A study of the effects of Computerized Gaming and cutting-edge research on students’ developing a more positive attitude towards and enabling the enduring nature of knowledge and skills in Biotechnology?

Action Research Project

Biomedical Explorations: Bench to Bedside

Center for Precollegiate Education and Training

University of Florida

7/2/2010

Mr. James Pignatiello, B.S., M.S.T.

Instructor: IB (HL and SL) and AP Chemistry and Biology

Flagler Palm Coast High School
Abstract

Computerized Gaming is very visual, personal, competitive and the core of the student’s existence. Thus, it may add the personal interest and emotional response that can increase the attitude towards and the enduring nature of the knowledge and skills beyond the traditional classroom and improve scores (Van Eck 2006). This can especially be helpful in areas of biotechnology where financial issues may negate the actual hands-on experience. Use of the Mission Biotech Gaming program and CCR (Careers, Cases and research) vignettes will be used to lend reality to Biotechnology knowledge and skills. Before and after tests, both multiple choice and open response questions, and an attitudes survey will be used to detect the level of endurance. It is anticipated that the gaming and CCR will yield a smaller increase in the short term as these students typically work well current unit. I expect to see better endurance through impromptu recall yielding less time spent on review in class and better responses to typical IB/AP test questions.

Rationale

When faced with the complexity of the chemical nature of biology, students typically respond with two basic attitudes. One is to ignore it and hope that it will not be a large part of the IB/AP test. The other is to try to reduce it to a list of impersonal facts that remove the possibility of any personalized interest. Students typically learn material for a test but forget it soon after the test is over. Often, memory is based in either repetition or the attachment of new information to meaningful information/experiences that the student already possesses. The more emotional impact is associated with the information and skills, the better it should be retained. Including authentic real-time current research brings the aspect of realism that helps to pique emotional/personal interest.

As a teacher of IB and AP courses, one of the main focuses of the course is the prepare students to be successful on the end of the year exam. The exams are written and graded by the respective 3rd party (IB and AP). Thus, the teacher, as well as the student, has very little idea what kinds of questions are going to be used to test the various concepts. Which will be ‘open response’ and which will be ‘multiple choice’? Which areas will be covered in more depth than the others? These questions necessitate a teaching style that requires an equal focus on all concepts. It also requires a cumulative philosophy to the in-class testing, as all information needs to be retained for a great period of time.

So, why do we remember the things we retell throughout our lives? Attitude tends to be at the heart of the issue. The great thing about attitudes is that you can always pick a new and hopefully better one. The more positive and serious the attitude, the more likely the material will be retained but more importantly, retained with enthusiasm.

One knows that if a long narrative were presented for memorization, the methodology would be to memorize one line first. Then, memorize the second line
and add it to the first. Memorize the third and add it to the first and second and so on. This produces far better results that reading the entire document over and over. However, the rote method does not imply any personal or emotional attachment. Often, much of the memorized verbiage is lost soon after the assessment of the memorization is over. Watch a group of people try to sing/recite *The Star Spangled Banner* on their own. How many times have we heard the lyrics to this song? For many, difficulty is encountered very early. I feel it is because of a lack of internalization. Internalization is defined in this sense as a personal or emotional attachment to the information. This is often centered either in neurotransmitters (dopamine and oxytocin) or in the amygdala of the brain. Before information is passed on to the higher cerebral centers for conscious processing and retention from short to long-term memory, it passes through the amygdala. The amygdala processes all incoming information for fear, threat and safety issues (Quantum Learning 2008). Those that are worth paying attention to are immediately attached to pre-existing situations or emotions that have had a great emotional impact on us for good or bad. These new experiences will always be remembered. Other favorites to try and finish are: "When in the course of human events....", "Four score and .....", "We the people.....", "In Flanders’s Field...."

