A 21st Century STEM Teacher Preparation Model

A model that provides learners an orchestrated immersion in Engineering, Technology, Science & General Education in a nontraditional, multisensory learning environment
21st Century Teacher Preparation

STEM Education Reform: Technology Learning Center

An orchestrated immersion in Science, Technology, Engineering, Math & General Education in a nontraditional, multisensory learning environment

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21st Century Teacher Preparation

Overview

- What is STEM?
- Traditional Teacher Preparation
- A 21st Century Model
  - The Learning Design
  - Implementation in Phases
  - Design Integration
- K-12 Repurposing/Migration/Integration
  - Collaboration & Partnerships
- Q & A
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What is STEM?

“STEM Literacy refers to an individual’s ability to apply his or her understanding of how the world works within & across four interrelated domains.”

Organisation for Economic Co-operation & Development & the International Technology Education Association
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What is STEM?

STEAM
- STEM + Art & Design
- Integrating the Arts – music, visual arts, drama & dance

STEAMIE
- STEAM + IE (Include Everyone)

STREAM
- STEM + Research + Art

General Education
- Important intellectual & civic capacities
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What is STEM?

STEM

“The Integration & Application of Knowledge Thus Addressing ALL Subject Matter!”

The NEW General Education in the 21st Century!

R. Lurker, 2012
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Traditional Teacher Preparation

- Lecture
- Boring
- “No Longer Relevant”

- Isolated Disciplines
  - Silos

- Defining Technology
  - Technology vs. Instructional Technology
  - Single Aspect of Technology
    - Ex. Computers, Laptops, iPads, Kindles

NGA, 2008, Taylor, 2009
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Traditional Teacher Preparation

The National Governors Association (NGA)

_Innovation America: Building a Science, Technology, Engineering & Math Agenda_ report

Factors that turn off students:

- Artificial separation in the curriculum of natural phenomenon into subjects.
- Lack of attention to the human-made world of engineering & technology.
- Disconnect of coursework from the lives of students.
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Traditional Teacher Preparation

The National Governors Association (NGA)

Innovation America: Building a Science, Technology, Engineering & Math Agenda report

Current Workforce:

✔ Under-qualified

The Solution:

✔ High quality preparation
  &
✔ Professional development
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The Learning Design
Integration & Application of Knowledge
Addressing ALL Subject Matter!

Teacher Needs:
- Learning Opportunity
- Experience
- Application

Student Needs:
- Relevant
- Integrated Disciplines
- Hands-On
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Goals

1. Comprehensive Facility
2. Prepare independent, self-directed learners
3. Develop skills
   - Individual Goal Setting, Problem Solving, Communication & Collaboration, Innovation, Self-evaluation
   - An Understanding of Evolving Technology

Applications

- Pre- & In-Service Teacher Education, General Education & Capstone Courses
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- **Best Practices**
  - Project-based, Hands-on, Active
  - Relevant, Constructivist Learning

- **Students**
  - Responsible for their own learning
  - Teachers act as facilitators

- **Whole Brain Teaching & Learning**
  - Delivery designed to respond to personal uniqueness
  - Learning through affirmation & discovery

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Central Core of Technology
- Common Technologies
  - Interdisciplinary Approach
  - Cross-Curriculum
- Career Exploration
- Grades 6 through Adult Education

Surrounding Support Areas
- Advanced Technology Zones
  - Cross-College
  - Multi-Discipline
- Collaboration Resources
  - Advanced Projects
  - Capstone Courses
- Customizable/Configurable
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Building Technology Core
- Central Core of Technologies
  - Technovation Plaza™
- Surrounding Areas
  - Advanced Technologies
  - Collaboration Areas
  - Project Development
  - Experimental Design Areas
- Visually Accessible
  - Open Atrium
  - Living Growing Environment
- Grades 6 through Adult Learners

Original concept developed for University of Central Missouri, Warrensburg
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General Education Technology Core

Science & Data Acquisition
Publishing
Computer Graphics
Mechanics & Structures
Robotics & Control Technology

Multimedia
Computer Simulations
Circuitry Electric/Pneumatic

Radiation Zone
Recycling/Reprocessing Zone
Transportation Zone

Biomes
Global Production
Anechoic Chamber
Animatronics
Sound Studio
Medical Zone

Alternative Energy
Robotics & Automation
Electrical/Electronics

Bio Technology Life & Earth Science Zones

Ideation Space™

Virtual Reality CAVE
Fire & Water Zone
Graphics
Production Zone
Aquaculture Zones
Materials Zone

Vocational Zones
Wind Tunnel Zone
Textile Zone
Imaging Zone
Art/Design Zone

Virtual Reality
Public Safety & National Security Simulators

Virtuality Studio & Editing Booth
Seminar Theatre Area
Other Possibilities ???

