The STEM Trifecta: Creating a STEM Learning Space, Designing Activities for Students with Disabilities, & Culturally Relevant Pedagogy in STEM

Laura Zieger, Ed.D.
Samantha Kozar, Ed.D
Dana Mason, Ed.D

NJCU's Educational Technology Department

NJCU

Master of Arts degree in Educational Technology

- 36 credits - 12 classes
  (4 of the 12 are the STEM courses)
- Completely Online Asynchronous
- Project-based (no tests)

- **Master of Arts degree in Educational Technology *(with a Specialization in School Library Media)***
- **Master of Arts degree in Educational Technology *(with a Specialization in STEM)***
- **Master of Arts degree in Educational Technology *(with a dual Specialization in STEM and School Library Media)***

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Graduate Level Certificates

- STEM (12-credits)
- Assistive Technology (15-credits)
- School Library Media Specialist (24-credits)

EdD in Educational Technology Leadership

3 Year Cohort-Based Program

- 2 years coursework (3 semesters/year) and 1 year dissertation
- Completely asynchronous online except for one week in mid-July each year.

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STEM Certificate

The Certificate in STEM Education is a rigorous four-course (12-credit) program that provides K-12 educators in all disciplines, school leaders and librarians with both the foundational STEM pedagogy, and the hands-on experience to be successful integrating STEAM in their classrooms and schools both on-site and remotely.

EDTC 645- STEM Foundations: Rethink Learning
EDTC 642- Curriculum Design: STEM Authoring Tools
EDTC 625- Integrating STEM across the Curriculum
EDTC 621-Leading Curriculum Change Using the Internet

Since 1998, Martinson Family Foundation has funded and guided dedicated programs at universities to enhance STEM instruction for K-12 students. The Foundation seeks innovation in curriculum, teaching methods, and professional development.

Martinson Family Foundation

STEM Certificate approved by the NJ President's Council Academic Issues Committee
April 2, 2021

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STEM Certificate

- State Approved Certificate Program
- 4 classes
- Transdisciplinary STEM learning
- Actionable & relevant for immediate application
- No tests or exams
- Aligned to State and National learning and professional standards
- Convertible to graduate credits
- Applies toward MA degree in Educational Technology or School Library certification

Continuing Education STEM Certificate

- Same content & pedagogy
- Faculty cohorts
- Ability to tailor to district needs
- Address district learning goals or initiatives
- Force multiply staff to teach STEM
- Earn STEM Certificate in as little as 15 weeks!
- (More in a moment!)

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Continuing Education STEM Certificate

The Continuing Education STEM Certificate contains the same content and pedagogical teaching and learning approaches for educational professionals, but offers continuing education units (18 total).

Individuals that maintain a letter grade of "B" or higher can convert the CEUs to graduate credit at the completion of the program at a reduced rate!

NCD 429- STEM Foundations: Rethink Learning
NCD 424- Curriculum Design: STEM Authoring Tools
NCD 426- Integrating STEM across the Curriculum
NCD 427-Leading Curriculum Change Using the Internet

- Multiple Formats Available
  - Hybrid or Asynchronous
- Grading Options
  - P/F or Letter Grades
- Designed for Working Professionals
- Focus on DEI in STEM
- Emphasis on district needs
- Evidenced-based practices & tools

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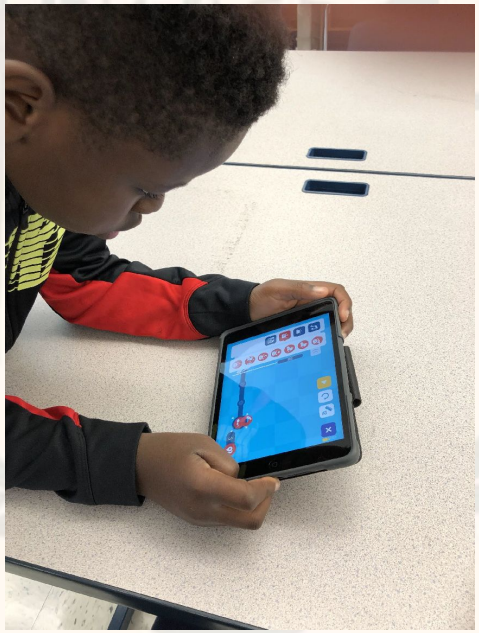
STEM Education

In an ever-changing, increasingly complex world, it's more important than ever that our nation's youth are prepared to bring knowledge and skills to solve problems, make sense of information, and know how to gather and evaluate evidence to make decisions. These are the kinds of skills that students develop in science, technology, engineering, and math disciplines collectively known as STEM.
(U.S. Dept. of Education ed.gov/stem)

Through STEM, students develop key skills including:

- problem solving
- creativity
- critical analysis
- teamwork
- independent thinking
- initiative
- communication
- digital literacy



