INVENTION EDUCATION

October 27, 2020

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INVENTION EDUCATION

October 27, 2020

Laura A. Peter

Under Secretary of Commerce for Intellectual Property and Deputy Director of the United States Patent and Trademark Office

Dr. Radia Perlman

Fellow, Dell Technologies, National Inventors Hall of Fame Inductee

Thoughts on Teaching Innovation

Radia Perlman

Radia.Perlman@dell.com

Why Teaching Innovation is Important

- I'm including in "innovation"
  - Creative thinking
  - STEM
  - Critical thinking
- Why STEM?
  - It is important to society...shortage of skilled workers and teachers
  - STEM is a great career
  - A healthy team needs people who think in different ways...so people who wouldn't thinking of themselves as natural "STEM people" are needed
- Why critical thinking?
  - People need to understand that not everything they hear or read is true
  - That most problems do not have a simple "right/wrong" answer...there are always tradeoffs

Making Decisions

- My career has been a sequence of totally random events
- My advice to people struggling with a decision
  - You'll never have enough information to make a totally informed decision
  - There are two types of people
    - Those that would be happy with either decision
    - Those that would be unhappy with either decision

Bad Habits that can be taught

- "Your work must be your own"
  - Learning from others, asking for help…"bad"
- There is a simple "right answer"… teaching facts, true/false, multiple choice – I will tell you the facts, you parrot them back
- You're always being judged…the goal is to get graded…don't make mistakes
- When I say "can be taught" I don't mean "should be taught"

An Observation

- I have a terrible memory
- Others could remember what the teacher wanted, and repeat it on tests – I had to be able to derive things from basic principles
- I wasted so much of my childhood memorizing history facts (that I quickly forgot 10 minutes after the test)
- And was frustrated by subjective grading, (even though I loved literature and creative writing)
- So I wound up in STEM

Stereotype of an Engineer

- Always taking thing apart
- I never did that
- But I loved logic problems, and getting to the conceptual heart of problems and solutions
- I actually hate computers
  - The world would be better if more people in the industry hated computers
- An important type of "diversity"
  - Complementary skills
  - Different ways of looking at the world
  - When people ask me "how can we create a culture that lets women and minorities thrive" I say…
  - Wrong question! "How do we create a culture that lets everyone thrive?"
  - Try to get students to understand that their "superpower" can be seeing things differently, or having different skills

An Observation, continued

- In science/math classes, I always knew I'd be the best student
- I wasn't even happy about it
- My fantasy…
- But then, my first computer class
  - A teacher noticed a nearby college had a programming class
  - The timing worked out, where she could drive a few of us there after school
  - And then I walked in…

Observations

- Learning requires self-confidence
- Meeting my daughter's 5th grade teacher
- My perception of phys ed class
  - But physical fitness is important, and actually fun (I learned way after school)
- I wonder how many kids get turned off to STEM because of being convinced they "aren't good at it" or that "it's hard"

Awareness of "Imposter Syndrome"

- My perception in grad school the first time
- I stumbled into the ideal job at the ideal time in history (designing how computer networks should move data, at the dawn of networks)
- I returned to grad school 10 years later
- I had learned "secrets"
  - When the professor is droning on, ask questions!
  - Start on problem sets as soon as you get them
  - If you've been doing the homework, you'll do fine on the tests

Encouraging Questions

- A great example of the opposite
- How to answer "naïve questions"
  - And sometimes these questions make you rethink assumptions and bring clarity to your thinking
  - If you can't explain it, you probably don't understand it
- Even more important … be a role model

Teaching Creativity

- Open-ended projects to get students used to not "having a box" to think within
  - I've learned, in Q&A after talks, to answer what I wish they'd asked
- Start with "the obvious right answer might be…but let's see if we can be more creative"
- Great example: Using a barometer to determine the height of a building
- Also, start with collecting life annoyances…that's a great opportunity for innovative solutions

Not everything you read is true

- How can you teach this?
- Maybe have the class read things (e.g., on the Internet), and discuss ways of deciding what's plausible, and how to fact check
- Rather terrifying these days…
- For college students…I recommend to professors
  - Don't just have your students read what you consider to be good papers
  - Have them read horrible papers in prestigious venues
  - And ground-breaking papers along with the reviews from the first n times the paper was rejected

Communication, and Clear Thinking

- Advice for being a good speaker:
    - Given a topic (you know about)
    - An amount of time
    - A level of the audience
    - Come up with an appropriate talk
    - This also causes the speaker to understand the topic better
- Buzzwords
    - Intimidate most people
    - There are those that are confident they know what it means, but they disagree about it
- Summarizing a book
- When attacking a problem…get rid of all the irrelevant details, and get to the conceptual heart of the problem being solved
    - Challenge: explain the problem to someone outside your field?