Other illustrations of this are to list a few songs that were popular back when one was in high school. Watch what happens when they hear a song title that they associate with a significant event. This could be a great sports victory or a special relationship they had at the time. They can tell you great details about the song and maybe even hum the melody and recite the lyrics. Other songs are recognized but only in a general sense. Ask them for a favorite memory from high school. I can bet that it probably does not have much to do with academics. It probably has to do with some interaction, probably social, that had emotional significance. This could be a traumatic experience as well as a good one. Teachers are not much different. The names of students we learn first and remember the longest are those that make a significant connection or emotional impact on us. This can be accomplished by a good experience or a student that did something wrong. Consequently, if we can apply the same concepts to school learning, we should be able to increase the retention of the important concepts.

Overcoming the often apathetic attitude that students possess as they enter the classroom is paramount. Watch what happens when they hear a song title that they associate with a significant event. How do we nurture the process of tapping into the vast list of experiences they bring into the class? How do we touch the experiences that mean something to each student? Since each student is different, how can we generalize the experience to reach as many as possible? Finally, how do we get students to look for and use these personal/emotional connections on their own? Traditional dissemination of knowledge may have been the tool of choice in the 20th century but is out of step with the current generation (Peng 2004). If it does not involve the use of two thumbs or a joystick, it probably carries little inherent interest. These students were born with and grew up with computers and process just about everything through them. We need to make use of this tool, as it will
engage a greater percentage of students on a more authentic and higher level (DeKanter 2005).

Many tools can be utilized for this. Among them are story telling from personal experience. Students see how I, the teacher, am personally and emotionally attached to the information. This caring and enthusiasm is very contagious. When I tell stories of my experiences as a biochemist, it fosters great interest, emotional ties and a more positive attitude. They always remember these stories so I use them often. The cases and research presented in this program gives me a great fertile ground for new inspirational stories. This helps in seeing the application of the material which brings authenticity.

This is the video generation and games are the nature of youth. Students often say, “Are we seeing a video today?” Even if a video is part of the lesson plan, it will succeed or fail based on whether it touches, stimulates or surprises them within the first few minutes. If not, they drift off into the world of theta waves and daydreaming. Students also ask, “Can we play a game today?” A game implies activity and competition rather than listening and sitting. This promises the release of dopamine for all of the little victories along the way as well as the ‘big win’ at the end. This release of dopamine gives a feeling of satisfaction and pleasure that will be connected with the activity. This brings the promise of a more positive attitude towards the subject and of longer retention. (Bergeron 2008) A further question that may need to be addressed is whether the retention will be the experience of the game or the content on which the game is based.

A combination of all of this leads us to the final question. Can a computerized gaming program and cutting-edge research be helpful in enabling a more positive attitude towards and the enduring nature of the concepts in Biotechnology? The computerized game can include personalized activity. It is visual. It can be competitive. It can evoke an emotional response depending on how it is written to capture the student’s interest. The computer is a huge part of every child’s life so it places the child in a position of confidence, relevance and security. This may foster a greater willingness to participate and get involved rather than participate merely as a ‘right of passage’ or to just get through it.

**Action Research Intervention**

1. I will use the Mission Biotech Computerized Gaming Program for the analysis and identification of a new pathogen using the concepts of PCR, gel electrophoresis, gene transfer and development of therapy.
2. I will use the information of the presenters for handouts and stories to motivate and inform.

I will implement the program with my class(es) of IB (International Baccalaureate) Biology students.

The lesson plan for the unit is attached.
Connection to Bench to Bedside Institute
The Mission Biotech as presented by Dr Sadler of UF and the biotech methodologies presented at the Bench to Bedside Institute are the focus of the content I need my students to retain.
The presenters have given me a wealth of new material for stories and examples to help motivate and inform.

Data Collection and Analysis
The following is the process:
1. Students will take a pretest that covers the biotech concepts and attitudes towards the subject.
2. The unit will be taught. This will include lecture, discussion and labs.
3. The Mission Biotech Gaming program will be implemented.
4. The student’s attitudes, knowledge of content, skills and procedures will be reassessed.
   a. However, this will be without prior warning to the students. This can be repeated at additional times.
   b. To avoid bias, I will not know how many times or how often the individual students played the game. I will get this information after all testing is complete and then integrate it.