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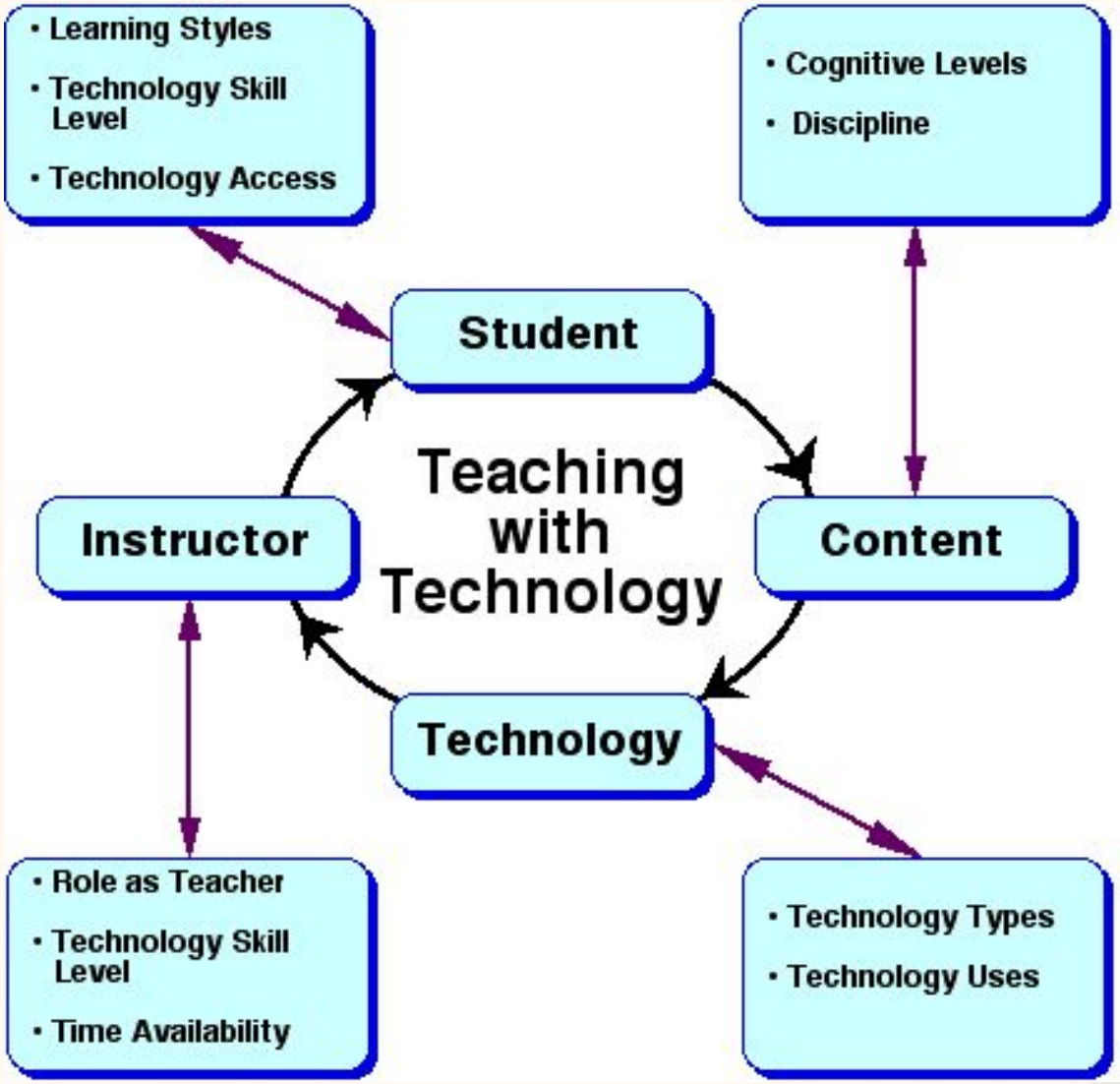
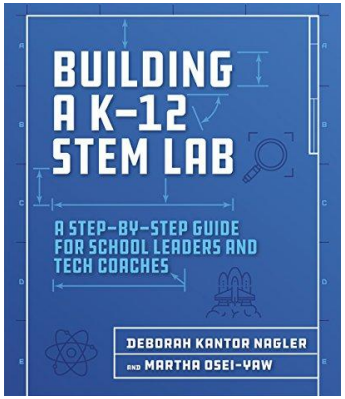
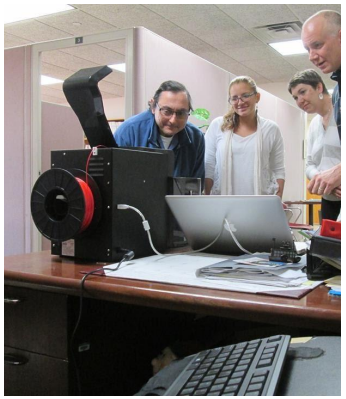

• Learning Styles
• Technology Skill Level
• Technology Access
• Cognitive Levels
• Discipline
Student
Instructor
Teaching with Technology
Content
Technology
• Role as Teacher
• Technology Skill Level
• Time Availability
• Technology Types
• Technology Uses

Cutting-Edge Curriculum

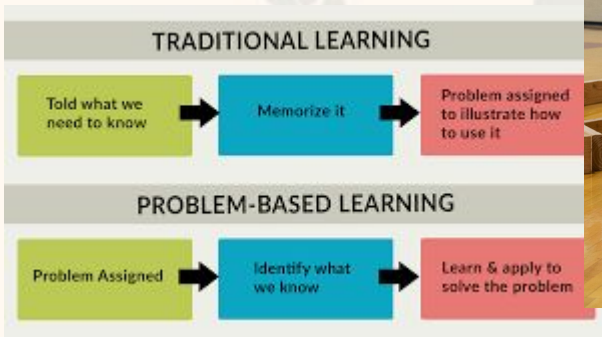


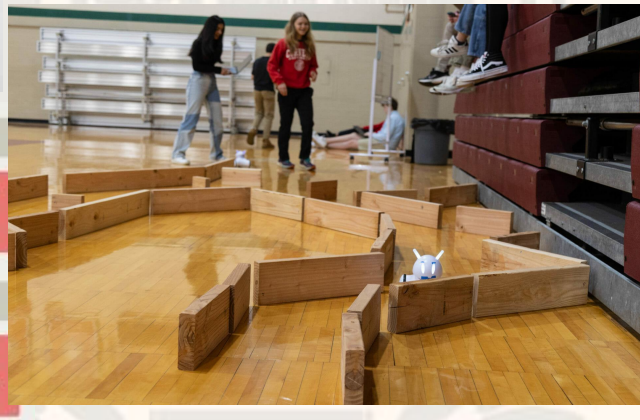


EDTC 645 Syllabus

Course Description:

