

STEM SUPPORT TO IMPROVE MATH AND SCIENCE INSTRUCTION



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The shortage of qualified math and science teachers has a profound impact on learning in underserved communities.

In this session I will present the STEM support model designed and implemented by the Royal High School-Prairie View A&M University Partnership and discuss ideas for replication.

PUBLIC PERCEPTION ABOUT ENGINEERS

<http://www.youtube.com/watch?v=qOtoujYOWw0>

This is a cute video.

SOME NUMBERS

The US has approximately 20,000 public and private high schools.

Physics majors 1.4% of ALL science and mathematics undergraduates. 40 years ago it was 4%.

In the 2004-2005 academic year, 1.1M high school students (about a third of all high school students) took a physics course.

About 1200 new teachers are hired each year to teach physics. 800 do not have formal training in how to teach physics and are deficient in physics knowledge.

With the exception of special education instruction, physics teacher positions are the most difficult to fill in high schools (American Association for Employment in Education).

- From Physics Today, February 2009

CHALLENGES

Lack of continuity and progression in the students' experiences in science elementary-middle and middle-high school interfaces.

Limited influence of science in helping to develop the students' skills in literacy, numeracy and information and communication technologies (ICTs).

Limited exposure to synergy between different fields.

Limited exposure to relevance of science to life situations.

A SYSTEMIC SOLUTION

- At PVAMU we are approaching the problem in a systemic manner.
- Components of our approach:
- Interactive Learning Environment - Science Education Center
- Student projects - relevant to learning and real world
- What-If scenarios
- Teacher-Faculty collaboration - Teacher In Residence, Faculty In Residence, continual feedback and assessment

DRIVING PHILOSOPHY

Students learn best when they study subjects in the context of a personal or social application, and with hands-on instruction and activity-based experiences.

NEED TO “UPGRADE OUR INTELLECTUAL SOFTWARE”

“Good management was the most powerful reason [leading firms] failed to stay atop their industries.

Precisely because these firms listened to their customers, invested aggressively in technologies that would provide their customers more and better products of the sort they wanted, and because they carefully studied market trends and systematically allocated investment capital to innovations that promised the best returns, they lost their positions of leadership.”

- Clayton Christensen, *The Innovator’s Dilemma*

“RE-IMAGINED MISSIONS”

“Never mind computers and tech services. IBM’s radical new focus is on revamping customers’ operations and running them.”

—Headline/ *BW*/ 04.18.05

“Big Brown’s New Bag: UPS Aims to Be the Traffic Manager for Corporate America”

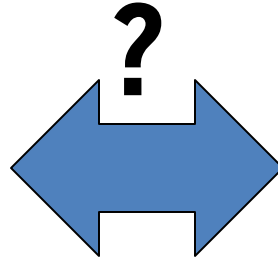
— Headline/*BW*/07.19.2004

It is important to understand basic characteristics and origins of motivation for our students in order to allow them to participate in their own education, rather than creating a disconnect in traditional style teaching and current practices in learning.

21st Century Skills Framework

Core Subjects

- Economics
- English
- Government
- Arts
- History
- Geography
- Reading or Language
- Arts
- Mathematics
- Science
- World Languages
- Civics



21st Century Themes

- Global Awareness
- Financial, Economic, Business & Entrepreneurship Literacy
- Civic Literacy
- Health Literacy

“The subject you studied in school doesn’t mean anything. What is significant is the training of your brain.”

- Bruno Salzer, CEO of Hugo Boss

“When a subject becomes totally useless, we make it a required core course.”

- Peter Drucker

If you are a Civil Engineering major,

The Dynamic Tower

80 floors in the world's first moving skyscraper with offices and a hotel, topped by apartments

Each floor will rotate 360 degrees, all at different speeds.

Designed by Italian architect David Fisher and located in Dubai (another is planned for Moscow), the prefab, wind-powered tower will cost an estimated \$700 million.

The residences will sell for \$3.7 million to \$36 million. The building should be completed in 2010.

If you are a Computer Science Major,

<http://www.youtube.com/watch?v=VFkyV7d5t8o>

This is a futuristic clip from the movie Disclosure.

If you are an Electrical Engineering Major,

Biocontact lenses!!!