Summary

- "Intelligence" isn't a linear scale

- Steps in problem solving
  - Finding the conceptual heart
  - Being able to explain it to others
  - Understanding similar things that have been done before, and problems with these approaches
  - Seek out people who disagree, and listen to them

- Teach how to summarize things clearly

Thank you!

STEM Webpage www.ed.gov/STEM

STEM Newsletter www.ed.gov/subscriptions

ED Grants https://www2.ed.gov/fund/grants-apply.html

Back to School Success Stories https://oese.ed.gov/

Next STEM Webinar: STEM Strategic Plan Update Nov.17, 2020, 1:30-3:00 PM ET

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Invention Education Pathways

Supporting Young Inventors:
Different Ages and Stages of Development

Dr. Stephanie Couch, Executive Director, Lemelson-MIT Program
Massachusetts Institute of Technology, Cambridge, MA

Dr. Kristin Moon, Program Administrator, Technology and Engineering,
Portland Public Schools, Portland, Oregon

Dr. Kristin Moon

Program Administrator, Technology and Engineering, Portland, Public Schools, OR

Dr. Stephanie Couch

Executive Director, Lemelson-MIT

Definitions of Invention Education

Researchers' Definition

Facilitation of educational engagement in which people find and define problems and design and build new, novel, useful, and unique solutions that contribute to the betterment of society

Practitioners' Definition

A pedagogical approach focused on problem identification through empathy and collaborative problem solving that results in novel solutions by integrating the process of invention into teaching and learning

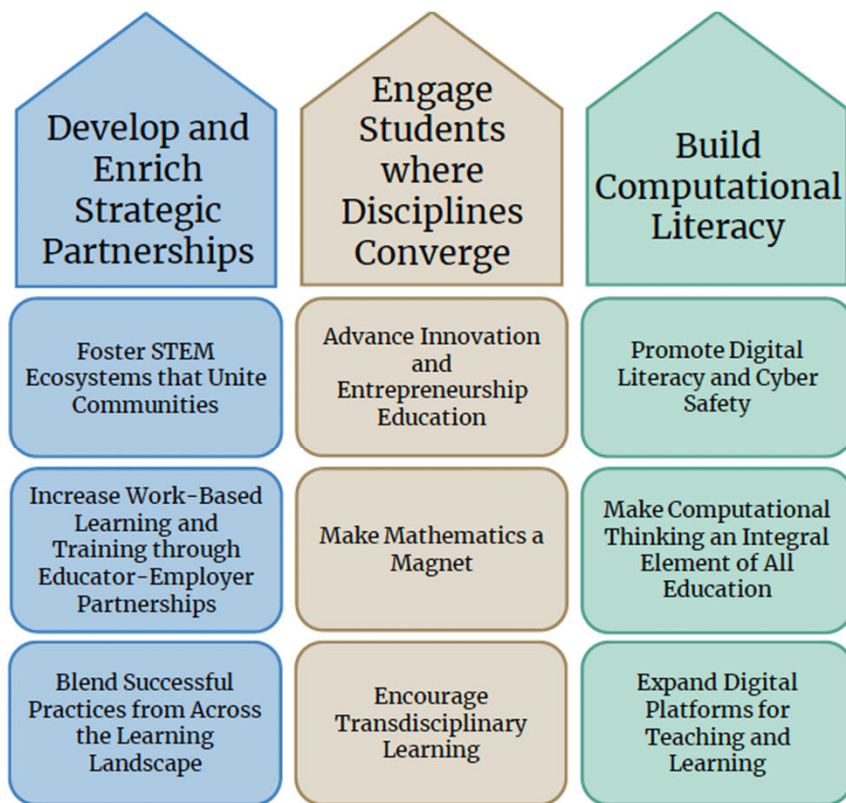*Framework available at:* *https://inventioneducation.org*

RESEARCHING INVENTION EDUCATION
A White Paper

Common Elements of Diverse IvE Programs

- A problem-finding or defining stage

- Open-ended inquiry to solve real-world problems

- Teamwork and collaboration within and beyond the team

- Mentors and others from the larger community

- Iterative and recursive learning and design cycles

- Embracing learning from failure and uncertainty

- Educators as guides, mentors, or coaches who learn alongside students

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Pathways for Federal STEM Goals and IvE