This integrated, transdisciplinary course challenges students to rethink learning by integrating innovative STEM practices and tools and providing hands-on and relevant learning experiences. Students will engage with comprehensive STEM tools to support pedagogical applications in all areas of the curriculum and in all grade levels.





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Three Remaining Courses

EDTC 621-Leading Curriculum Change Using the Internet
This course develops students' capacity to create and lead school-wide STEM efforts to foster student success using internet-based tools and applications. Students will learn and practice strategies for using the internet to analyze data, determine learner needs, and generate curriculum and policies to support faculty and learner success.

EDTC 625- Integrating STEM across the Curriculum
Students will learn how to apply a variety of technologies in systemic approaches to STEM curriculum design and implementation. They explore leadership and supervisory approaches to the redesign of instruction through emerging and online technologies in alignment to standards that address technology integration and professional development.

EDTC 642- Curriculum Design: STEM Authoring Tools
In this course, students will explore a variety of multimedia creation tools. Students will conduct a comprehensive survey of STEM authoring tools and create projects applying design elements. Throughout the course, students will reflect upon the capabilities of STEM authoring tools that are available to instructional multimedia designers.

The STEM Certificate Program Employs Guided Pathways

•Instructional Choice & Flexibility

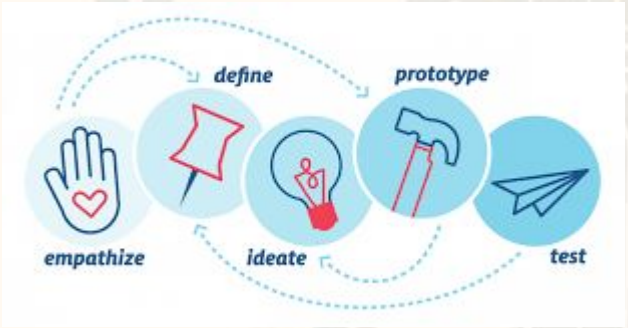
•Each Course Has Activity Pathways Geared Towards Educators and Administrative Professionals that links employment with further education.

Instructors Help Students Choose Pathways that Increase Awareness, Promote Creativity, and Foster Collegiate Collaboration.

The Program is Designed to Ensure Learning is Happening with Intentional Outcomes.

Projects

- Develop and build a podcast
- Design challenge
- Create multimedia content using emergent technologies
- Build projects using Scratch
- Create tech-enhanced student choice boards with SEL components
- Develop a DEI STEM PD



Creating Culturally Relevant STEM Learning Spaces through Pedagogies of Engagement

Dr. Samantha Kozar

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"What are you doing as an administrative leader to help your teachers build habits of mind for culturally responsive STEM instruction?

Consider

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"Throughout the whole enterprise, the core issue, in my view, is the mode of teaching and learning that is practiced. Learning 'about' things does not enable students to acquire the abilities and understanding they will need for the twenty-first century. We need new **pedagogies of engagement** that will turn out the kinds of resourceful, engaged workers and citizens that America now requires."

Russ Edgerton *(reflecting on higher education projects funded by the Pew Memorial Trust)*

Pedagogies of Engagement: Classroom-Based Practices

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ABSTRACT

Educators, researchers, and policy makers have advocated student involvement for some time as an essential aspect of meaningful learning. In the past twenty years engineering educators have implemented several means of better engaging their undergraduate students, including active and cooperative learning, learning communities, service learning, cooperative education, inquiry and problem-based learning, and team projects. This paper focuses on classroom-based pedagogies of engagement, particularly cooperative and problem-based learning. It includes a brief history, theoretical roots, research support, summary of practices, and suggestions for redesigning engineering classes and programs to include more student engagement. The paper also lays out the research ahead for advancing pedagogies aimed at more fully enhancing students' involvement in their learning.

Keywords: cooperative learning, problem based learning, student engagement

I. INTRODUCTION TO THE PEDAGOGIES OF ENGAGEMENT

Russ Edgerton introduced the term "pedagogies of engagement" in his 2001 *Education White Paper* [1], in which he reflected on the projects on higher education funded by the Pew Charitable Trusts. He wrote:

> "Throughout the whole enterprise, the core issue, in my view, is the *mode* of teaching and learning that is practiced. Learning 'about' things does not enable students to acquire the abilities and understanding they will need for the twenty-first century. We need new pedagogies of engagement that will turn out the kinds of resourceful, engaged workers and citizens that America now requires."

Prior to Edgerton's paper, the widely distributed and influential publication called *The Seven Principles for Good Practice in Undergraduate Education* [2] stressed pedagogies of engagement in concept. Three of the principles speak directly to pedagogies of engagement, namely, that good practice encourages student-faculty contact, cooperation among students, and active learning.