I will be looking for trends in the enduring quality of the answers.
I will also look for the rates at which retention quality is changing. See comments in the lesson plan.

Permission/Consent Forms
Standard ‘Informed Consent’ for will be signed by students and parents.

Bibliography
Bergeron (2008), Learning and retention in adaptive serious games.
Quantum Learning (2008), www.qln.com
Van Eck, Richard (2006), What are we playing at?, Univ. of ND, Net.educause.edu

Budget Justification
Perishable materials for procedures like e-gel electrophoresis consumables have been purchased. Can the $200 be applied to this?
Action Research Lesson Plan

Concepts:
DNA extraction, PCR, Gel Electrophoresis, Gene transfer/cloning and using micropipettes, CCR (Cases, Careers and Research).

Key Vocab:
Viruses, DNA, RNA, double helix, hydrogen bond, PCR, centrifuge, thermocycler, gel plate, denaturing, annealing, elongation, nucleotides, primers, Taq polymerase, buffers (lysis, elution, wash), spin column, positive and negative controls, staining, restriction enzymes, sticky ends, ligase, reverse transcriptase, host, micropipette

Timeline:
1. Two Days: Lecture/Discussion of specific and required knowledge and procedural protocols as outlined in the Biotechnology Handout (Attached)
2. Five days: Labwork on DNA extraction, gel electrophoresis, PCR simulation, Colony (gene/plasmid) transfer (optional)
3. 5 days: Computerized Gaming with Mission Biotech c/o Dr. Sadler, Univ. of Florida. Students will be able to access the game outside of class as well but it will be on an ‘as needed’ basis.
4. As appropriate (3-4 days): CCR (Careers, Cases and Research). An overview of the core and cutting edge technologies as presented in the Bed to Bedside Program. See ‘cpet notes’ document for sections like PKU, Diabetes, Glycogen storage diseases for use in Genetic and Cell Units.

Assessment
1. 3 days (over time): Assessment: Pre-test, post-test and retention post-test.
   a. First, will be the tests developed by the Mission Biotech Team.
   b. Second, students will be expected to explain either orally or in written form, the procedures listed. This will be in the form of ‘open response’ type questions. This will be the expectation on the IB/AP test. Students will be judged according to IB/AP standards of completeness and accuracy from past IB/AP tests.
   c. Third, will be an attitudes survey.
2. These students are very good at short-term studying for an announced test. If one were to ask question without warning, the results would be far less encouraging due to the loss of endurance. Therefore, post-tests will not be announced so true endurance/retention can be assessed as opposed to last minute studying and short term memory.
3. Changes in student scores will show the rate of change in retention.
4. Aspects such as gender, attitudes towards biotechnology and gaming frequency will also be analyzed and integrated at the end.
Survey Questions to assess changes in perception towards/about Biotechnology

1. What does Biotechnology mean?
2. What do you find interesting about Biotechnology concepts?
3. What careers are available in Biotechnology?
4. What Biotechnology career would you be interested in learning more about?
5. What kind of research is biotechnology doing in medicine?
6. How is Biotechnology research important to or benefit the common person?
7. What areas of biotechnology research would you like to learn?
8. Name some biotechnology procedures.
9. Pick one of these procedures and explain how it is done?
10. What kind of experience and education are required for Biotechnology?
Biotech is BIG

So says Mr Pig
Interdimensional Guest
An his Apprentice Cohort
En Garde!!

- Micropipettes at the ready
Putting your heart into your work

“Mr. Pig....I love biology”
E (Everybody loves these things) -gels
Getting seated and welling up
The CSI crew
The Storyteller
Making Better Technicians (MBt)

- Science Knowledge = zero difference
- MBt knowledge = average +4/student
- Attitude = average +2.5/student
And now we wait for the enduring nature of the knowledge to show up........or not.