<http://www.youtube.com/watch?v=qdILVMGXSQk>

If you are a Biology Major,

- Revolutionize how biologists interface with research scientists, clinicians and patients to access petabyte [10^{15} bytes] and maybe even exabyte [10^{18} bytes] scales of data.
- People with intense knowledge of disease biology at a protein–protein, biochemical level, should interface with those who are building the more genomics-oriented data sets.
- A researcher in Seattle looking at how all 35,000 genes in breast cancer patients are dialed on or off at a certain stage of illness can make critical comparisons by stacking results up against a deeper and broader data pool that integrates clinical, genetic, and other molecular data from peers from anywhere else.
- So as scientists query their data sets against this platform, they are actively contributing that data to the platform to make it even better.
- You can think of it as a Wikipedia type of thing where you have this active-contributor network-based approach that just makes the information more and more informative.

SECOND LIFE

- **Second Life is developed by Linden Lab, a company founded in 1999 and provides the technology but the Second Life residents themselves are the ones who really help shape the world and make it unique.**
- **Faculty and industry experts will be brought in for special educational projects as well.**

A NEW WAY TO LEARN

<http://www.youtube.com/watch?v=xHAHpvFmgQk>

This is an interesting video clip on teaching science in “Second Life”

A NEW WAY OF LEARNING SCIENCE

[http://www.youtube.com/watch?
v=4R1SrZua5ww&feature=PlayList&p=ED0A1237F37AE24C&playnext=1&p
laynext_from=PL&index=7](http://www.youtube.com/watch?v=4R1SrZua5ww&feature=PlayList&p=ED0A1237F37AE24C&playnext=1&playnext_from=PL&index=7)

This is another interesting video clip on teaching science in “Second Life”

Now,
Two Specific Examples of
Implementation

- English Language Arts
- Physics

Curriculum Redesign

English Language Arts

- Learning is taken from concrete to abstract.
- Information is presented as a problem to provoke cognitive dialogue and student discovery.
- The depth of student understanding is enhanced through perspective: personal, local, regional, national and global.
- Cooperative student learning groups (RHS-PVAMU)

Txt Msg Unt



Objective: Students will understand, analyze and evaluate the value of printed communication in the forms of traditional printed text, translated text messaging, and vocational dialogue.

Instructional strategies:

- Students worked in groups of 2-3 to read, analyze and note the purpose, audience, and intent of Newsweek, USA Today, and U.S. News and World Report magazine articles.
- After breaking down the articles, students translated the articles re-wrote the articles using traditional text messaging techniques.
- Students then evaluated the value of the contents and the level to which the original text was relayed in translation.
- This was then applied to an evaluation of vocational articles and the vocabulary and modes of translation.

Audio Analysis

- **Objective:** Students will understand tone from famous historical speeches from Martin Luther King, Abraham Lincoln, at a level of analysis and evaluation. Students mastery of this understanding will be evident in their future writing.
- Students were asked to identify the tone of each speech and provided evidence from the text for the specific words/phrases that indicate the identify tone.
- Students then listened to the speeches on individual CD players as spoken by the original authors and did research on the historical context of the speech and were then asked to reevaluate their diagnosis of the tone.
- Students then had to identify and defend the reason for changing their original analysis (if this was the case) indicating if it was the context or delivery that most affected the tone of the speech.

Novel Portfolio: Student Choice



- **Objective:** Students will learn how to select activities and master a level of independent work and accountability to produce a portfolio compiled of ongoing projects to accompany the class novel and develop a deep level of comprehension of the text and apply the indicated theme and context to evaluate the literary merit of the novel.
- **Instructional Strategies:**
 - Journaling, graphing, visual representations, presentations, graphic organizers, quizzes, essays, research, literary term identification, teacher-student discussions, poetry, character maps.

A Modest Proposal

- **Objective:** Students will understand the purpose of satire, the reality of the social issues addressed, and be able to apply this understanding by researching current events and then portraying the most critical aspects of the issue through satire.
- **Instructional Strategies:**
 - The instructor will engage students in heated dialogue by verbally recreating a “Swift” like proposal pertaining to modern social issues which directly impact students.
 - Students will then read and analyze Jonathan Swift's *Modest Proposal*. Students will analyze the use of irony and dialogue about the real issues being addressed. Students will research the historical context of the proposal.
 - Students will research and select a current social issue and create their own version of a “modest proposal”
 - Students participate in discussion with PVAMU students regarding current issues and their impact on literature.
- **Cross Curricular Connection:** Student gains awareness of the historical context of Swift’s writing, current events and propaganda.