More recently, the project titled The National Survey of Student Engagement (NSSE) [3] deepens our understanding of how students perceive classroom-based learning, in all its forms, to and connects the bigger issue of student engagement in their college education. The NSSE project conceives that student engagement is *not* just a single course in a student's academic career, but rather a pattern of his or her involvement in a variety of activities. As such, NSSE findings are a valuable assessment tool for colleges and universities to track how successful their academic practices are in engaging their student bodies. The NSSE project is grounded in the proposition that student engagement, the frequency with which students participate in activities that represent effective educational practice, is a meaningful proxy for collegiate quality and, therefore, by extension, quality of education. The annual survey of freshmen and seniors asks students how often they have, for example, participated in projects that required integrating ideas or information from various sources, used e-mail to communicate with an instructor, asked questions in class or contributed to class discussions, received prompt feedback from faculty on their academic performance, participated in community-based projects, or tutored or taught other students. Student responses are organized around five benchmarks:

1. *Level of academic challenge*: Schools encourage achievement by setting high expectations and emphasizing importance of student effort.
2. *Active and collaborative learning*: Students learn more when intensively involved in educational process and are encouraged to apply their knowledge in many situations.
3. *Student-faculty interaction*: Students able to learn from experts and faculty serve as role models and mentors.
4. *Enriching educational experiences*: Learning opportunities inside and outside classroom (diversity, technology, collaboration, internships, community service, capstones) enhance learning.
5. *Supportive campus environment*: Students are motivated and satisfied at schools that actively promote learning and substantive social interaction.

Astin's [4] large-scale correlational study of what matters in college (involving 27,064 students at 309 baccalaureate-granting institutions) found that two environmental factors were by far the most predictive of positive change in college students' academic development, personal development, and satisfaction. These two factors—interaction among students and interaction between faculty and

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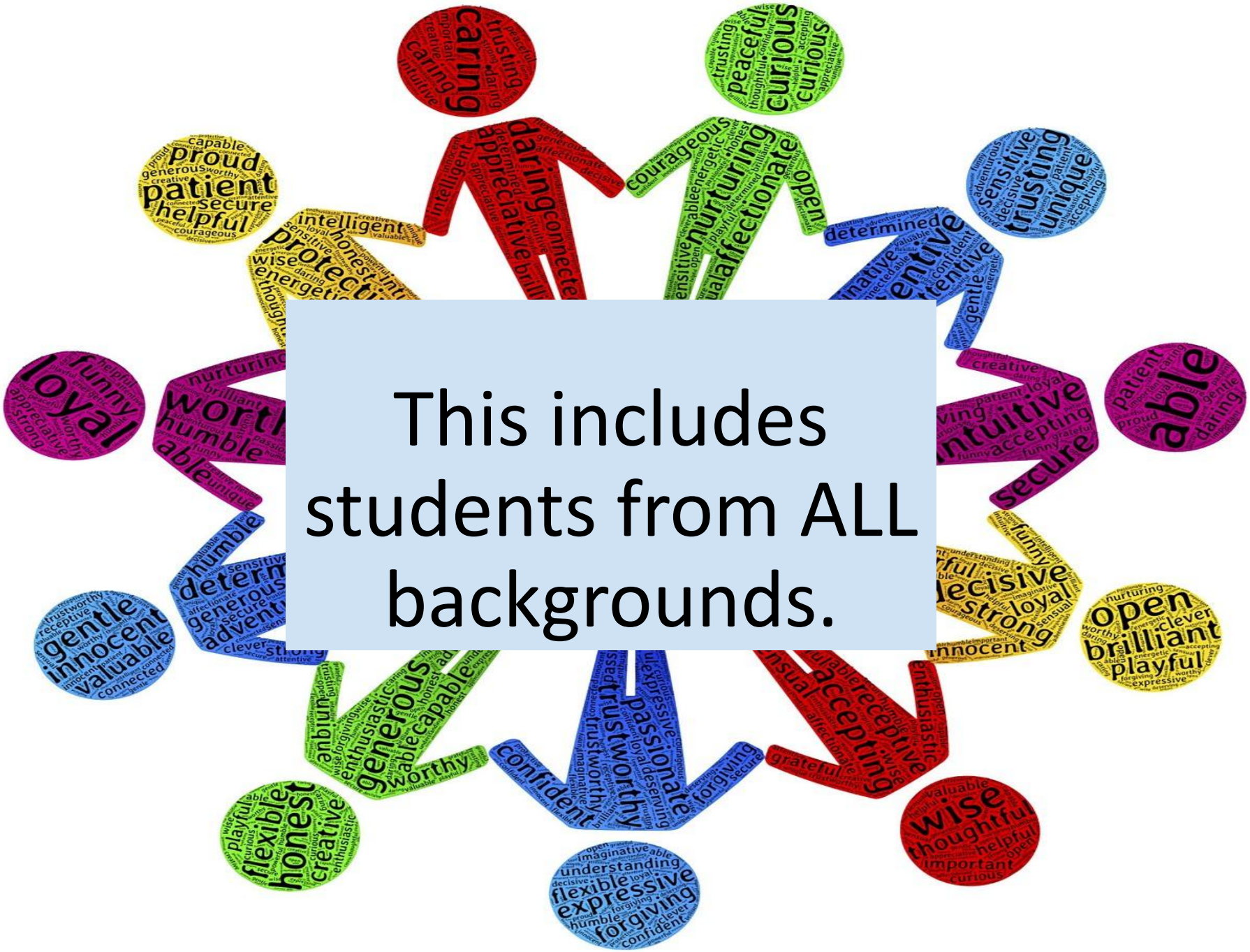
caring
curious
proud
patient
helpful
secure
daring
courageous
nurturing
affectionate
sensitive
trusting
unique
determined
loyal
able
humble
gentle
innocent
valuable
connected
generous
capable
trustworthy
confident
passionate
accepting
grateful
wise
thoughtful
important
flexible
creative
honest
expressive
forgiving
understanding
open
brilliant
playful
clever
strong
decisive
funny
intuitive
This includes students from ALL backgrounds.