- Tune in next time...
- Same Biotech time...
- Same Biotech channel
A study of the effects of Computerized Gaming and cutting-edge research on students’ developing a more positive attitude towards and enabling the enduring nature of knowledge and skills in Biotechnology?

Action Research Project

Biomedical Explorations: Bench to Bedside

Center for Precollegiate Education and Training

University of Florida

7/2/2010

Mr. James Pignatiello, B.S., M.S.T.

Instructor: IB (HL and SL) and AP Chemistry and Biology

Flagler Palm Coast High School
Abstract

Computerized Gaming is very visual, personal, competitive and the core of the student’s existence. Thus, it may add the personal interest and emotional response that can increase the attitude towards and the enduring nature of the knowledge and skills beyond the traditional classroom and improve scores (Van Eck 2006). This can especially be helpful in areas of biotechnology where financial issues may negate the actual hands-on experience. Use of the Mission Biotech Gaming program and CCR (Careers, Cases and Research) vignettes were used to lend pictorial and conceptual reality to Biotechnology knowledge and skills. The data suggests a positive correlation especially for females. This also correlates well with the current research regarding how male and female brains process material differently, especially with respect to emotional connections.
**Rationale**

When faced with the complexity of the chemical nature of biology, students typically respond with two basic attitudes. One is to ignore it and hope that it will not be a large part of the IB/AP test. The other is to try to reduce it to a list of impersonal facts that reduce the possibility of any personalized interest. Students typically learn material for a test but forget it soon after the test is over.

Often, memory is based in either repetition or the attachment of new information to meaningful information/experiences that the student already possesses. The more emotional impact is associated with the information and skills, the better it should be retained. Including the authenticity of real-time current research brings the aspect of realism that helps to pique emotional/personal interest. This also increases retention.

As a teacher of IB and AP courses, one of the main focuses of the course is the prepare students to be successful on the end of the year exam. The exams are written and graded by the respective 3rd party (IB and AP). Thus, the teacher, as well as the student, has very little idea what kinds of questions are going to be used to test the various concepts. Which will be ‘open response’ and which will be ‘multiple choice’? Which areas will be covered in more depth than the others? These questions necessitate a teaching style that requires an equal focus on all concepts. It also requires a cumulative philosophy to the in-class testing, as all information needs to be retained for a great period of time.

Since males and females process and retain information differently, material needs to be presented with various formats and styles. This will allow both sexes to process and store information better. The MBt gaming format combines the critical elements of language, science content, competition and pictures/faces with the powerful benefits of current biotechnological research to provide a successful platform.
Intervention

I implemented the program with my IB (International Baccalaureate) HL (Higher Level) Biology students.

1. I gave a brief overview of virus types, structures and reproductive cycles. This took two days.
2. I spent one day giving an overview of PCR and Gel Electrophoresis.
3. I used the Mission Biotech Computerized Gaming Program for the analysis and identification of a new pathogen using the concepts of PCR, gel electrophoresis, gene transfer and development of therapy. This was implemented for two weeks in the beginning of December 2010.
4. I used the information of the Bench to Bedside presenters for handouts, LCD presentations and stories to motivate, inform and build emotional connections to content through pictures and stories. Some concepts used that were especially well received were Diabetes, PKU, Glycogen Storage Disease and Protein Structure intervention. These were presented both before and after the MBt program.
5. We did the electrophoresis lab.
6. Announced post-tests were given.
7. Unannounced follow-up post tests are in progress.
**Dissemination of Bench to Bedside Summer Institute Materials**

1. Powerpoint presentations from institute presenters were used in classroom discussions and as in-class examples. Pictures of equipment, lab results, graphs, etc.

2. Notes taken during the institute were incorporated into existing handouts for students. Examples include diabetes, PKU, Glycogen Storage disease, etc.