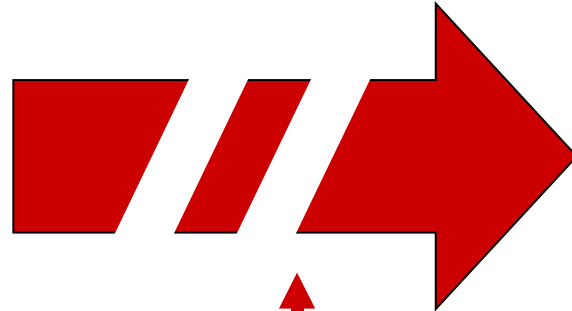
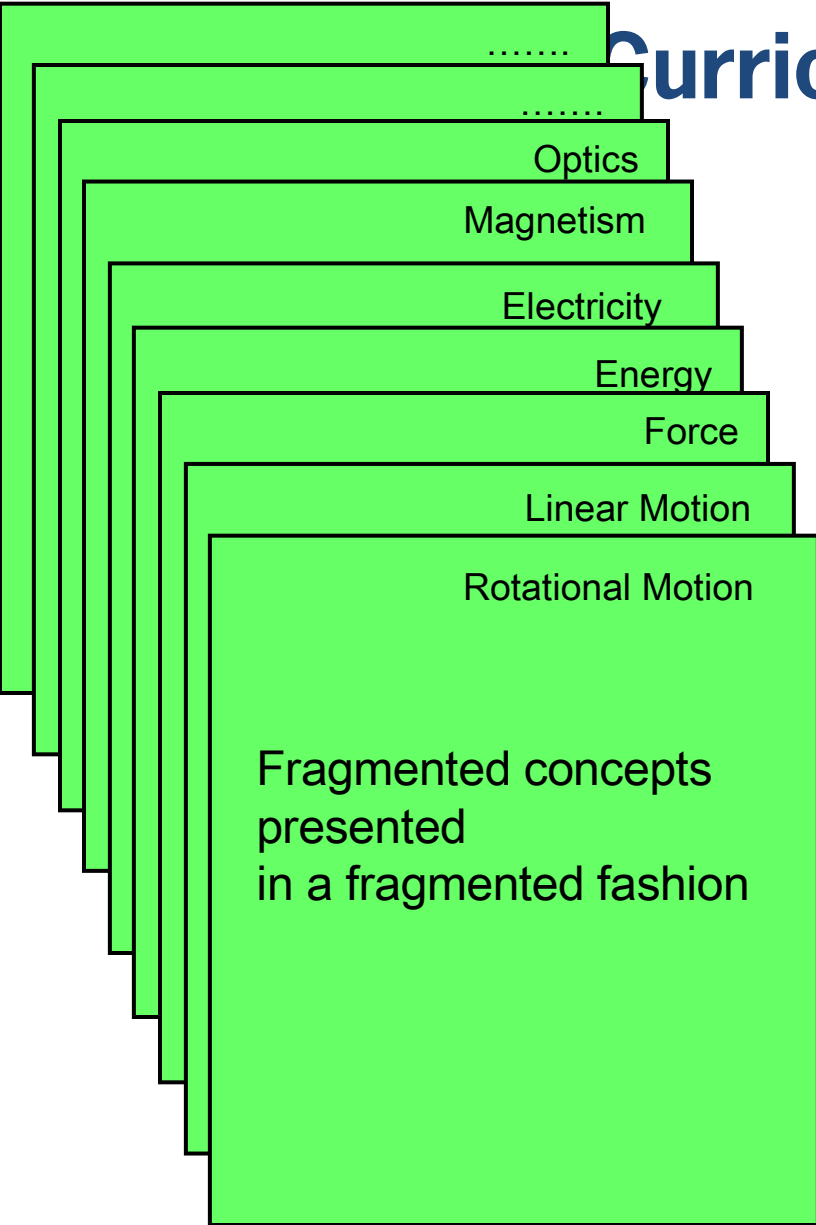
Skipping Christmas - Perspective

- *Skipping Christmas*: in theory and practice
 - This theory takes learning of literature through the layered process of: Using John Grisham's *Skipping Christmas* students will go through the following phases of literature analysis:
 - Personal reflection and comprehension (9th)
 - Personal perspective
 - Local analysis and application (10th)
 - Affects of one's actions on the community
 - Regional application and evaluation (11th)
 - Impression and affect from a broader perspective. – connect to current regional event: elections, community upkeep, school performance
 - Global application, evaluation and synthesis (12th)
 - Evaluate how an individual's actions have a global impact; mini research