Student Engagement Research Evidence

- Perhaps the strongest conclusion that can be made is the least surprising. Simply put, the *greater* the **student's involvement or engagement** in academic work or in the academic experience of school, the *greater* **their level of knowledge acquisition and general cognitive development** …(Pascarella and Terenzini, 2005).
- **Active and collaborative instruction** coupled with **various means to encourage student engagement** invariably lead to better student learning outcomes irrespective of academic discipline (Kuh et al., 2005, 2007).

See Smith, et.al, 2005 and Fairweather, 2008, Linking Evidence and Promising Practices in Science, Technology, Engineering, and Mathematics (STEM) Undergraduate Education - http://www7.nationalacademies.org/bose/Fairweather_CommissionedPaper.pdf

Impacts

- Curriculum and Instruction
- School Climate
- Teacher Retention and Recruitment
- Teacher Evaluation
- Professional Learning for Educators
- Overall Student Learning

Culturally Relevant STEM Education

1) **Deepen Knowledge on Culturally Relevant Education**
   a) Affirm students' identifies
   b) Utilize lived experiences in development of classroom activities/performance measures
   c) Maintain high expectations
2) **Deepen Knowledge on Students from Historically Underserved Communities**
   a) Increase students' sense of belonging (representation in STEM)
3) **Shift Paradigm of Education & Share Power with Students**
   a) Move from teacher-centered to student-centered
   b) Share power with students
4) **Reflection in Action**
   a) Iteration, feedback cycles, transparent checkpoints, adjusting to needs.

RESTUCTURING EDUCATIONAL PEDAGOGY: A MODEL FOR DEEP CHANGE

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Numerous research studies support the claim that affect plays a critical role in decision-making and performance as it influences cognitive processes [1] [2] [3]. Despite this body of research there is insufficient theory within educational pedagogy to recognize and address the role and function of affect. The innovative models and theories that have been proposed to facilitate advancement in the field of educational pedagogy tend to focus on cognitive factors. Consequently, affective cues, which have a significant role, are often misinterpreted or ignored. We propose several new models for framing a dialogue leading to new insights and innovations that incorporate theories of affect into educational pedagogy.

Introduction

> The education establishment, including most of its research community, remains committed to the educational philosophy of the late nineteenth and early twentieth centuries, and so far none of those who challenge these hallowed traditions has been able to loosen the hold the educational establishment has on how children are taught.
>
> - Seymour Papert, *The Children's Machine*

Education traditionally has emphasized conveying a lot of information and facts, and has not modeled the learning process. When teachers present material to the class, it is usually in a polished form that omits the natural steps of making mistakes (feeling confused), recovering from them (overcoming frustration), deconstructing what went wrong (not becoming dispirited), and starting over again (with hope and maybe even enthusiasm). Learning naturally involves failure and a host of associated affective responses. However current educational pedagogy is lacking in certain areas and must be refocused and then reengineered.

But refocusing and reengineering educational pedagogy is a non-trivial task. To justify any change let alone this two-phased change, it must be shown that past research or legacy research is obsolete or irrelevant. To make our point we need to briefly review the nature and purpose of education over the years.

In Colonial days, schools were based upon 'recitation literacy' and from the World War I era forward schools were based upon 'extraction literacy' [4]. However a major shift in intellectual abilities necessitated the requirement for students of the new millennium to understand the state of their knowledge, be able to build upon it, improve it, and apply it appropriately. In short "[s]ociety envisions graduates of school systems who can identify and

November 14, 2022-*MIT Press.*
https://web.media.mit.edu/~reilly/pathways.pdf

EDUCATION

Farewell, Lecture?

A physics professor describes his evolution from lecturing to dynamically engaging students during class and improving how they learn.

Eric Mazur

Discussions of education are generally predicated on the assumption that we know what education is. I hope to convince you otherwise by recounting some of my own experiences. When I started teaching introductory physics to undergraduates at Harvard University, I never asked myself how I would educate my students. I did what my teachers had done—I lectured. I thought that was how one learns. Look around anywhere in the world and you'll find lecture halls filled with students and, at the front, an instructor. This approach to education has not changed since before the Renaissance and the birth of scientific inquiry. Early in my career I received the first hints that something was wrong with teaching in this manner, but I had ignored it. Sometimes it's hard to face reality.

When I started teaching, I prepared lecture notes and then taught from them. Because my lectures deviated from the textbook, I provided students with copies of these lecture notes. The infuriating result was that on my end-of-semester evaluations—which were quite good otherwise—a number of students complained that I was "lecturing straight from (his) lecture notes." What was I supposed to do? Develop a set of lecture notes different from the ones I handed out? I decided to ignore the students' complaints.

Click here. Students continually discuss concepts among themselves and with the instructor during class. Discussions are spurred by multiple-choice conceptual questions that students answer using a clicker device. See supporting online text for examples of such "clicker questions."

