

A Study of the Impact of Biotechnology Lessons on
Student Learning in Anatomy and Physiology
By Comparing Two Assessment Strategies

Joanie Martir

Anatomy & Physiology Honors Teacher

Harmony High School

School District of Osceola County

MartirJo@osceola.k12.fl.us

Abstract

My action research will test the validity of a popular Marzano teaching technique referred to as “Four Fingers”, which is widely used to assess student comprehension in the classroom during two biotechnology lessons. The traditional and standardized way of testing student learning gains is through pen-and-paper assessments, such as the FCAT. In Marzano’s model, students can self-assess their newly gained knowledge by holding up fingers corresponding to how well they understand the material. Is this self-reporting method an effective indication of biotechnology knowledge learned in the classroom when compared to paper-and-pencil testing? To find out, I plan on conducting lessons on a completely novel topic to high school students on biotechnology using resources provided by University of Florida. After each lesson, the students’ self-reported knowledge will be recorded and will be compared to results from four multiple-choice questions related to that day’s lesson.

Keywords: biotechnology, four fingers, self-reporting

A Study of the Impact of Biotechnology Lessons on
Student Learning in Anatomy and Physiology
By Comparing Two Assessment Strategies

Rationale

I continue to be shocked at how much emphasis is placed on data from Standardized Tests in the Public School System, specifically FCAT Test results. One of the main purposes of the FCAT is to determine prospective high school graduates' mastery of the state curriculum (Center of Education Policy, 2010). Student results create data that controls everything from the creation of student class schedules to what needs to be taught in the classroom within a given amount of time, which, in turn, may build limitations to teacher effectiveness and, in many ways, student growth. In order to increase scores on Standardized Tests, the State has adopted new learning strategies created by Marzano. To illustrate many of these strategies within the classroom, there are videos available of exemplary and/or “innovative” teachers in the classroom (www.iobservation.com/Marzano-Suite/Library/). One of the most popular techniques presented in the videos is called the “Chunking Content into Digestible Bites” where the “Four Finger” self-assessment is presented, which is now a required addition to daily instruction in many classrooms throughout the state of Florida. This technique is referred to in the elementary school setting as the “Fist to Five”. “The Fist-to-Five strategy is a strategy that can be used daily to quickly assess your student’s level of understanding” (Johnson, 2011). In this technique, students self-report on the amount of learning and understanding attained at the end of each lesson. In a nearly identical strategy using four fingers instead of five, students place one of their hands in front of themselves and hold up zero to four fingers. The scale is as follows: holding up no

fingers represents no understanding at all, while four fingers represent mastery of the topic at hand. Students are given the opportunity to self-assess their knowledge and honestly present their knowledge to their teacher in a more private way so that the teacher can examine the impact of the lesson given. My question then becomes: How does the amount of fingers held up compare to a pencil-and-paper assessment? When students are administered the Math FCAT, the students are not asked to hold up fingers of how well they understand math. Can students who claim to have a four-finger-mastery of a topic truly demonstrate that same level of understanding by achieving a perfect or nearly perfect score on a written test?

Biotechnology lessons on microarrays and viruses will be presented to the students as a springboard to compare the two strategies. The reason biotechnology lessons will be used is because hands-on biotechnology is something the students have not been exposed to as it “is non-existent in mainstream biology coursework” (Micklos et al., 1998). I will be using a hands-on approach within these lessons, as a recent study has shown that four out of five participants reported they learned the most during authentic inquiry laboratory experience (Hanegan & Bigler, 2009). The purpose of this study is to evaluate the effectiveness of biotechnology lessons by comparing student learning gains through a self-reporting Marzano strategy and standard pen-and-paper tests, where the validity of the Marzano technique will be put to the test.

Action Research Intervention

In order to answer these questions on the validity of the Marzano technique in question, I will collect data at the end of each lesson, as described in the Data Collection and Analysis section, during the biotechnology topics taught in class. I will teach two biotechnology lessons within the Immune System Unit in my Anatomy & Physiology Honors class. The two

biotechnology lessons taught will consist of firstly using Microarrays and then using the Viral Quest two-week lesson plan on emerging pathogens. The Microarray lesson plan will take place over the course of a week and begin with a review of DNA and gene expression. Then students will be introduced to microarrays with a Power Point Presentation provided by CPET. Students will then be taken into a computer lab where they will individually access a website with a microarray tutorial and complete a microarray animated virtual lab (<http://learn.genetics.utah.edu/content/labs/microarray/>). An in-class discussion will be held on the pros and potential cons of this technology, and students will write a paper on whether or not they would want a full microarray analysis done on themselves. Then, using the Microarray locker provided by CPET, the students will have the opportunity to perform a simulated microarray in the laboratory and will analyze the results. The second biotechnology lesson plan will take two weeks to complete and is provided by Viral Quest. Students will be introduced to the topic of virology and emerging pathogens with a mock newspaper article about a patient who died of an unknown disease that is thought to be sexually transmitted. From there, a research assignment on viruses will be assigned. Students will have to look up facts on HIV and HPV and compare the two to the new virus. Students will then be given a Viral Whodunit Assignment where they will use facts and evidence from a crime scene investigation to try and figure out who the murderer is. For the next few days, students will be conducting experiments in the lab similar to a crime scene investigator. They will complete a lab on DNA extraction using strawberry DNA. Students will learn about PCR and how to analyze PCR graphs as well. This combination of activities will lead to uncovering the truth behind the unknown virus, using a real world scenario to drive learning. Biotechnology techniques will be applied in the form of hands on laboratory activities to identify the virus.