Develop and Enrich Strategic Partnerships	Engage Students where Disciplines Converge	Build Computational Literacy
Foster STEM Ecosystems that Unite Communities	Advance Innovation and Entrepreneurship Education	Promote Digital Literacy and Cyber Safety
Increase Work-Based Learning and Training through Educator-Employer Partnerships	Make Mathematics a Magnet	Make Computational Thinking an Integral Element of All Education
Blend Successful Practices from Across the Learning Landscape	Encourage Transdisciplinary Learning	Expand Digital Platforms for Teaching and Learning

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Biogen-MIT Biotech in Action
STEM+ Meets Invention (Summer Virtual Lab)

Students from MA & NC

- 400 High School Students Engaged as Transdisciplinary Researchers and Inventors

- 75% research posters addressing 13 neurological diseases (including Huntington's and Alzheimer's)

- 25% posters with inventions (including ALS)

Encourage Transdisciplinary Learning

Speakers and Topics

- Dr. Peter Bergethon
  VP of Quantitative Medicine, Biogen

  - *Science, Technology, Mathematics, Physics, Data Science, Disease Modeling, Social and Behavioral Sciences*

- Professor Michael Cima
  MIT's Koch Institute for Integrative Cancer Research (Prolific Inventor)

  - *Materials Science, Chemistry, Engineering Devices for Data Capture and Drug Delivery*

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Computer Science and Computational Thinking

- Technological invention produces a wide range of outputs, including machines, devices, materials, processes, algorithms, and databases

- Students' InvenTeam projects increasingly involve some form of computing technologies

- In 2019, 14 of 15 InvenTeams' working prototypes were projects that included CS/CT components

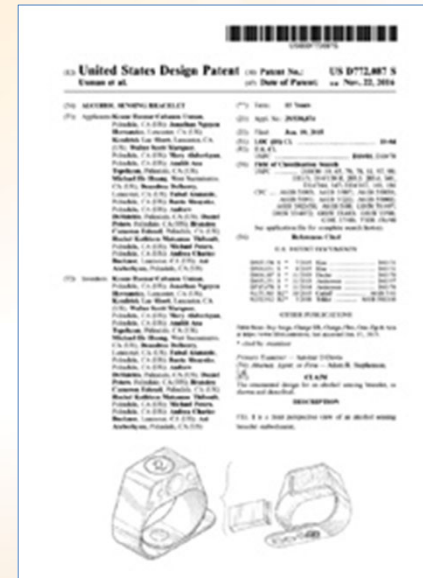Make Computational Thinking an Integral Element of All Education

Lemelson-MIT InvenTeams
SOAR High School, Lancaster, CA

COMMUNITY SUPPORT KEY TO YOUNG INVENTORS' SUCCESS

Community Case Study

SOAR High School InvenTeam helps improve safety and accomplishes something that few teens do – receive a U.S. Patent

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Foster STEM Ecosystems that Unite Communities

Post-Secondary Programs Producing LMIT Student Prize Winners

Johns Hopkins University
BME Undergraduate Design
Team Program

MIT
Global Engineering and
Research (GEAR) Lab

Brigham Young University
Rollins Center for
Entrepreneurship and Technology

**Ithemba
2019 "Cure it!"
Undergraduate Team
Student Prize Winner**
*A reusable, low-cost,
contamination-free breast
biopsy device*
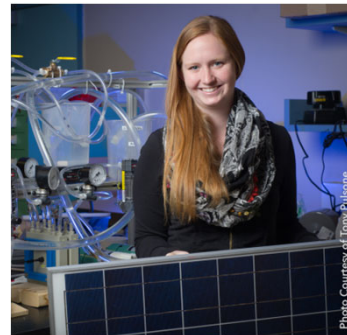
**Natasha Wright
2017 "Eat it!" Graduate
Student Prize Winner**
*Solar-Powered Desalination
System for Off-Grid Water
Production in India and Gaza;
and Usage Sensor for
Household Water Treatment
Devices*

**Neptune Plastics, Inc.
2020 "Use it!"
Undergraduate Team Student
Prize Winner**
*Single-use, biodegradable and
compostable plastic film*

Empathy and Introduction to Inventing through Literature

Grades K-3

- Abby Invents

- Literacy component of [Full STEAM Ahead*](#) (March 2020) for youngest inventors