A few years later, I discovered that the students were right. My lecturing was ineffective, despite the high evaluations. Early on in the physics curriculum—in week 2 of a typical introductory physics course—the Laws of Newton are presented. Every student in such a course can recite Newton's third law of motion, which states that the force of object A on object B in an interaction between two objects is equal in magnitude to the force of B on A—it sometimes is known as "action is reaction." One day, when the course had progressed to more complicated material, I decided to test my students' understanding of this concept not by doing traditional problems, but by asking them a set of basic conceptual questions (*1*, *2*). One of the questions, for example, requires students to compare the forces that a heavy truck and a light car exert on one another when they collide. I expected that the students would have no trouble tackling such questions, but much to my surprise, hardly a minute after the test began, one student asked, "How should I answer these questions? According to what you taught me or according to the way I usually think about these things?" To my dismay, students had great difficulty with the conceptual questions. That was when it began to dawn on me that something was amiss.

In hindsight, the reason for my students' poor performance is simple. The traditional approach to teaching reduces education to a transfer of information. Before the industrial revolution, when books were not yet mass commodities, the lecture method was the only way to transfer information from one generation to the next. However, education is so

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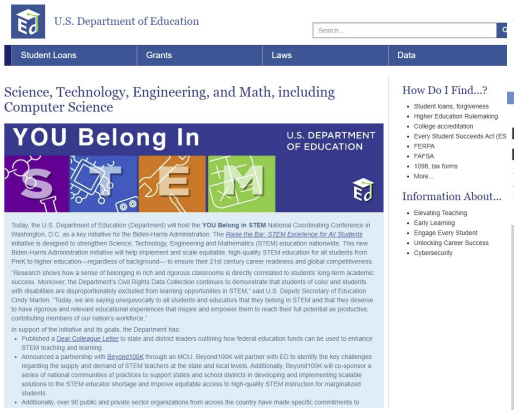
January 13, 2019—*New York Times*
http://www.nytimes.com/2009/01/13/us/13physics.html?em



November 2022- *Raise the Bar: STEM Excellence for All Students initiative*

Calls for Evidenced-Based Teaching Practices

THE GATEKEEPER

Lila M. Smith

NJCU | NEW JERSEY CITY UNIVERSITY

Melissa A. Navarro Martell, 2020

- **How do your teachers frame their courses?**
- **Where are they getting the expectations, guidelines, or policies?**
- **Who is checking them?**

Addressing

Pedago-pathologies

- Amnesia
- Fantasia
- Inertia

- **Which one do you see evident in staff?**
- **Why?**

Lee Shulman – MSU Med School – PBL Approach (late 60s – early 70s), President Emeritus of the Carnegie Foundation for the Advancement of College Teaching

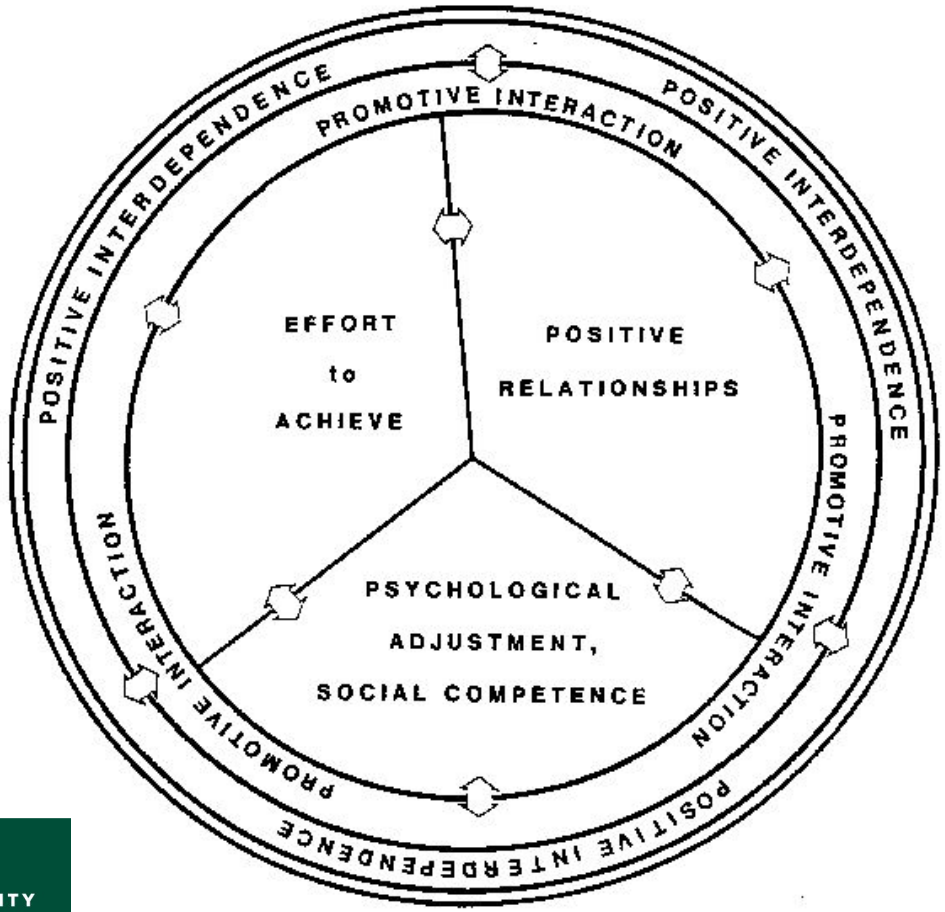
Shulman, Lee S. 1999. Taking learning seriously. *Change, 31* (4), 11-17.

What do we do about these pathologies?

- **Activity** – Engage learners in meaningful and purposeful activities
- **Reflection** – Provide opportunities
- **Collaboration** – Design interaction
- **Passion** – Connect with things learners care about

Shulman, Lee S. 1999. Taking learning seriously. Change, 31 (4), 11-17.

