

**Title:** Enhancing the learning achievement and attitude of biotechnology for the student with the aid of virtual gaming.

**Contact information:**

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Abstract:

Teachers find many roadblocks throughout their careers that limit the learning for the student. Those areas include a shift from student-centered to teacher-centered as a 'comfort zone' subconsciously moved by the teacher as the generation gap widens, not to mention the rapidly changing field of biotechnology as well as the inadequately supplied classrooms with even the basic biotechnology equipment. Many researchers have found that the area of virtual gaming can overcome those roadblocks. The virtual gaming also brings in the student's imagination and interested. We have to enter their world. If done successfully, not only will the students gain ownership of their learning but will gain knowledge in the science of biotechnology that has immeasurable impact on the overall health and well being of society. This study not only analyzed the attitudinal and knowledge impact of biotechnology virtual gaming but sought to find out if simple pre-activities that gave students the opportunities to handle the equipment used in the lab techniques aided in their knowledge and/or attitude change. ***(will need to add information about results once the action plan as ended.)***

Rationale:

Many adults can contest that we are not adapting as fast to the changing social/academic technology as it is changing in the world. Kids have a much better handle on that change in addition to spending countless hours on the computer practicing those skills. As soon as I feel confident on how to use my iTouch, how to upload videos to various websites, my satisfaction of accomplishment is quickly diminished and skills are obsolete. To further lower the confidence level, the strategies familiar by most teachers to learn and study are viewed by many of the students as archaic. By reaching the students through their medium it is my hope the students will gain in their education while exposing them to the world of biotechnology. I wholeheartedly believe to be an effective teacher I must be able to adapt to reach my students and to do so in the area of biotechnology is not an exception. This may take me out of my comfort zone but I am up for the challenge.

Many studies have been conducted and many articles written that outline the challenges and benefits of teaching biotechnology as well as the potential of incorporating virtual gaming into one's curriculum.

During the high school years students are exposed to a variety of knowledge including the field of biotechnology. Dawson (2007) found through those years students increased their knowledge and understanding of the examples within biotechnology. In fact, not only did their knowledge increased but their attitude as well. The change greatly influenced their desire to learn more. This desire and subsequently the further learning will allow students to choose fields in this 'cutting-edge' arena of science (Dawson, 2007). As a teacher I must capture those moments of desire to enhance their learning.

To merge the desire to learn about biotechnology, what are some ways to spark the interest in the learning process for the student? As stated by Shaffer, Squire, Halverson, & Gee (2005), the world is controlled today by computers and computer games in the classroom will not only bring in a popular past time for teenagers but also can improve learning. Video games can create new worlds, "worlds that help us learn by integrating thinking, social interaction, and technology..." (Shaffer et al., 2005; p. 105). It is clear in the article that such games should neither be a substitute for the entire learning process nor be used in antisocial ways. The most popular games do include massive amounts of violence and illegal behavior. Simply this medium of the virtual world can allow for real world applications. Instead of just learning terms and definitions students can use the terms through a virtual experience. "... games integrate knowing and doing" (Shaffer et al., 2005; p. 107). The article continues by stating examples where students will engage into scenarios that have real world applications such as a 14-year running against others for a political position in a faction within gaming system. She learned about the realities of politics such as voter fraud, back alley politics, and deception. However, for this learning style to be affective, teachers have got to be comfortable in delivering this method. With most not comfortable, the preventative elements for this process to continue is lack of schools seeing the potential of gaming, how it can shape the learning process, and how to incorporate learning into the current curriculum. "Video games have the potential to change the landscape of education as we know it" (Shaffer et al., 2005; p. 111). For this change to occur, technical, professional, and emotional support must be given to the teachers. We are asking them to move out of their comfort zone into an area of the unknown. By providing professional development and the supplies needed, majority of the teachers will use the virtual gaming as a teaching tool. We are here for our students AND we want to make a difference.