- Graphic novel

- Problem identification & solving

- Invention cycle

- Patent activity

Grades 4-8

- Stepping into Coding and Inventing Through Literature

- Introducing inventing via Ideas4ears competition

- Literacy component: El Deafo

  - Autobiographical

  - Graphic novel

  - Empathy building

[*https://fullsteam.mit.edu/week-2-package-stepping-into-invention/](#)
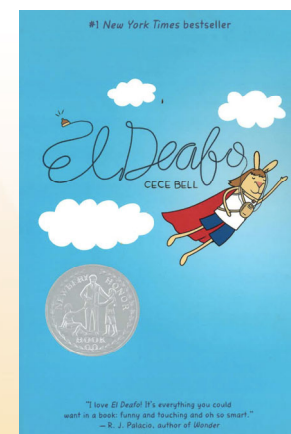
Students' Developmental Trajectory

- Useful – Beginner

- Unique – Intermediate

- Reduce to practice – Proficient

- Not obvious to one skilled in the art - Advanced

For more information, read the report by
the Committee for the Study of Invention
https://lemelson.mit.edu/node/2522

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Teachers' Reasons for Engaging in Invention Education

- Connecting students to real world experiences
- Opportunities to help students integrate and apply knowledge
- Excitement
- Connecting with community
- Interest in problem solving of real-world challenges
- Equity and social justice
- Process of learning

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A White Paper

Knowledge and Experiences Needed by Teachers

- Open-ended, problem-based inquiry
- Scaffolding instruction
- Utilizing knowledge, people, and resources across disciplines and industries
- Integrating student backgrounds and home funds of knowledge
- Developing and using various formative and summative assessments
- Information and inquiry literacies
- Collaborating with others beyond school

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Challenges in Facilitating Invention Education

- Time in the school day

- Assessments and accountability not geared towards the transdisciplinary nature of IvE

- Teachers are often trained to know, teach, and transmit knowledge in a singular discipline rather than making the connections and learning alongside students working in teams.

- Physical and environmental aspects of IvE, including space, physical and human resources, tools, and the technical and applied knowledge

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All Grades: In- or Out-of-School
Invention Conventions alongside Science & Engineering Fairs

Invention Education & the Federal STEM Plan

Aligns with federal STEM goals:

– Builds strong foundations for STEM literacy

– Prepares the STEM workforce for the future

– Increases diversity, equity and inclusion in STEM

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Invention Education

Preparing Students for a Future Yet To Be Invented

David Coronado
The Lemelson Foundation

Joyce Ward
U.S. Patent and Trademark Office

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David Coronado
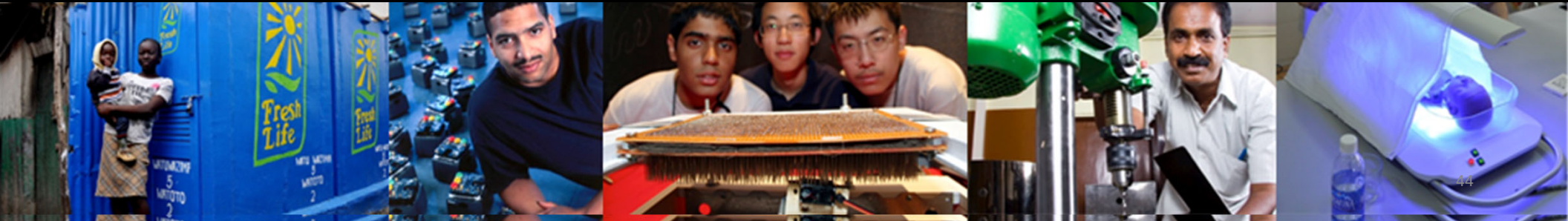
Program Officer, The Lemelson Foundation

Joyce Ward

Director, Office of Education,
U.S. Patent & Trademark
Office

The Lemelson Foundation

improving lives through invention

UNITED STATES PATENT AND TRADEMARK OFFICE

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- Agency Overview
- Importance of Invention Education to work of USPTO - Partnerships
- 5-Year Plan "Advance Innovation and Entrepreneurship"

Advance Innovation and Entrepreneurship Education

Innovation generally depends on a convergence of ideas at the intersection of different fields and sectors to produce new products or processes. It often derives from and/or leads to scientific discovery. Entrepreneurship leverages and applies innovation to introduce new processes, services, and products into the marketplace and society. In an increasingly competitive global economy, STEM education that emphasizes convergent processes and promotes problem-finding and creativity is needed to accelerate innovation and entrepreneurship. Education in these critical skills should play a larger role in STEM courses for learners from all demographics and communities to provide a pathway for more Americans to contribute to the Nation's dynamic economy.
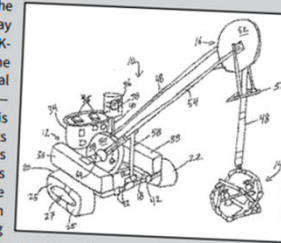
Innovation and entrepreneurship are critically important to U.S. competitiveness and security. To keep pace with our competitors, U.S. companies must remain on the forefront of new discoveries and be able to efficiently transfer new technologies into products and services. The U.S. STEM community has a leadership opportunity in strengthening learners' abilities to create and compete in the future economy through inclusive strategies in preK-12, higher education, and informal learning environments that nurture and support innovation and entrepreneurship skills.

