstrate mastery of the state standards on the Biology EOC exam. While the intervention will only directly affect one unit, the concepts introduced or reviewed in that unit (e.g. natural selection, the Central Dogma of Biology, etc.) may have an effect on the final scores of the students, and should be examined as well.

**Connections to CATALySES summer institute:**

During the CATALySES summer institute, teachers were introduced to relevant emerging pathogens in Florida, such as dengue virus, and participated in laboratory activities that demonstrated how epidemiologists and medical professionals identify infected individuals, determine appropriate treatments or further testing, and prevent the further spread of disease. This action research proposal will directly incorporate several laboratory activities (“Pipetting by Design”, “The Dengue Dilemma”) that were modeled during the summer institute, as well as information regarding emerging pathogens that will be added to instruction in the Pathology/Immunology unit.

**Literature cited:**

1. Serin, O. (2011). The Effects of the Computer-Based Instruction on the Achievement and Problem Solving Skills of the Science and Technology Students. *The Turkish Online Journal of Educational Technology*, 10(1).
2. Christenson, S. L., Rounds, T., & Gorney, D. (1992). Family factors and student achievement: An avenue to increase students’ success. *School Psychology Quarterly*, 7(3), 178-206. doi:10.1037/h0088259
3. Rockoff, J. E. (2004). The Impact of Individual Teachers on Student Achievement: Evidence from Panel Data. *American Economic Review*, 94(2), 247-252. doi:10.1257/0002828041302244
4. Snyder, R. F. (2000). The Relationship between Learning Styles/Multiple Intelligences and Academic Achievement of High School Students. *The High School Journal*, 83(2), 11-20.
5. Christensen, R., & Knezek, G. (2001). Instruments for Assessing the Impact of Technology in Education. *Computers in the Schools*, 18(2-3), 5-25. doi:10.1300/j025v18n02\_02
6. *The Dengue Dilemma*, Julie Bokor, Houda Darwiche, Drew Joseph, Mary Jo Koroly

**Permissions:**

Permission to use a laptop cart for the technology aspect of the action research project will be obtained from the Buchholz High School assistant principal of curriculum and the Buchholz High School site tech. No direct permission will be needed from the principal or parents.