Garris, Ahlers, and Driskell concur with the idea of interactive technologies providing a learning environment for the student (2002). With the teaching style of a

traditional instruction transitioning to a learner center model with a focus on the active learner, many educators (teachers, administrators, etc) are taking notice of this new learning environment. "Some empirical evidence exists that games can be effective tools for enhancing learning and understanding of complex subject matter" (Garris, Ahlers, and Driskell, 2002; p. 442). They continue to state that a focal point needs to remain on generating quality virtual gaming. There needs to be a balance between the format presented, the quality of instruction delivered, and the engagement of the student. Youth are drawn into the gaming world because of the fantasy, established rules/goals, the sensory stimuli, the challenge, the mystery, and the control (Garris, Ahlers, and Driskell, 2002). Mixed with the state standards, the Mission Biotech virtual gaming I am using will also address the cognitive learning outcomes Garris, Ahlers, and Driskell state are necessary for growth:

Declarative knowledge – reproduction or recognition of some item of information

Procedural knowledge – how a task is performed which requires skills learned

Strategic knowledge – applied principles or development of new principles for a situation (2002; p. 456)

After the virtual gaming, opportunities for real world applications need to occur to complete the learning process. In one study preceding the gaming, the students were presented with a problem. "Many of the students were able to find the solution and make the necessary transfer of learning – but only when give [a] hint....." (Garris, Ahlers, and Driskell, 2002; p. 460). This is a concern for me, however, I hope by having mini-activities prior to the gaming the students will be able to make the connections more quickly. I have no doubt that the maturity level of the student is a hindering fact in this process. This is why I am addressing a class that contains junior and senior students. Nevertheless, "to achieve self-directed, self-motivated learners, we must provide support for knowledge construction" (Garris, Ahlers, and Driskell, 2002; p. 460).

In conclusion, students must develop a deeper understanding of the changing world around them. Virtual gaming will allow students to move from the traditional form of singular learning to a small community setting where they will be able to interact with other learners. Engaged learning enhances the learning process by allowing deeper connections and connections to real world applications. Video gaming can be the tool to allow such a process to occur.

Furthermore, the field of biotechnology is on the cutting edge of research that will have a lasting impact on the health of individuals. Learning about the science of biotechnology will allow students to become a functioning part of a society, to make informed decisions, and to know they have the ability to change the health field at an exponential rate. Those elements, the topic of biotechnology and the delivery of virtual

gaming, I believe, will intrigue the students to want to learn more. The purpose of this study is two-folded. 1) to assess the impact of virtual gaming in the learning process of biotechnology for high school students grades 11<sup>th</sup> - 12<sup>th</sup> on assessment scores (pre/post test developed by MBt and additional pre/post test developed by the teacher) and 2) to determine the effectiveness of the 'intervention' pre-activities on the virtual gaming experience and their willingness to enter a career in biotechnology (survey at the end of the project).

#### Action research intervention:

Through the dual enrolled BSC 1020 course students (11<sup>th</sup> and 12<sup>th</sup> graders) continue to learn about DNA replication, protein synthesis, and biotechnology. At Arnold High School all freshmen either take Biology or Biology I Honors. Biology I Honors is taught as a pre-Advanced Placement course and on average 99% of all students enrolled in the BSC 1020 course took the honors form of the freshmen biology course. Unfortunately the information about biotechnology was only in a brief description. I want to bring to the students more hands-on activities and processes so that they can understand the applications of biotechnology more effectively before the virtual gaming is implemented. The BSC 1020 curriculum schedule covers all micro topics (cell – parts, functions, cycles, DNA, and RNA) in the first 6 weeks of the semester (on the block system) therefore the remaining 12 weeks are devoted to the tissues and the organ systems.

As we progress through the virtual gaming timeline stated below, students will record their 'suggestions for their peers,' questions about the day and gaming level scores. We will review those items each day at the start of class. I want to make sure each student is clear on where we are currently and if not, how to progress. The recording of the level scores are just to motivate a small competition setting among the avid gamers.

For more detail information please refer to the completed lesson plan found at the end of this document.

#### Timeline and class information:

For the fall of 2010 the course BSC 1020 is from 7:30-9 AM CST and consists of 26 students. August 30<sup>th</sup> - September 7<sup>th</sup> will consist of (\*) objectives required from Gulf Coast Community College for this course and (~) pre-hands on activities determined to introduce the biotechnology in the virtual gaming. Beginning September 8<sup>th</sup> the remaining items are set by the MBt Scenario #2. The timeline set up by MBt is based on a 55 minute class schedule. I am on a 90 minute block. I want to use all 90 minutes at least for the gaming and will adjust with presenting 2 lessons on some days. I may include the additional MBt lesson on PCR during the non-gaming days if time

allows. Those changes are indicated on the calendar below. If too much time has been determined I may start to incorporate the next topic on the BSC schedule, genetics. Such change will be noted in the conclusion.