Competitions such as science fairs, cybersecurity contests, robotics and invention challenges, and mathematical gaming, including some supported by Federal agencies, are another way to engage students at all levels in real-world, applied, experiential learning, and have been catalysts for the careers of some our Nation's most well-respected scientists, engineers, and entrepreneurs. However, sponsors and supporters must make a greater effort to make such competitions appeal to and be accessible to all members of the community.

Federal agencies advance innovation and entrepreneurship education through various means including financial support, coordination, and facilitation of programs. They develop and conduct professional development programs for educators to incorporate innovation and entrepreneurship into curricula. The Federal Government also promotes innovation and entrepreneurship at the post-

National Summer Teacher Institute on Innovation, STEM, and Intellectual Property

To foster innovation and entrepreneurship in STEM fields, the U.S. Patent and Trademark Office offers an immersive, multi-day interdisciplinary professional development experience to help K-12 educators become more knowledgeable about how the invention process works and the important role that intellectual property—patents, trademarks, copyrights, and trade secrets—plays in innovation and entrepreneurship. Following his experience in one of these summer institutes, Massachusetts engineering and robotics teacher Doug Scott modified his approach to teaching and was better able to guide a group of his students as they filed for and received a U.S. patent for their ice search and rescue underwater robotic vehicle. Today, when students in his classes work to identify solutions to engineering problems, their assignments routinely include researching existing patents and considering how to protect and market their intellectual property.

https://www.uspto.gov/learning-and-resources/outreach-and-education/national-summer-teacher-institute

Image: http://pdfpiw.uspto.gov/.piw?Docid=09511833

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SUCCESS Act –National Council for Expanding American Innovation

Study of Underrepresented Classes Chasing Engineering and Science Success (SUCCESS) Act of 2018

America's long-standing economic prosperity and global technological leadership depend on a strong and vibrant innovation ecosystem. To maximize the nation's potential, it is critically important that all Americans have the opportunity to innovate, seek patent protection for their inventions, start new companies, succeed in established companies, and achieve the American dream.

The Study of Underrepresented Classes Chasing Engineering and Science Success (SUCCESS) Act of 2018 directed the Under Secretary of Commerce for Intellectual Property and Director of the U.S. Patent and Trademark Office (USPTO), in consultation with the administrator of the Small Business Administration, to prepare a report that:

- Identifies publicly available data on the number of patents annually applied for and obtained by women, minorities, and veterans
- Identifies publicly available data on the benefits of increasing the number of patents applied for and obtained by women, minorities, and veterans and the small businesses owned by them
- Provides legislative recommendations for how to promote the participation of women, minorities, and veterans in entrepreneurship activities and increase the number of women, minorities, and veterans who apply for and obtain patents.

"Expanding participation in the innovation ecosystem is one of our nation's best and most tangible opportunities for enhancing economic growth and improving the standard of living and quality of life for every American.

- DIRECTOR ANDREI IANCU

Opening remarks at the inaugural meeting of the National Council for Expanding American Innovation

"To maintain our technological edge, the United States must seek to broaden our innovation ecosystem demographically, geographically, and economically."

— USPTO Director Andrei Iancu

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Growing an InventEd Network

- A diverse group of leaders from education, government, policy and more

- Committed to increasing access to quality Invention Education to more students across the country

What We Need to Solve For

Complex Challenges – US and Global Health, Climate Change, Sustainable Business, Inequality, etc. (Source: UN)

Rapidly Changing Technologies – New technologies are changing the workplace at an unprecedented rate (Source: Deloitte)

Talent Shortages - In information technology, engineering, technicians, and others required for 21st Century jobs (Source: ManpowerGroup)

Lack of Diversity - Patent holders and leading technology innovators are 90% male and nearly 95% Asian or White (Source: Nager et al., 2016)

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What is Needed

A Diverse Pipeline of Future Inventors and Problem-Solvers

Agile Thinkers

New Ideas and Solutions

Technical Talent

Inclusive Problem Solving

Empathetic Leaders

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Invention Education

- Opens Minds and Possibilities

- Enhances Learning

- Prepares Students for the Economy of the Future

By teaching today's youth how to be inventive thinkers, we can prepare them to succeed in an everchanging world

We can create a better future for us all

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So how do we prepare students today for an unpredictable future?