3. Implementation of the MBt Gaming Program.

4. Purchase of the e-gel system that is now being used by the entire Biology Department. I presented its uses, benefits and procedures.
Data Collection and Analysis

Assessment was based in pre and post-test scores. The post test-1 scores were announced given at the end of the unit. The post test-2 scores were not announced and given about a month later. Another two post-tests will be given 3 and 4 months after the end of the unit but that will occur after this paper is written.

The N value for the group is 13 with 4 males and 9 females. The regular class averages are 78 for the females and 77 for the males.

Science Content: class average score based on a maximum of 20

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th>Post-test 1</th>
<th>Post-test 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>19.00</td>
<td>18.50</td>
<td>19.00</td>
</tr>
<tr>
<td>Female</td>
<td>17.56</td>
<td>17.33</td>
<td>17.5</td>
</tr>
<tr>
<td>Overall</td>
<td>18.75</td>
<td>17.88</td>
<td>18.86</td>
</tr>
</tbody>
</table>

Overall, we see no significant change in any category. One reason may be that the science content is rather basic and has been covered in multiple years. Scores were very high ranging from 87% to 95%. This gives very little room for change. It also demonstrates a high level of mastery. Two students, one male and one female received a perfect score of 20 all three times. Males maintained a slight advantage over females but did follow the same pattern. Basic science facts do not make as great an emotional impact. Therefore, it can be a reason why the females did not score as well. Female brains process information using both sides simultaneously (language and emotion). Thus, without an emotion connection, the processing tends to be less efficient and takes on more of a rote role.7
**MBt (Mission Biotech):** class average score based on a maximum of 24

<table>
<thead>
<tr>
<th></th>
<th>Pre-test</th>
<th>Post-test 1</th>
<th>Post-test 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>18.50</td>
<td>19.75</td>
<td>16.25</td>
</tr>
<tr>
<td>Female</td>
<td>15.11</td>
<td>20.22</td>
<td>16.88</td>
</tr>
<tr>
<td>Overall</td>
<td>16.38</td>
<td>19.88</td>
<td>16.43</td>
</tr>
</tbody>
</table>

The MBt game made a big difference for the females in the group. The females made huge gains after playing the game culminating in a score that surpassed the males. Visual impact is far more successful in eliciting an emotional response than mere facts. The content was retained at a far greater efficiency for the females. ⁴

Although both sexes dropped in their retention over time, the females still maintained higher scores. Without a control/comparison group that did not play the game, given the same experiences, no conclusion can be drawn. However, it does indicate that immediate benefits are possible, especially for females. Repeated exposure to the game as a review activity would probably increase the retention rate.

Male brains tend to be very focused and process with only one half of the brain at a time. This along with the effect of testosterone, leads to the desire to dominate and/or conquer a challenge. The mere presence of a game to win demands their attention. Without the prompting of the game, as in past years, the material would probably not be retained as well.
**MBt Level Exams**

MBt had four levels. We were only able to adequately cover the first two in the allotted time because there were some technical issues with saving prior sessions. This forced the students to redo many of the activities. It led to much frustration but they continued to play the game to the best of their ability. This information was heavily focused on the MBt content. Like the previous section, females and males scored very close at the end.

<table>
<thead>
<tr>
<th></th>
<th>Post test 1</th>
<th>Post test 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>80%</td>
<td>76%</td>
</tr>
<tr>
<td>Female</td>
<td>78.33%</td>
<td>78%</td>
</tr>
<tr>
<td>Overall</td>
<td>79.38%</td>
<td>77%</td>
</tr>
</tbody>
</table>
**Attitude/Response**

It is interesting to note that as a direct result of information and materials from the UF Bench to Bedside Institute, I have 3 students attending or will attend seminars at UF or work in ‘real world’ research labs during the summer of 2011. This is three more than last or the year before.

In the words of the students, here are the main responses to some of the ‘attitude type’ questions. This information was forwarded to Dr. Sadler.