Electoral Essay: Teachable Moments

- **Objective:** Expose the students to the literary aspects of writing as well as mathematical aspects such as ratios of polls on issues, their comparisons, effectiveness of their proposals to alleviate the economic and health industry problems, and the personal, local, national and global impact of political rhetoric and propaganda.
- **Instructional Strategies:**
 - Students will research the historical grounds of party platforms, McCain and Obama's platforms, and their implications. Students will also research the American electoral system and dissect the ratios by which the election was won.
 - Students will write a political news report to discuss and analyze the election and a class forum will be held to debate both candidates political campaigns.
- **Cross Curricular Connection:** Students will better understand the American electoral system and apply mathematical skills to their analysis of the election, students will then demonstrate mastery of public speaking and debate.

Curriculum Redesign - Physics



connection almost never made

Real life systems are complex. Each particular phenomenon requires an understanding of multiple interconnected key ideas.

ONGOING AND PLANNED PROJECTS

Inventor-Wild-Wind

Ferris Wheel

Electronic Arcade

RoboLab

Aircraft Carriers - Arrested Landing and Catapulting

Magnetic Levitation

Solar Physics - Solar House, Heat Pump

Structures - Bridges, Roller Coasters

Weather Analysis and Forecasting

AND MANY, MANY MORE!

Relating Physics With The Outside World

- Design paper planes of various shapes and sizes and discuss their flying dynamics.
- Build Your Own Roller Coasters, Program Your Own Robots.
- Learn How An Automobile Works.
- Learn how many different disciplines make up a Dyson vacuum cleaner.
- See how fluid flow principles are the same in the design of airplanes and golf balls and soccer balls.
- And So On ...

The Soccer Ball

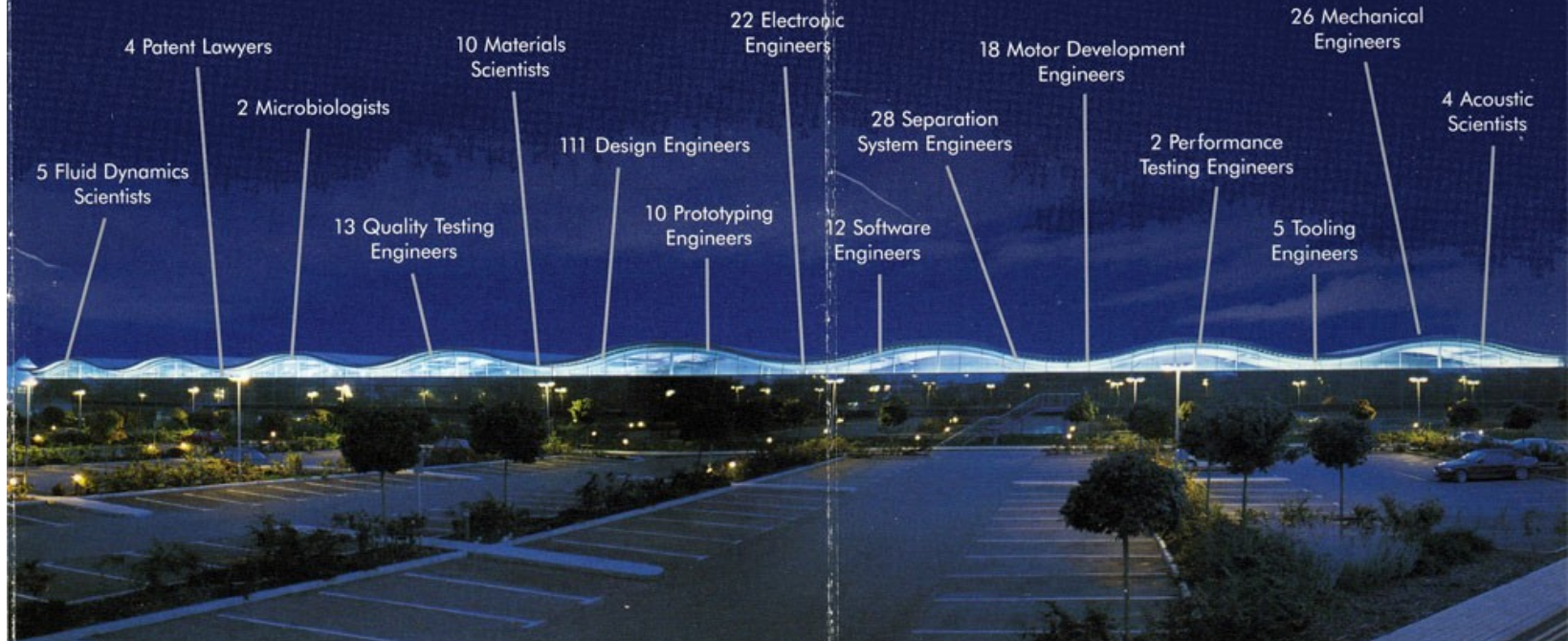
- No ball is a perfect sphere, but the closer it is to one, the smoother the trajectory.
- After goalkeepers during the 2006 soccer World Cup in Germany complained that the latest design had an unpredictable trajectory, **South African geologist** Jos Lurie decided to use his expertise in polyhedra and his 15 years of studying soccer ball designs to come up with a better pattern: 12 panels of a pentagonal dodecahedron and 30 of a rhombic triacontahedron.
- That makes for 42 panels--10 more than the popular Buckminster design and 28 more than the newer 14-panel Adidas Teamgeist. "The more panels you have, the more spherical the ball becomes," he says.
- Ready for the next World Cup, which will be held in South Africa in 2010.