Invention Education Resources

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Why Invention Education?   In Action   The Network   Resources   About

Preparing Students for a Future Yet To Be Invented

Why Invention Education?

More About InventEd

Our children face a future of new, more demanding, and increasingly complex problems

Solving these problems will require agile thinkers with diverse perspectives and life experiences, and an ability to identify and acquire the new, yet unknown knowledge needed to operate and create tomorrow's technologies and industries. At the same time, our educational system risks growing increasingly out of step with the needs of life and work in the 21st century. Invention Education offers a powerful approach to bridge this gap.

Learn more about how Invention Education supports:

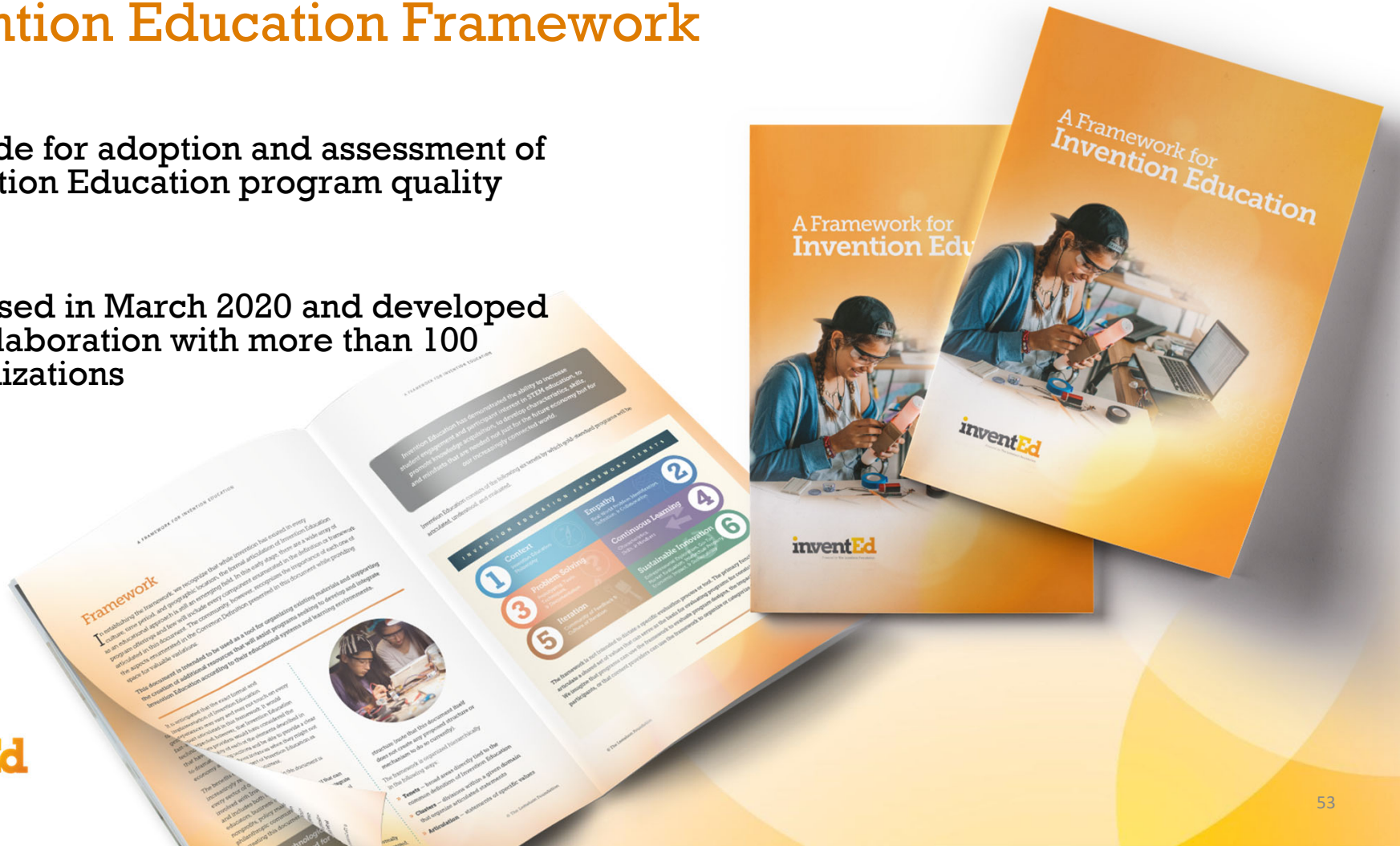Students   Educators   Society
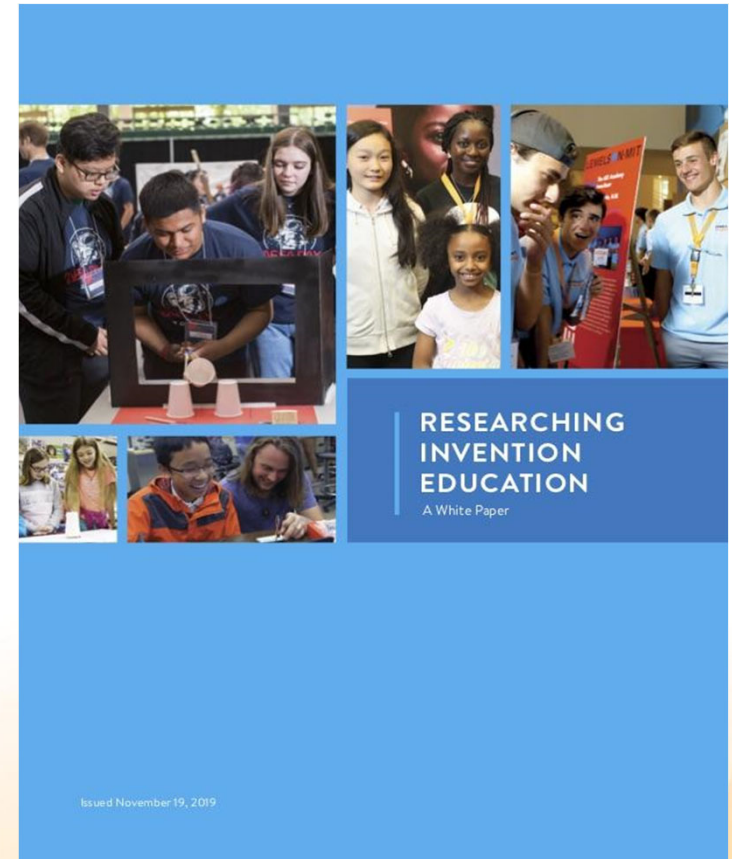
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Invention Education Framework