High Technology Hard Fabrication & Prototyping Zones

Collaboration Cove™

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Potential Core Course Offerings

**Public & Charter Schools**
- TECH 100: Introduction to Technology
- TECH 200: Technology & Self Direction
- TECH 400: Technology Project Design & Development

**Undergraduate**
- TECH 1000: Introduction to Technology (3)
- TECH 2000: Technology & Self Direction (3)
- TECH 4000: Technology Project Design & Development

**Graduate**
- TECH 5100: Technology in a Facilitative Environment (3)
- TECH 5200: Technology Philosophy & Practice (3)
- TECH 5400: Practicum in Technology
- TECH 6000: Project Design & Development (3-6)
- TECH 6999: Facilitating Technology in a Hands-on Environment (3)

**Certificate Program**
- Undergraduate & Graduate Technology Certificates
  - 3-4 Courses
  - Electives
  - 15 Credits
- Technology Environment
  - Inquiry-based
  - Hands-on
  - Interdisciplinary
  - Facilitating
  - Teams
  - Projects

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Curriculum “Best Practices”

- Creative Learning Systems
  - Learner Centered, Project-Based Learning
    - Open-Ended – **NOT** Modular Approach
    - Multiple Learning Paths
  - Self-Directed Learning Format
  - Constructivism
  - Brain-Based Learning Theory
  - Theory of Multiple Intelligences
  - Positive Outcomes
    - Improved STEM test scores
  - More Than 20 Years Experience
  - Technology & Alternative Energy

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The Harry & Jeanette Weinberg Technology Plaza, Mid-Pacific Institute, Honolulu, Hawaii

1. Aqua Culture
2. Bio-Technology Zone
3. Robotic Work Cell
4. Global Commons™
5. Facilitator Zone
6. Knowledge Wall
7. Ideation Zone™
8. Collaboration Cove™
9. Head End Room
10. Digital Editing Booth
11. Virtuality Studio™ w/ CYC Wall™
Learning Areas: Integrated Systems of Technology

2D & 3D Vector Graphics • Aerodynamic Modeling • Animated Graphics • Applied Math • Applied Science •
Architectural Design and Drafting • Basic Structural Elements • Business Simulations • Collaborative Design •
Computer Aided Design • Computer Aided Manufacturing • Computer Aided Publishing • Computer Animation •
Computer Interface Control Technology • Computer-Assisted Musical Composition and Notation • Computerized Flight Simulation • Critical Problem Solving • Data Processing • Digital Audio Engineering • Digital Imaging •
Electronics and Microelectronics • Engineering & Design Concepts • Entertainment Technology • Environmental Sciences and Studies • Global Communications • Graphic Design • Higher Level Thinking Skills • Hypermedia Tools • Image Processing • Internet Research Strategies • Lasers, Optics, Light • Manufacturing Systems • Manufacturing Systems of Technology • Materials Testing • Measurement of Heat, Light, and Movement • Mechanic of Materials and Machines • Modeling of Structural Systems and Human Settlements • Multimedia Applications Authoring • Multimedia Communications • Non-Linear and Linear Digital Video Editing • Plant Layout Modeling • Pneumatics • Portfolio Creation and Maintenance • Presentation Design • Principals of Mechanical Systems • Product Design • Research & Design • Resume / Employment Skills • Robotics & Automation • Robotics & Automation Technology • Simulated Flights • Sound-Effects • Space Frame, Geodesic, Flexible Membrane Structures • Speed, Motion, and Trajectory • Story-Boarding • Structural Stress Testing • Super Conductivity • Systems of Construction • Systems Simulations • Team Effectiveness Training • Tech Related Social Assessment • Technical Career Exploration • Technology Ethics / Morality • Technology History / People • Vehicle Design and Performance • Web Page Design • Wind Tunnel Testing • Word Processing

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Students’ Comments

- “Most Teens Associate School with Boredom, Fatigue”

*SmartLab™ students report “High Levels of Interest”

Source of school survey data – “Most Teens Associate School with Boredom, Fatigue” Gallup Organization, 2004
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Outcomes

- Student Technology Literacy
- Student Recruiting
- Transdisciplinary Studies
- Test Score Improvements
- Self Directed Learning
- Project-Based Learning
- School Partnerships
- Electronic Portfolios
- Student Retention
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Phase I - 21st Century Learning Demonstration
- STEM Pre-Service, In-Service Education
- Temporary Facility

Phase II - Design Collaboration & Construction
- Public Planning Process, Design Development, Construction,
  Concurrent with Demonstration Phase

Phase III - 21st Century in Practice
- STEM Teacher Education
- Regional Professional Development Center
- Child Development Center
- Small Business Development
- General Education
- Capstone Program Support
- Community Resource
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Phase I - 21st Century Learning Demonstration

Staffing
Facilitators:
University/College Faculty
Graduate Students

SmartLab™
Learning Environment:
- Critical Thinking
- Problem Solving, Creativity
ePortfolio
Collaboration
Communication
Self-Direction
Application of Technology
Project Management
Information & Media Literacy

* Creative Learning SmartLab™ a basic version of the Technovation Plaza™
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Community Design Applications/Interactions

- **Building Overview**
  - Multi-Age Learning Environment
  - Collaboration Resource

- **Community Resource**
  - Professional Development
  - Business, Industry, Law Enforcement, Military
  - Public, Private Schools, University, Community College
Community Design Applications/Interactions