SYSTEMS THINKING

Who makes a Dyson?

A third of the people at Dyson are engineers working in Research, Design and Development (RDD). We don't have product stylists – our machines look the way they do because they're functional – *technology can be beautiful*.



TECHNOLOGY INNOVATIONS

- A customized webpage for each teacher and a webpage of Best Practices is maintained on the Marshall-Gates website.
- A Teachers' Community Of Practice Network (TCOPNet) will be formed and maintained.
- A Students' Community Of Learning Network (SCOLNet) will be formed and maintained.
- Technology incorporation - multi-media animations and simulations (including the Wii set ups) as well as Virtual Worlds - should make the delivery more interesting.
- Project based learning - via K'Nex and Lego Mindstorms/NXT - has already proved to be a major asset in attracting students.

RESULTS

- Science and English passing rates have increased
- Curriculum is more rigorous through problem-based learning
- Increased participation and success in UIL events
- Several innovative approaches to instruction
- “Spiraled” approach builds comprehension in successive grade levels
- Integration of concepts and thinking across subjects and disciplines
- Increased number of students entering post-secondary education
- Increased faculty awareness of global competitiveness

SEALY INVITATIONAL UIL ACADEMIC MEET

ì 36 schools represented

s Angleton, Barbers Hill, Bay City,
Bellville, Blanco, Bellville, Blanco,
Boling, Brazos, Bridge City,
Brookeland, Calhoun, Centerville,
Challenge, Columbia, Dawson,
Dickinson, El Campo, Gonzales,
Hardin Jefferson, Industrial, Iola,
LaGrange, La Vernia, Livingston,
Morton Ranch, Navasota,
Needville, North Shore, Robinson,
Royal Sealy, Shepherd, Shiner,
Stafford, Waller, and West Hardin.

, The Royal science team finished
first scoring 488 points.

Results of the District 24AAA UIL Academic Meet

Science Contest (54 Participants)

Results:

Royal- 418

Pearland- 340

Stafford- 310

Needville- 234

Columbus- 192

Wharton- 164

Sealy- 162

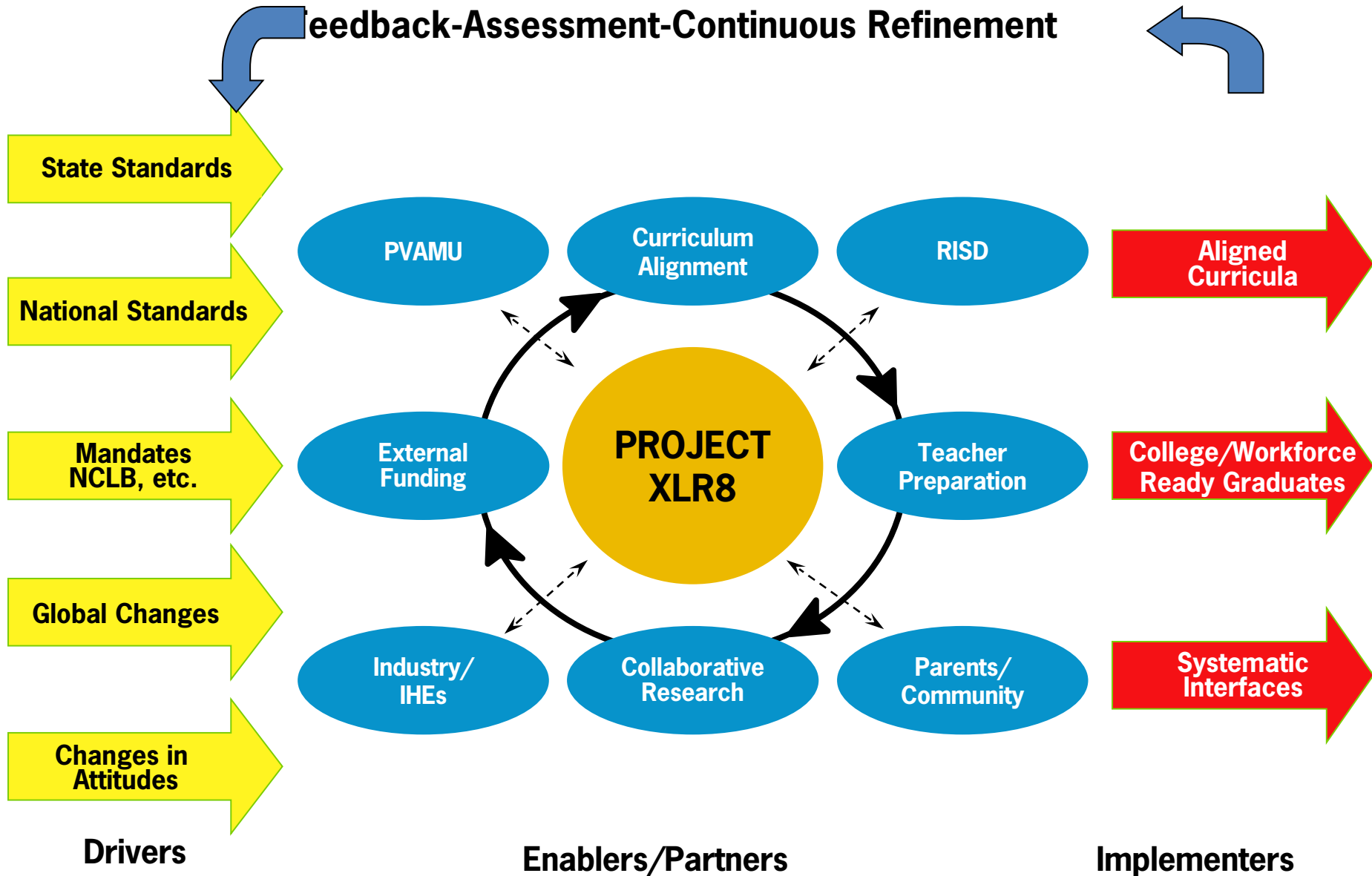
Columbia- 152

Sweeny- 116

NEXT STEPS - EXPAND PROGRAMS TO MIDDLE AND ELEMENTARY SCHOOLS

The National Science Board suggests that critical decisions about pursuing higher level mathematics and science courses in high school or majoring in related fields are determined based on student performance and interest in mathematics and science during the middle years.

A ROADMAP FOR PROGRESS



PARTING THOUGHT

We don't consider a patient cured when his sprain has healed or he's been restored to a minimal level of functioning. The patient is cured when he can again do the things he loves to do.

- Dr Stanley A Herring

<http://www.bartleby.com/63/63/2963.html>

We can paraphrase this statement for education!

PARTING THOUGHT

We don't consider a student ready to graduate from school when he/she passes a typical standardized test or can perform at a minimal level of functioning.

The student graduates when he/she can contribute effectively to a chosen career, is capable of meeting the needs of the workforce or of the preparation for an advanced degree, and is on par with his/her counterparts in the international arena.

THE SIXTH SENSE

<http://www.youtube.com/watch?v=mUdDhWfpqyg>

TED sixth sense technology

NOT ON THE TEST

<http://www.youtube.com/watch?v=8dAujuqCo7s>

Thank you for your time.
We welcome collaborations.
Any Questions?

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acknowledged.*

Project XLR8 Webpage:
<http://www.pvamu.edu/MarshallGates>

OUR MOTTO

***“Converting Student
Potential Into Lifetime
Achievement”***