- A guide for adoption and assessment of Invention Education program quality

- Released in March 2020 and developed in collaboration with more than 100 organizations

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Invention Education Research

- Consolidates current knowledge base for those advancing the field of Invention Education

- Released at InventEd 2019, builds on work published in April 2019 issue of *Technology & Innovation Journal*

RESEARCHING INVENTION EDUCATION
A White Paper

Issued November 19, 2019

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Why Invention Education?   In Action   The Network   Resources   About   🔍

< Back to Resources

Curricula

Search Curricula

--Grade Band-- ⌄   Topic   **Find Curricula**

Select a grade level and/or enter a topic and click the Find Curricula button to discover Invention Education curricula.

76 results found

Oregon State University

The Oregon State University (OSU) Office of Precollege Programs provides programs designed to increase that target Oregon's youth. Their website contains useful information that could be useful to teachers and students nationwide.

⬇ Download Curricula   ⊕ Link to Program

Michelson Institute for IP

Grades 9–12

The Michelson Institute for IP presents Intellectual Property resources that are accessible to learners. There is an engaging series of resources for the layperson in the Intangible Advantage IP book and video series.

⬇ Download Curricula   ⊕ Link to Program

PBS NEWSHOUR
EXTRA

News for **Students** and
Teacher Resources
6–12 Grade Level

Site Search

Extra

GO

Lesson Plans

«BACK TO LESSON PLAN ARCHIVE

Print   Like 0   Tweet   Pin it

August 26, 2018

Lesson plan: How inventions are saving sea turtles

Sea turtles are amongst the world's most endangered species. Prized for their eggs, meat and shells, poachers and human encroachment destroy more than 90 percent of sea turtle nests each year across Central America.

Standards ⓘ

Relevant National Standards:

NGSS Standards

HS-LS2-7 Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-LS4-6 Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.

HS-ETS.1A: Defining and Delimiting Engineering Problems Humanity faces major global challenges today, such as the need for supplies of clean water and food or for energy sources that minimize pollution, which can be addressed through engineering. These global challenges also may have manifestations in local communities.

HS-ETS1.B: Developing Possible Solutions When evaluating solutions, it is important to take into account a range of constraints, including cost, safety, reliability, and aesthetics, and to consider social, cultural, and environmental impacts.