Monday	Tuesday	Wednesday	Thursday	Friday
No School	September 7  AHS test on DNA/RNA & biotechnology  Biotech – Stundon pre-test  MBt - consent forms	8  Pre-activities ~ Pipette Activity  ~ Virus Outbreak activity	9  Pre-activity ~ review the virus activity  ~PCR Dash Activity (DNA extraction)  MBt pre-test/surveys  - may start virus lesson	10  Virus Lesson & Equipment Lesson  Computer set up/student log on
13  Game Play	14  DNA extraction lesson	15  Game Play (complete level 1)	16  Game Play	17  PCR Lesson I and II
20  Game Play (complete level 2)	21  PCR Analysis Lesson & Careers Lesson	22  Game Play	23  Game Play and catch-up	24  Finalize all items.  Mail out computers for 2 PM pick up

At the time of submission of this action plan on September 9<sup>th</sup>, the project start date is September 8<sup>th</sup>.

Connections to Bench to Bedside summer institute:

Dr. Troy Sadler presentation on Mission Biotech virtual gaming was very impressive. It not only focused on the content that we want the students to know but stressed how students today learn differently. To be given a tool to bridge the generation gap between teacher and student is very exciting. Dr. Kim Golart and Mrs.

Julie Boker's assistance during the lab activities were critical in understanding not only the concepts but the applications as well. Giving their assistance in our own classrooms is such a valuable tool that cannot be passed up.

#### Data Collection and analysis:

I will give a series of pre and post test (developed by MBt) to determine a change in both attitudes of biotechnology and also of the overall knowledge of biotechnology. I will use the data analysis used by the MBt team then determine what additional analysis needs to be done. In addition the students will provide feedback about the necessity of the pre-activities through a survey (teacher develops). Were the pre-activities necessary? Did the hands-on mini-activities transcend into the virtual lab setting? Would the unit lecture test be more effective after the gaming or would it make a difference?

1. Attitudinal surveys – developed by MBt
  - a. Survey of Ideas about Technology and Science – pre and post testing
  - b. Survey of Knowledge about Science related to Biotechnology – pre and post testing
2. Unit Test – developed by MBt
  - a. Pre and post testing
  - b. 20 Multiple choice items
3. Standards - aligned test (proxy for FCAT) – developed by MBt
  - a. 20 Multiple choice items
4. Student gaming checklist – optional. Only if a student wishes. It will assist in the procedure needed to complete each level. (addressing the student who needs a step by step procedure rather than an exploration approach)
5. Teacher daily journal
6. Student daily journal - to discuss roadblocks, suggestions, etc. We will discuss these before each day.
7. Gaming Level quizzes – go be given to each student as they complete a section.
8. Teacher's own develop pre/post test on biotechnology (MC, fill in the blank, and free response questions)

9. Student opinion of pre-activities – developed by teacher

a. Questions:

1. Were the pre-activities necessary to learn the lab techniques from the game? Explain.
2. Did the hands-on mini-activities transcend into the virtual lab setting? Explain.
3. Would my unit test be more effective after the gaming or would it make a difference? Why or Why not?
4. What other avenues should be taken to enhance the virtual gaming experience, hence the learning of biotechnology?

Literature cited:

Dawson, Vaille. (2007). An Exploration of High School (12-17 year old) Students' Understanding of, and Attitudes Towards Biotechnology Processes. *Research of Science Education*, 37, 59-73.

Garris, Rosemary; Ahlers, Robert; Driskell, James. (2002). "Games, motivation, and learning; A research and practice model." *Simulation & Gaming*, 33.4, 441-467.

Shaffer, David; Squire, Kurt; Halverson, Richard, and Gee, James. (October 2005). "Video Games and The Future of Learning." *Pi Delta Kappen*, 87.2, 104-11.

Budget and budget justification:

Even though the virtual gaming is the testing tool, it is essential for the students to experience a hand-on interaction with some of the equipment being used in the game. The items below are either requested for purchase or for loan from CPET- UF.

CPET is supplying the following the week of Sept. 7<sup>th</sup>.