Designing Learning Environments Based on HPL (How People Learn)



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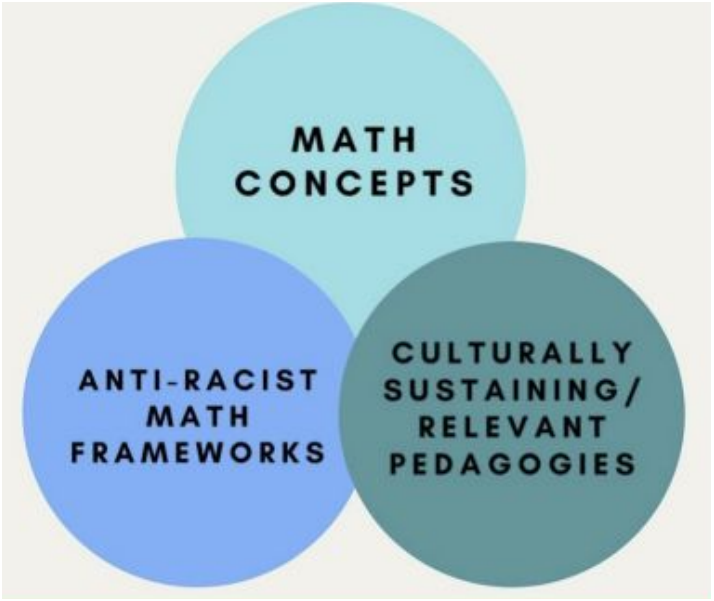
Teaching Science and Math to BIPOC* Students
Curriculum Considerations



- **Do assigned readings include BIPOC scholars?**
- **Does the curriculum expose students to the scientists, mathematicians, or authors they read that are representative of their communities?**
- **Is student feedback requested at the end-of-the year about the curriculum?**
- **How do we create Professional Learning that develops teachers' understanding of DEI practices in STEM?**

**Black, Indigenous, People of Color*

Address Pedago-pathologies by Modeling
Innovative Leadership Skills

- **Activity** – Engage learners in meaningful and purposeful activities
- **Reflection** – Provide opportunities
- **Collaboration** – Design interaction
- **Passion** – Connect with things learners care about

Implement Professional Learning Choice Boards to Promote Using Voice, Choice, & Agency

Danielson for Teachers Framework PD (ongoing)

PD Day (Department-specific in Science)

Free Template

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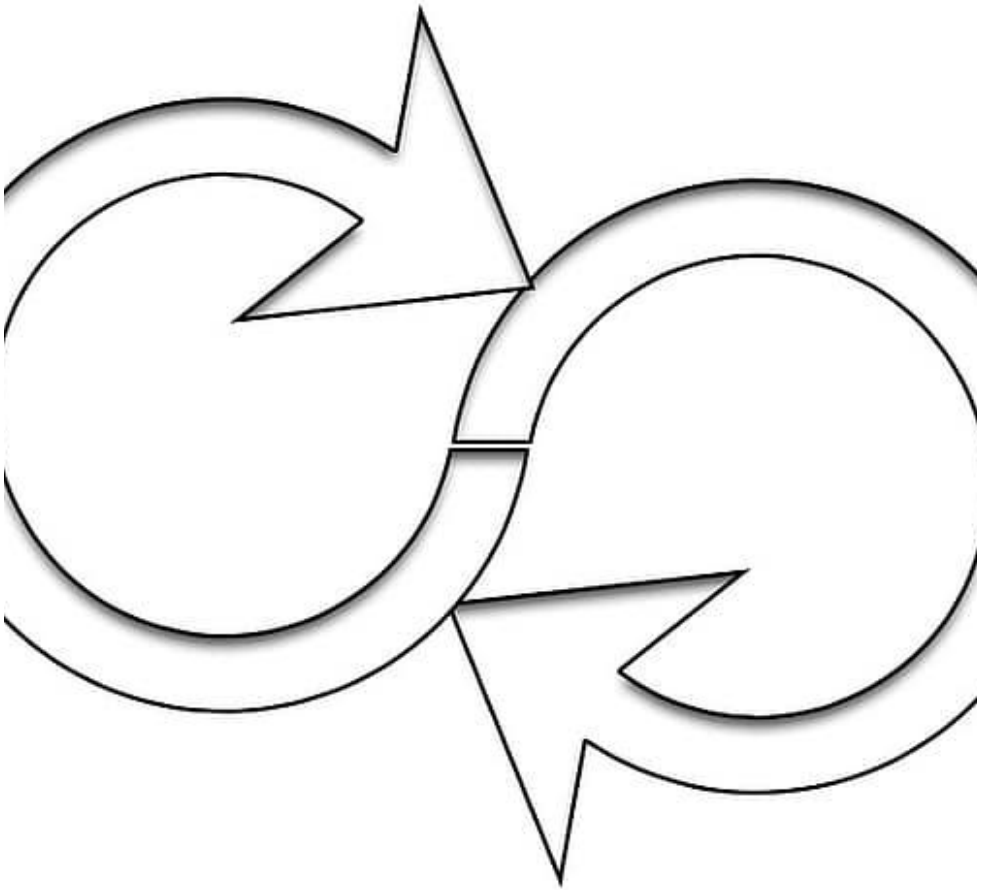
Pedagogies of Engagement

- Encourage active participation and inquiry
- Model evidenced-based teaching practices
- Prevent reflexive practices
- Encourage sustained, continued support and dialogue
- Foster relationships and feedback cycles
- For use with school counselors, administrative teams, department or discipline teams, parents, and even students in the classroom!