1. **What did you like about the MBt game?**
   - I enjoyed playing the game because it not only involved fun games and procedures with added suspense when uncovering the plaguing disease at hand. I found that I was remembering the steps to DNA extraction and PCR without harsh memorization.
   - It help me understand how PCR worked and how it would look like if I were to do it my self.
   - It actually felt like I was playing a game, but I felt myself learning at the same time.
   - I liked that it was an interactive way of learning other than just being lectured, and that you got to experience what you were being taught
   - I liked the realistic aspect of the game. The fact that you would have to restart if your gloves were contaminated was pretty cool. Also the game, chain reaction, really helped me remember the order and temperatures for PCR. I also liked the little workbook fill in the blank thing.

2. **What improvements would you suggest for the next generation of MBt?**
   - I recommend a change in the story line or levels of the game. I recall the game becoming quite monotonous after the first few times of recognizing the disease at hand. I understand that this is how it is in the real world, but high school students could become bored with the material. Maybe introducing the diseases and other concepts a bit slower would help.
   - That they find I way to fix the problems that occur, like the not saving data part
   - Picking up objects and moving around was difficult at times.
   - I would suggest making things easier to pick up and use when they are needed in the game
   - I would like to see more levels and maybe a couple more different aspects of biotechnology, such as gel electrophoresis. Then the students could see if the patient sample was a match to a suspect or see if the patient is related to the suspect or something along the lines of that. Also, students could make the master mixes themselves at least once to see exactly how it’s done.
3. How would you respond to the comment, ‘Students will just play the game to win or have fun and not focus on learning the content of Biotechnology?’
   - I agree with the statement. Most students, especially those enrolled in regular level classes, will ignore most of the substantial information within the game. Students may ignore important details, such as the role of each buffer, and just go through the motions for the “fun” of the game.
   - I would disagree with that statement, because if I were to win a level I would have to know what I’m doing, and master it to win. In the process, I would also be learning from what I mastered.
   - Even if the student only wanted to have fun while playing the game, the repetitiveness will force the concepts to stick in the student’s mind.
   - I think that having the competitive edge in the game makes it more interesting and a better tool to learn from. The way the game is set up it is hard to go through it and win it without learning anything.
   - I don’t agree with that because I learned a lot playing this game. It helped me fill in the blanks to some concepts that I was sort of confused about. You can really learn a lot by playing this game.

4. How well do you feel you have learned the concepts and skills of a biotechnologist?
   - I feel that the game has enhanced my knowledge of biotechnology and the real life application of the field. Going through the virtual steps provided the kinetic experience that aids in the retention of information.
   - I felt like I learned what I needed to know about isolating DNA and the beginning of PCR, I didn’t go far, because of complications, but I learned.
   - I feel that I would be able to perform a successful DNA extraction and I have gained knowledge about genetic engineering all around.
   - I feel that I have learned the basic skills of being a biotechnologist and this program is a good groundwork for future biotechnologist who are looking to get into the field, it is a good way to get their feet wet in the program.
   - I think I have learned a lot about what biotechnologists do, at least the general concepts and aspects. The only thing I don’t really know is how much time it really takes to perform all these processes and how certain solutions and master mixes, etc. are actually made.

5. If a Biotech company opened in Palm Coast, for which position(s) do you see yourself applying (assuming you have the qualifications)?
   - I would apply for any position available in the laboratory because that is where all the analysis occurs.
   - Isolate DNA position
   - Biotechnologist
   - I would want to be a head lab technician
   - I would become a biologist.

6. Would you like to see the gaming concept developed for other science concepts? If so, what areas.
- Yes. Having the game developed for the concepts students struggle with would be the most beneficial which includes DNA replication, transcription, translation, and human systems.
- Osmosis
- Yes, as many concepts as possible. The game really allows the student to focus without being bored to death and in some cases without even realizing it.
- Yes, this game would be beneficial in almost all areas of science of concepts, especially for those who are hands on learners and do not have access to all the proper equipment needed.
- It would be interesting to see something about the ecosystem and ecology. Students could practice the capture and release methods and random sampling. Also, if they made something with the human systems, that would be fun. Maybe students could see how all the systems interacted with each other and things like that. I think that would help students learn all the different vocabulary that comes with all the different aspects of biology.