1. Pipette practice lab –

(30) 200 um pipettes and tips

(30) 100 um pipettes and tips

(30) wells

2. Viral Outbreak wet lab (mini-lab from Julie Boker)

(15) Gel Electrophoresis and solutions

Dr. Sadler is supplying the following

### 3. Virtual Gaming

(30) computers with program – borrow from Dr. Sadler

#### Additional items needed

4 – Post It - self stick table top pads (cat 563) - I want the students to be able to brain storm their virtual gaming findings, level scores, and suggestions throughout the room.

1 color ink cartridge “HP 23 tricolor”

1 B/W ink cartridge HP 45 – both cartridges are required for the print outs of the biotech equipment and display as required by the MBt lessons.

1 box of 50 page covers – the MBt states to laminate but I believe sheet protectors will suffice.

20 small spiral note pad for student and teacher journals.

5 rolls of scotch tape (5 groups) for the PCR dash

3 gallons of distilled water – Virus outbreak lab

5 pieces of cheesecloth – for DNA extraction lesson

19 paper folders for 3 hole punched paper (folders for the students to keep track of hand-outs, check-list, etc.

#### Permissions:

1. Photo release forms will need to be obtained from each of the students so that photos can be taken during the virtual gaming. Those photos then can be used for publications and presentations.
2. Dr. Sadler and BMt permission/consent form.
3. Dr. Sadler will have to contact David Smith, ITS of BDS, for permission to bring in laptops to the school and for internet

#### LESSON PLAN:

***Theme: Virtual Gaming to Learn Biotechnology***

<b>Lesson Title</b>	<b>Enhancing the learning achievement and attitude of biotechnology for the student with the aid virtual gaming</b>
<b>Grade Span</b>	<b>11-12</b>
<b>Content Emphasis (Mathematics or Science)</b>	<b>Science – BSC 1020 dual enrolled course; a Human Biology course. Equivalent to the freshman biology requirement for non-science majors.</b>
<b>Targeted High School Benchmark(s)</b>	<b>SC.912.L.14.52; SC.912.L.16.3-5; SC.912.L.16.7; SC.912.L.16.10-12; SC.912.L.18-4; SC.912.L.18.11; SC.912.N.1.3; SC.912.N.1.4</b>
<b>GCCC Course Objectives</b>	<b>Explain the use of genetic engineering in medicine and agriculture</b>
<b>Author(s)</b>	<b>Tammy Stundon</b>
<b>School</b>	<b>J.R. Arnold High School</b>
<b>District</b>	<b>Bay District Schools</b>
<b>Lesson Preparation</b>	
<p><b><u>Learning goals:</u> What will students be able to do as the result of this lesson?</b></p> <p>Enhance the student's knowledge, analysis, attitude, and application of biotechnology through virtual gaming and pre-activities.</p> <p>AHS does not have an Advanced Placement Biology course, which this lesson unit would ideal for. The students in the high school freshman biology honors course are not yet prepared for such rigor.</p>	
<p><b><u>Estimated time:</u> Please indicate whether this is a stand-alone lesson or a series of lessons.</b></p> <p>This is a series of lessons that will span over 2-3 weeks with a lecture component integrated within. The time spent will include lecture, activities, and mini-labs in preparation for the implementation of the virtual gaming.</p>	

**Materials/Resources: Please list any materials or resources related to this lesson.**

Even though the virtual gaming is the testing tool, it is essential for the students to experience a hand-on interaction with some of the equipment being used in the game. The items below are either requested for purchase or for loan from CPET- UF & MBt.

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5 rolls of scotch tape (5 groups) for the PCR dash

3 gallons of distilled water – Virus outbreak lab

5 pieces of cheesecloth – for DNA extraction lesson

19 paper folders for 3 hole punched paper (folders for the students to keep track of hand-outs, check-list, etc.)

**Teacher Preparation: What do you need to do to prepare for this lesson?**

- finalize calendar
- develop student biotech pre/post test and attitude survey
- secure the loan of equipment from CPET- UF and Dr. Sadler
- review MBt lessons for specific materials that will be needed and items that will need to be printed and copied. In addition, insert URLs and ppts on the computer for the presentations. Also, convert youtube videos into files for showcasing during class.
- copies for each lesson, powerpoints, handouts, etc
- District computer support in corporation with Dr. Sadler's team.