At the end of each day, for the three weeks of the above mentioned biotechnology lessons, students will be asked to self-report the knowledge gained each day with a show of zero to four fingers, followed by answering four questions on the topic covered that day. This information will be collected and recorded daily on an Excel spreadsheet. There will be approximately 160 students participating in the study. All participating students are in Anatomy & Physiology Honors. These students are all in eleventh and twelfth grade.

Connections to Bench to Bedside Summer Institute

In the past, I have not covered the Immune System in Anatomy & Physiology because of time constraints and lack of resources, including relevant laboratory and hands-on activities. By attending the two-week University of Florida's Bench to Bedside Program provided by CPET in July 2012, I was exposed to many new biomedical topics, including many medical advances with the use of viruses and many biotechnology techniques used or being developed to diagnose diseases. I was provided with a full curriculum on the function and applicable use of microarrays as a diagnostic tool for diseases that affect gene expression. I was also presented with a full curriculum on an emerging pathogens using Viral Quest. I will be able to use both of these sets of lesson plans over a course of three weeks while covering the Immune System Unit.

Data Collection and Analysis

- a) Fingers vs Questions Test
 - i) At the end of each lesson, I will have students hold up the number of fingers according to their self-reported knowledge gained in accordance to the Marzano strategy presented on the innovative video.

- ii) I will have the students write down the number of fingers they held up next to their name on the upper right corner of their exit-paper.
 - iii) Then, I will place a transparency with 4 multiple choice questions which will be counted as a daily quiz for the unit. Each question will reflect a level of difficulty on the Bloom's Taxonomy Scale. They will answer all four of the questions on their paper.
 - iv) To account for variables such as levels of student participation and motivational biases, I will make the four question exit slip count as a ten-point daily quiz:
 - (1) One point for their name at the top of the paper.
 - (2) One point for their four-finger number.
 - (3) Up to four points for actually answering the question (not leaving it blank).
 - (4) Up to four points on the accuracy of the answer (1 point if correct, no points if incorrect).
 - v) Students will turn in their paper to me on their way out each day.
 - vi) I will grade their work daily and keep a spreadsheet of their quiz score including only grading category (4), the accuracy of their answers to the pen-and-paper test questions. I will also keep track of their self-reported finger score.
 - vii) I will run statistical tests, specifically a Chi-Square, to compare the two after converting the finger scores into percentages of knowledge learned. Zero fingers will be a 0%, one finger = 25%, two fingers = 50%, three fingers = 75%, and four fingers = 100%. Besides the Chi-Square Test, I will present the raw data compared side-by-side on a bar graph generated in MS Excel.
- b) Grade Improvement Test

- i) I will keep track of overall category 4 grade improvement scores by tracking class averages over time.
 - ii) This data, showing the change in class averages over time on both strategies, will be presented on a MS Excel generated line graphs, one per biotechnology topic.
- c) Teacher Observations
- i) I will keep track of several students a day reporting the same number of fingers held up in comparison to the number they write down on their daily quiz.
 - ii) I will keep notes in a composition notebook about student engagement in comparison to low or high self-reports of learning.
- d) Student Questionnaire
- i) Students will be surveyed using surveymonkey.com on their views on the accuracy of their personal self-reporting using the Marzano technique and how the number reflected their actual test scores. I will also look at their attitudes and interests regarding the two biotechnology lessons and the value of the knowledge gained from those lessons.
 - ii) The survey will also include an open-ended question to allow for multiple student responses and, perhaps, other suggestions for self-reporting. This will include their attitudes about the self-reporting strategy and its effectiveness in the classroom.
 - iii) I will analyze the above mentioned survey answers by entering totals from each option on the likert scale into a spreadsheet that will permit for easy data manipulation to calculate the means of each answer option. I will read the answers to the open-ended questions and tally the responses into three or four general categories, depending on the range of answers provided.

Budget and Budget Justification

Both Viral Quest and the Microarray Curriculum have materials provided free of charge by CPET at University of Florida. The necessary photocopies of instructions, handouts, and worksheets will be made free of charge and within my copy-limit at Harmony High School. I will pay for any miscellaneous laboratory materials required with my \$200 CPET mini-grant money.

Permissions

I will be informing my Principal, Buddy Butler, about my Action Research before implementing the intervention in my classroom. I plan on debriefing my students after data collection is completed and sharing the results of the data with them.

References

Florida Evaluation System [video file] Retrieved from: [www.iObservation.com/ Marzano-Suite/Library/](http://www.iObservation.com/Marzano-Suite/Library/)

FL State Profile. Florida: Florida Comprehensive Assessment Test[R] (FCAT). (2010) Center on Education Policy, 9.

Hanegan, N. L., Bigler, A. (2009) Infusing Authentic Inquiry into Biotechnology. *Journal of Science Education and Technology*, 18, 393-401.

Johnson, K. (2011) *RTI Strategies That Work in the K-2 Classroom*. Larchmont, NY: Eye on Education.

Micklos, D., Cumella–Korabik, J., Kruper J., Christensen M. (1998) *Biotechnology labs in American High Schools*. Cold Spring Harbor: National Science Foundation.