7. What other comments would you like to share?
   - I thoroughly enjoyed having the opportunity to play Mission Biotech. Thank you so much!
   - That maybe there should be some cool music in the background or a game music
   - I just want to thank you for making this game. It was awesome and it really helped me learn something. Thank you so much and I really hope that there will be new aspects with the game in the future.
**Conclusions**

The data shows that there is an overall positive correlation. Based on experience with students from past years, this year’s students do retain the material better and for longer because of exposure to the MBt game and the CCR stories that I can tell. This may not fit the criterion for a legitimate scientific conclusion but there is an obvious difference in the classroom and assessments. Students were involved, talking about the material and the problem solving process. The game met them in ‘their world’ and brought them into the science world. In my experience, it is important to utilize the skills, attitudes and energy that students possess as they walk into the room. It is our job to take what they bring and help them mold that into a new and higher level of competence.

The realism and hope of the CCR stories and the promise that they could be part of the process in the future brought hope to their lives and for the world that they will live in. So many want to make a difference but do think that they matter or can make a difference in the grand scheme of things. As one student said, “I can do this. I can help make a difference in this world!” As a teacher, that is all I need to hear.

Often we see information in the media about the state of education. Articles in Time, Newsweek and on CNN continually tell us that we are falling behind the rest of the world. In my opinion, a quick glance in a classroom shows many of the same practices that have been in place for decades. Science research has unlocked many of the secrets regarding how the brain functions and processes material. A comparison shows that we are not adjusting the teaching and learning to the biochemical processes of the brain.\textsuperscript{6,8,9} In the 2009 *Harvard Educational Review*, one finds articles relating to this concept. If one combines the existing theory on brain function from fMRI’s and PET scans and facts regarding the differences in how male and female brains process information, the correlation warrants further investigation and expansion into other science topics.\textsuperscript{1,5} It shows that we can do
better and we must do better. As ‘Teacher in Space’ Christa McAuliffe said ‘We touch the future.’ That is a powerful responsibility and honor.

Focusing on the science of the learning process and adapting our methods to that process will be a huge step in the right direction. To many students, teachers and parents, I am known as the ‘storyteller’. I learned very early, although without any research backing at the time, that emotional involvement and authenticity are vital to the learning process. I also use the concept of ‘the challenge’ both in class and especially in lab. I challenge students to solve problems and ‘fix’ labs by applying what they know. I set questions and labs before them that are designed with inherent problems and errors. They need to fight their way through this and develop a high tolerance of ambiguity. This was reinforced by the Harvard Assessment Seminars, which stated that students learn more if they work through labs that don’t work rather than ‘tip-toe’ through labs that always come out right. This helps take play into the functions of dopamine and testosterone (focus and reward).

The motivation and attentiveness of the students is very high. The realism piqued interest. In the end, there was something with which both male and female neural processes could interact to increase retention.
Informed consent permission forms were signed by the students and parents prior to the activities.

Financial expenditures (~$600.00) were for the purchase of the e-gel electrophoresis systems.

Sources
1. Blakemore and Firth; 2005; The Learning Brain: Lessons for Education
2. Cahill; 2001; “Sex-Related Difference in Amygdala Activity during Emotionally Influenced Memory Storage”
3. Dolcos, LaBar, Cabeza; 2004; “Remembering one year later: Role of the amygdala and the medial temporal lobe memory system in retrieving emotional memories”
4. Herlitz and Rehnman; 2008; “Sex Differences in Episodic Memory,” Current Directions in Psychological Science
7. Quantum Learning; 2008; www.qln.com
9. Are We Flunking Science; 2006 (Feb.) Time Magazine
10. Your Childs Brain; 1996, Newsweek