- Level 1 – Lower Level Example

“Three-dimensional Textbook”*

- Multisensory Design
- Silent Curriculum
- “Best Practices”
- Cross Discipline
- Reconfigurable & Deployable
- Visual access to learning areas
- Holistic, Sustainable Environment
- Application & Integration of Technology

(*Taylor, 2009)
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Community Design Applications/Interactions

- Level 2 - Example
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Community Design Applications/Interactions

- Level 3 – Roof Example
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K-12 Repurposing/Migration/Integration

Department of Defense Educational Activity (DoDEA)

- 34th Largest School System
  - Operates 194 Schools
  - Serving 86,076 Students
  - 14 Districts
    - 12 Foreign Countries, 7 States, Guam, & Puerto Rico

The Charge

- ReVision for 21st Century Education
  - Replace or Revamp 194 Schools
  - 5-7 years - $4B

Define 21st Century Education!

DoDEA, Jacobs, Work Session #1 Report, 2011
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K-12 Repurposing/Migration/Integration

Results – WS #1

- Themes
  - Differentiated Learning
  - Multiple Modalities
  - Multidisciplinary Teaching
  - Real-World Skill Development

Student-Centered Education

- Over-reaching Theme
  - Curriculum & Instruction
  - Facilities
  - Policy
  - P.D. Funding?

DoDEA, Jacobs, Work Session #1 Report, 2011
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K-12 Repurposing/Migration/Integration

P-20 Planning Considerations
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K-12 Repurposing/Migration/Integration

P-20 Planning Considerations

- **Professional Development**
  - Who needs to receive this training?
    - Teachers
      - All Teachers, All Levels
    - Counselors
    - Administrators
    - School Board Members
    - Project Partners
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K-12 Repurposing/Migration/Integration

Opportunities for Your Involvement

- **Partnerships**
  - Education
  - Business & Industry
  - Government
  - Foundations

- **Sponsorships**
  - Labs, Facilities, Exhibits

- **Advisory Group Committees**
  - Technology Center
  - Child Development Center
  - Professional Development Center
  - Business & Entrepreneurial Center

- **Research**
  - STEM
  - Educational
  - Business & Industry

- **Funding**
  - Public, Private
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K-12 Repurposing/Migration/Integration

Potential Revenue Source Generation

Service Partnership Opportunities
- University/College
  - Tuition & lab usage fees
- Public & Charter Schools
- Community Education
- Businesses
  - Product development/prototyping
  - Food production sales
  - Facilities & equipment rentals
- Summer Camp/Summer Workshops
  - Housing, food services, facilities

Community Resources
- Energy Generation
  - Wind, solar, other
- Recycling Center/Processing
- Food Service/Coffee Shop
  - Student program management
- Physical Arcade
- Climbing Wall
- Global Production Biomes
  - Food production & plant sales
  - Aquaculture production
  - Community gardens
Potential Revenue Source Generation (Cont.)

Advanced Technology Zones

- Collaboration Coves & Ideation Spaces
  - Business collaboration/meetings
- Business & Research Rentals
  - Anechoic Chamber
  - Virtual Reality Simulators
  - Virtual Reality CAVE
  - Virtuality Studio & Editing
  - Sound Studios
  - Hard Fabrication & Prototyping
  - Fire & Water Zones
  - Bio Technology Zones

Elementary Technology Center

- Classes & Programs for Children
  - After-school classes
  - Evening classes
  - Summer programs/classes

Child Development Center

- Day & Evening Childcare
- Community Workshops
  - Parents, childcare workers
News release ITEEA reported:

“...the National Science Board & the National Academy of Science, as part of the process of creating a new generation of science standards, released a draft that includes technology & engineering as a major addition to the science content to be taught, ...”

- What would this look like?
- Two New Boxes?
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K-12 Repurposing/Migration/Integration

High School: Repurposing Model v1.0

Science & Technology Learning Center

- Bio Technology Life & Earth Science Zone
- Aquaculture Zone
- Global Production Biomes
- Culinary Arts
- Kitchen
- Food Court
- Entrepreneurial Zone
- Design Studio
- High Technology Hard Fabrication & Prototyping Zone
- Career Zone(s)
- Specialty Zone(s)
- Virtuality Studio & Editing Booth

Collaboration Cove(s)™
Ideation Space(s)™

Technology
Engineering
Art
Biology
Chemistry
Physics
Health
Energy
Math
Environment
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Summary

- **Defining STEM**
  - The Integration & Application of ALL Knowledge, ALL Disciplines

- **Good Learning Design**
  - Application, Relevant, Integrated Disciplines, Hands-On

- **Planning Considerations**
  - Curriculum, Facilities, Policy

- **Partnerships**

- **Revenue**

- **Rethinking School Design**
  - Integrating the Curriculum
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STEM Education Reform: Technology Learning Center

“In the realm of technology, the educational community is playing catch-up. Industry is far ahead of education. & tech-savvy high school students often are far ahead of their teachers.”

“Public schools that do not adapt to the technology needs of students risk becoming increasingly irrelevant. Students will seek other options.”

“Reforms within the system will require strong leadership & a willingness to restructure the learning environment in fundamental ways.”

~ Conclusions, National Technology Plan, 2005 ~