**Lesson Procedure and Evaluation**

**Introduction: Describe how you will make connections to prior knowledge and experiences and how you will uncover misconceptions.**

This unit is for BSC 1020 dual enrolled students. All students have previously had biology honors which introduced such concepts. I will review those concepts and introduce the application of. I will form small groups and ask those groups to brainstorm various types of biotechnology and applications along with careers within the field. Those small groups will report to the class and we will combine ideas. From there I will add any missing elements. By doing this I am insuring that even though students may have had one of three various honor teachers or come another school, district, state, all students are on target to proceed.

**Exploration:** Describe in detail the activity or investigation the students will be engaged in and how you will facilitate the inquiry process to lead to student-developed conclusions.

Through the dual enrolled BSC 1020 course students (11<sup>th</sup> and 12<sup>th</sup> graders) continue to learn about DNA replication, protein synthesis, and biotechnology. At Arnold High School all freshmen either take Biology or Biology I Honors. Biology I Honors is taught as a pre-Advanced Placement course and on average 99% of all students enrolled in the BSC 1020 course took the honors form of the freshmen biology course. Unfortunately the information about biotechnology was only in a brief description.

I want to bring to the students more hands-on activities and processes so that they can understand the applications of biotechnology more effectively before the virtual gaming is implemented. The BSC 1020 curriculum schedule covers all micro topics (cell – parts, functions, cycles, DNA, and RNA) in the first 6 weeks of the semester (on the block system) therefore the remaining 12 weeks are devoted to the tissues and the organ systems. So at the end of the DNA/RNA/Biotech chapter I will continue the lesson with additional biotechnology information and activities so that the students will be able to learn more about biotechnology, equipment used, and research.

The activities include the following on the following dates:

Monday	Tuesday	Wednesday	Thursday
No School	September 7  AHS test on DNA/RNA & biotechnology  Biotech – Stundon pre-test	8 Pre-activities  ~ Pipette Activity  ~ Virus Outbreak activity	9 ~ PCR Dash Activity  MBt pre-test, surveys, & consent forms

This action plan will implement a modified MBt scenario #2. “Modified” because the MBt scenarios are based on 55 minute class schedule. AHS is on a 90 minute block schedule. We will use all 90 minutes for the days for game playing but lessons will be combined. As we progress through the virtual gaming and the timeline (stated below), students will record their ‘suggestions for their peers,’ questions about the day’s activity and gaming level scores. We will review those items each day at the start of class. I want to make sure each student is clear on where we are currently and if not, how to progress. The recording of the level scores are just to motivate a small competition setting among the avid gamers.

Monday	Tuesday	Wednesday	Thursday	Friday
				10  Virus Lesson & Equipment Lesson  Computer set up/student log on
13  Game Play	14  DNA extraction lesson	15  Game Play (complete level 1)	16  Game Play	17  PCR Lesson I & II
20  Game Play (complete level 2)	21  PCR Analysis Lesson & Careers Lesson	22  Game Play	23  Game Play and catch-up	24  Finalize all items.

**Assessment:** Describe how student knowledge is being assessed at the appropriate cognitive level for the targeted benchmarks.

I will give a pre and post biotechnology test to determine an increase of knowledge on the subject. I will also give an survey at the end of the project to determine, based on student opinion, if the pre-activities enhanced their learning and progression through game. I will also use the data analysis used by the MBt team then determine what additional analysis needs to be done.

1. Attitudinal surveys – developed by MBt

b. Survey of Ideas about Technology and Science – pre and post testing

c. Survey of Knowledge about Science related to Biotechnology – pre and

post testing

2. Unit Test – developed by MBt
  - a. Pre and post testing
  - b. 20 Multiple choice items
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7. Gaming Level quizzes – go be given to each student as they complete a section.
8. Teacher's own develop pre/post test on biotechnology (MC, fill in the blank, and free response questions)
9. Student opinion of pre-activities
  - a. Samples questions:
    5. Were the pre-activities necessary to learn the applications from the game?
    6. Did the hands-on mini-activities transcend into the virtual lab setting?
    7. Would my unit test be more effective after the gaming or would it make a difference?

**Teacher Self-Reflection:** Record your thoughts on the lesson and describe any modifications you would recommend based on the outcomes

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attitude of biotechnology for the student  
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Tammy Stundon

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Biology teacher, participant of Bench to Beside of CPET-UF

June 2010 – January 2011