Related Stories ⓘ

Lesson Plan: Contested elections in American history

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< Back to Resources

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[--Grade Band-- ▾]   [Topic]   [**Find Curricula**]

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[⬇ Download Curricula]   [⊕ Link to Program]

Educator Resources & Professional Development Opportunities

USPTO Kids Pages

National Summer Teacher Institute (NSTI)
on Innovation, STEM and Intellectual Property
www.uspto.gov/teacherinstitute

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Monthly Offerings for K-12 Educators

- ## "Last Tuesday" Webinars

Monthly virtual professional development workshops for K-12 educators interested in integrating intellectual property (IP), invention, and innovation content into STEM/STEAM classrooms. Explore different types of IP protection including patents, trademarks, copyright, and trade secrets. Sessions are held the last Tuesday of each month from 6:00pm-7:30pm ET. Visit the USPTO Events page to register or email us as education@uspto.gov.

- ## Wednesday Office Hours

Monthly virtual "Office Hours" for K-12 educators and learners provide an informal opportunity to ask intellectual property related questions and allow deeper exploration of ideas to integrate intellectual property and invention education concepts into various subject matter. Office hours are held on the last Wednesday of each month from 3:00pm to 4:00pm ET.
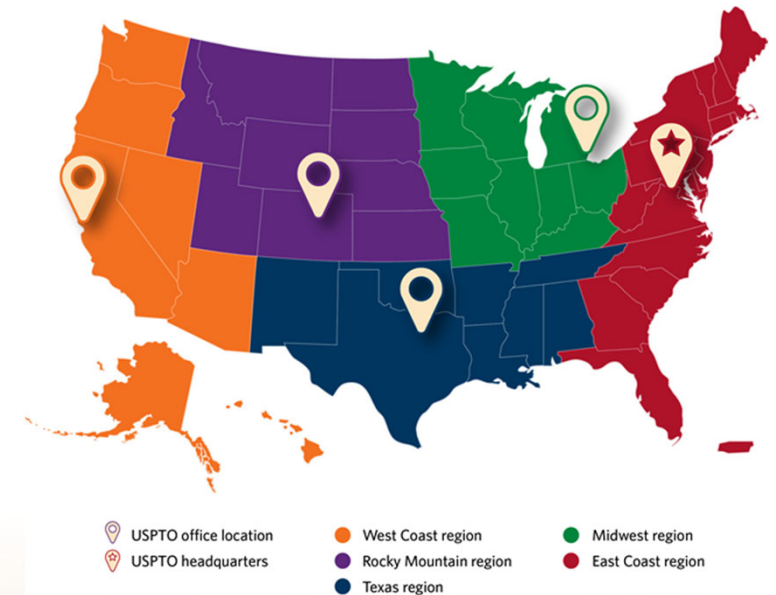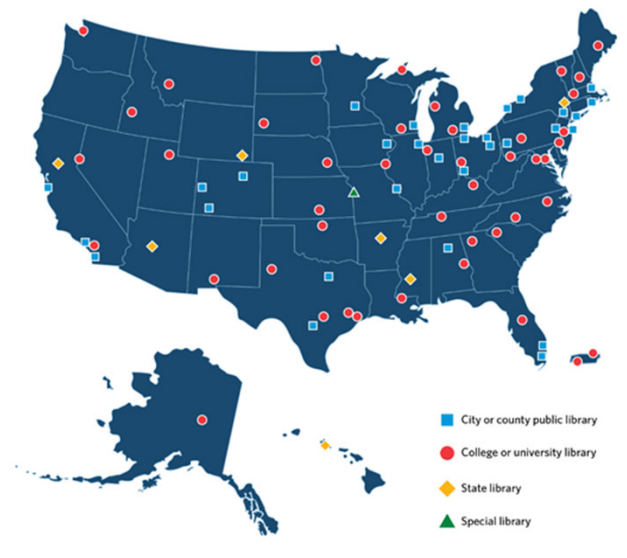
USPTO Inventor Collectible Card Series

www.uspto.gov/kids

Education@uspto.gov

USPTO Resources & Regional Offices

- **Patent and Trademark Resource Centers (PTRC)**

Nationwide network of public, state, and academic libraries designated by the USPTO to disseminate patent and trademark information and support the intellectual property needs of the public

City or county public library
College or university library
State library
Special library

USPTO office location
USPTO headquarters
West Coast region
Rocky Mountain region
Texas region
Midwest region
East Coast region

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Actions to Take Now:

- Learn more at inventioneducation.org
- Join our mailing list
- Download the free Invention Education Framework
- Download free Invention Education Curricula

Join Us.
Together we can bring the promise of Invention Education to all students