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Troubleshooting

Challenges

1) Lack of pedagogical training
2) Structural issues
3) Faculty workload

Suggestions

1) Engage in individual and collaborative learning
2) Encourage Departmental conversations and action
3) Adopt strategies for balancing teaching, duties, and service.

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"What are you doing as an administrative leader to help your teachers build habits of mind for culturally responsive STEM instruction?

Circle Back Now

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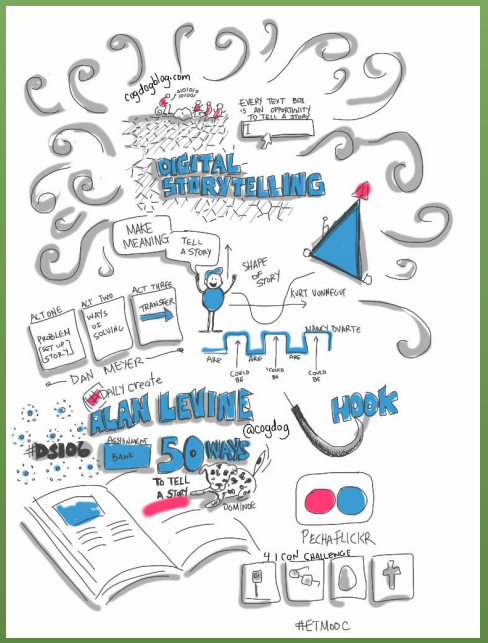
Digital Storytelling for *Inclusive* STEM Education



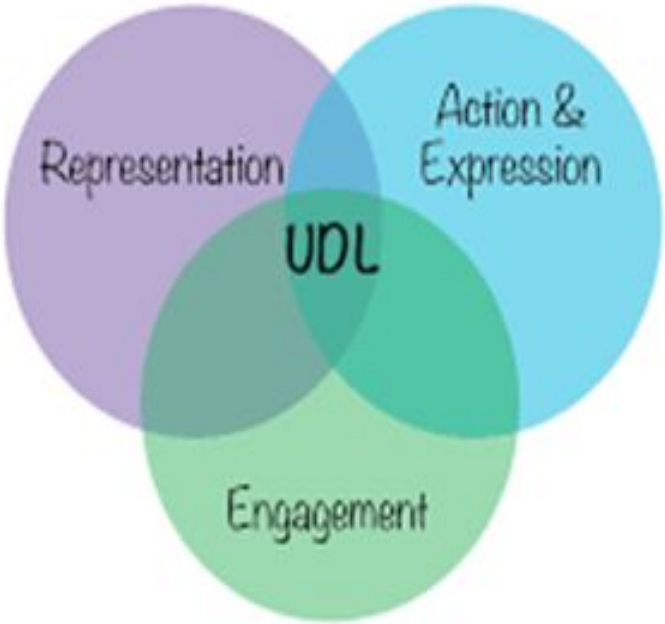
Dr. Dana Mason

NJCU | NEW JERSEY CITY UNIVERSITY

What is Digital Storytelling?

- The art of telling a story through the use of multimedia. This can incorporate graphics, video, audio or web-based publishing.
- Computer-based tools can help us participate in storytelling through computer-based narratives, electronic memoirs, interactive storytelling, or digital essays.

Inclusive Approach to Transdisciplinary Learning



- Project-Based Learning, supported by backwards design.
- Multimedia choices provide options to meet students at their ability level.
- Empowers learners to demonstrate learning and enhance skills through 21st century methods.
- Builds communities and helps support students and families beyond the classroom.
- Communication tool for the school and community.

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Digital Storytelling Provides a Voice for All Types of Learners

RTI (Response To Intervention)

3 Tiers of Support

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Project Ideas to Get Started

- Scripted Story
- Informative/Historical Video
- Introductory – (Ex – Welcome to our school/city/country)
- Misconception Video (Tackle FAKE NEWS!)
- PSA – Public Service Announcements
- Advertisement
- How-To
- Book/Product Review

Cross Curricular Inclusive Approach

- Digital storytelling can be used in ANY subject, at virtually any grade level, pre-readers to high school.
- Along with the use of technology, Digital Storytelling is a medium of expression for students that can showcase their skills.
- Promotes student leadership – when students are willing to share what they know they emerge as thought leaders and develop their confidence to think big. They are **empowered** by the impact they make in their community and social groups.

Materials for Digital Storytelling are Minimal

WeVideo | Flip | Adobe Spark | loom | Screencastify

Materials

- Chromebooks
- Laptops (Mac/Windows)
- Tablets/iPads

****At home, students can use their own devices or BYOD. (iPhone/Android/Tablets, etc.)*

Additional Resources for Video Production added to the Digital Swag:

- Cornell Notes (Idea Organization and Collaboration)
- Duck Duck Moose (Free Animation Platform)
- Worndershare Filmora
- iMovie (Mac, iPhone, & iPad)
- Powtoon for Animation
- Filmora and Filmora Go (for mobile devices)
- Kapwing Online
- Open Shot
- VideoScribe (2D Whiteboard Animation)

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Scan for Digital Storytelling Apps and Resources for Use in Your District

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Cohorts for Summer STEM Classes Forming Now!

Submit your registration by May 15th

Questions?

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Chairperson
NJCU Educational Technology Department
lzieger@njcu.edu

Dr. Samantha Kozar
STEM Certificate Grant Program Director
NJCU Educational Technology Department
skozar@njcu.edu

NJCU

Thank you!

edtech@njcu.edu

Educational Technology Department at NJCU

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