AI in K12:
What Students Should Know

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sySTEMnow Conference
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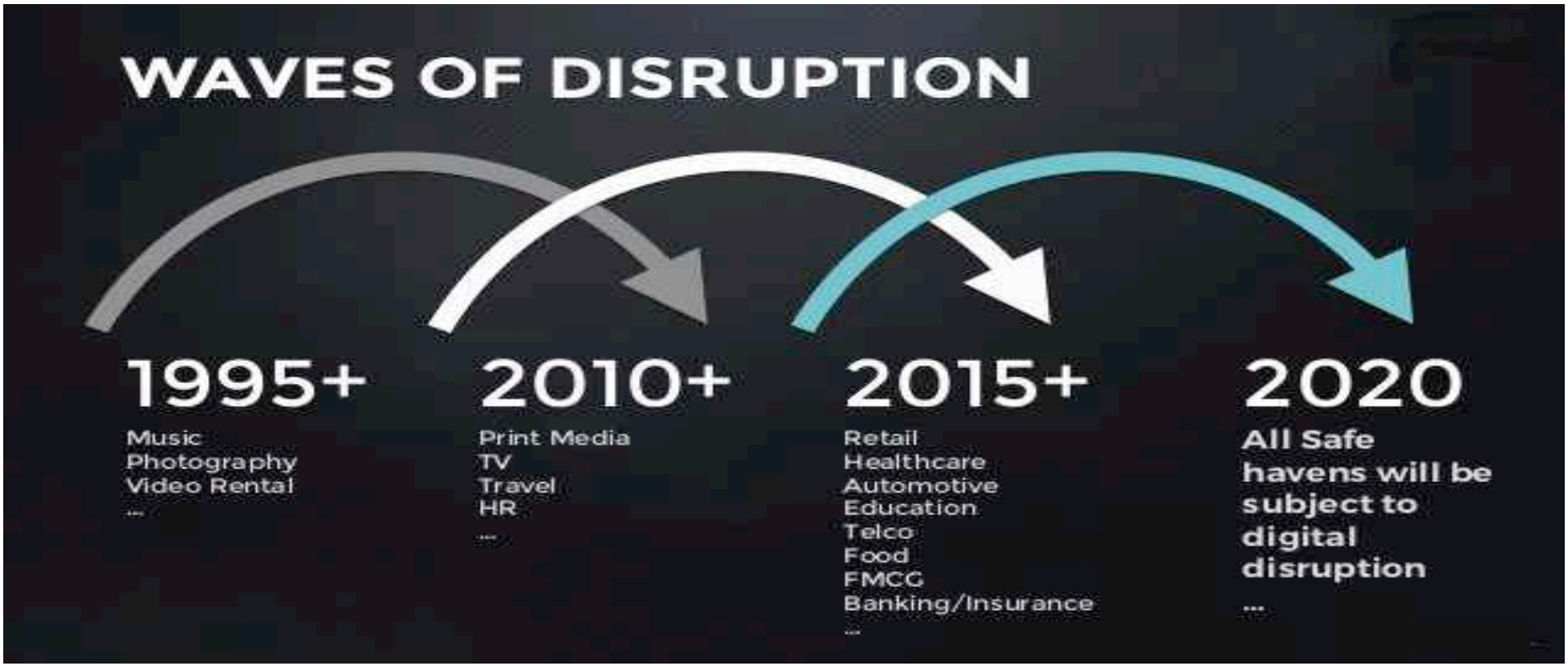
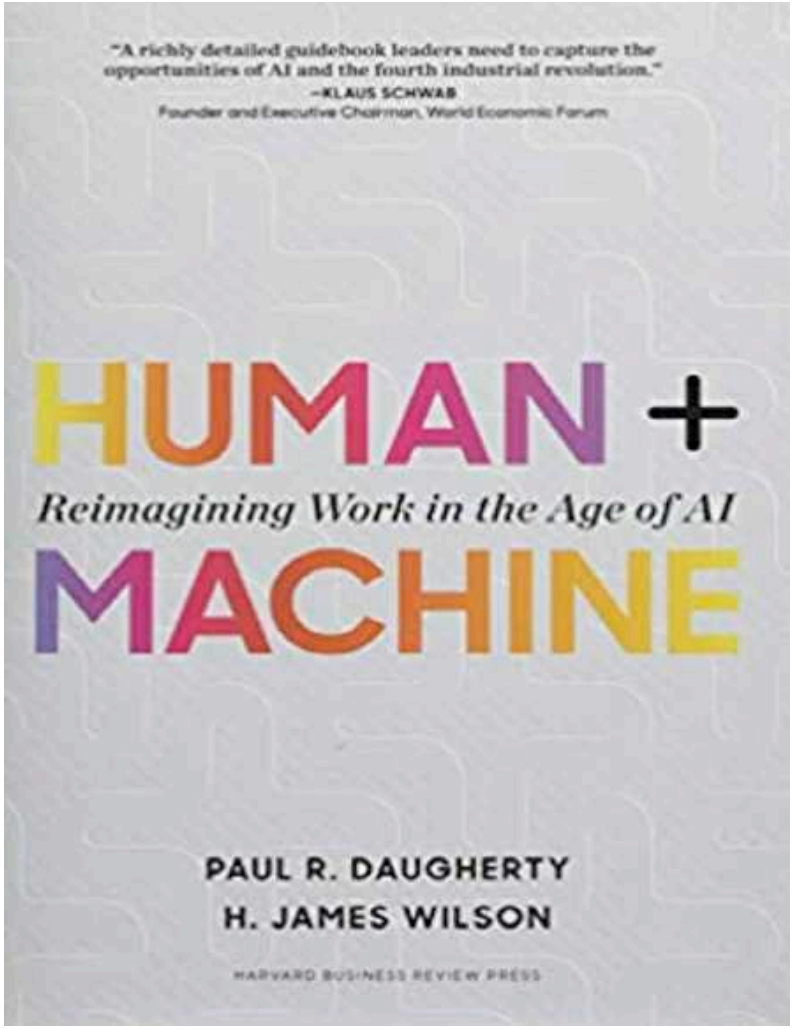
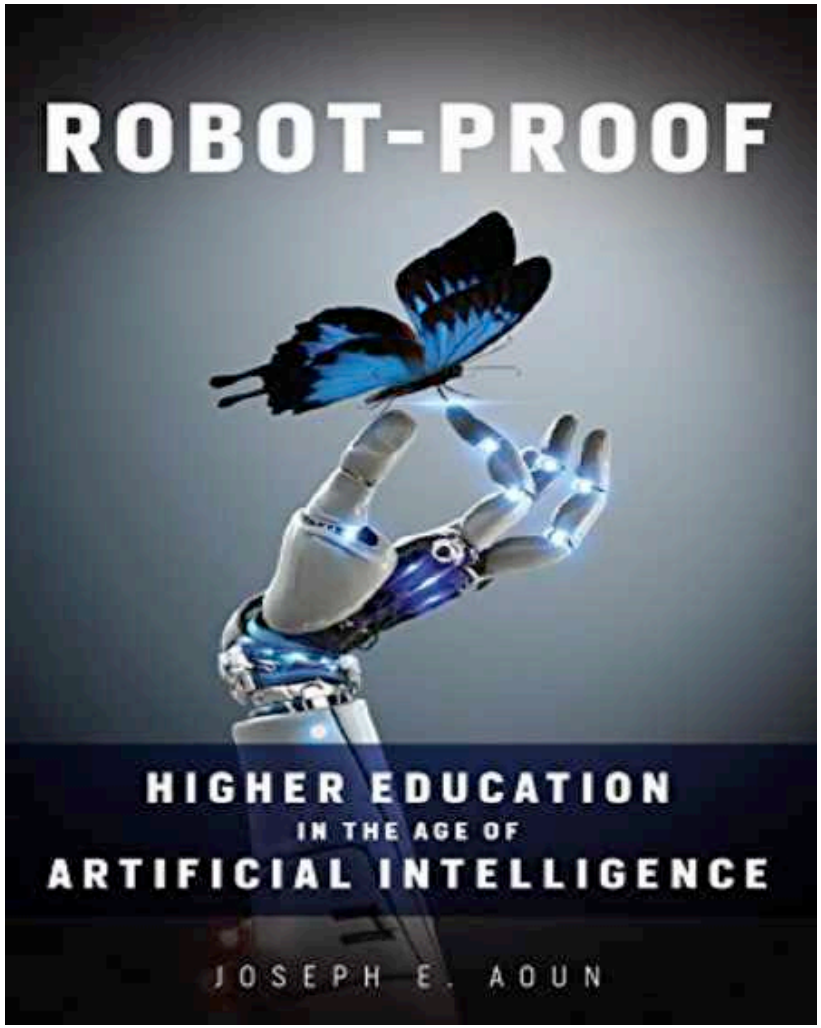
#AI4K12

“Digital disruption is the change that occurs when new digital technologies and business models affect the value proposition of existing goods and services.”


WAVES OF DISRUPTION
1995+
Music
Photography
Video Rental
...
2010+
Print Media
TV
Travel
HR
...
2015+
Retail
Healthcare
Automotive
Education
Telco
Food
FMCG
Banking/Insurance
...
2020
All Safe havens will be subject to digital disruption
...


"A richly detailed guidebook leaders need to capture the opportunities of AI and the fourth industrial revolution."
–KLAUS SCHWAB
Founder and Executive Chairman, World Economic Forum
HUMAN +
Reimagining Work in the Age of AI
MACHINE
PAUL R. DAUGHERTY
H. JAMES WILSON
HARVARD BUSINESS REVIEW PRESS


ROBOT-PROOF
HIGHER EDUCATION
IN THE AGE OF
ARTIFICIAL INTELLIGENCE
JOSEPH E. AOUN

Technologically Literate Citizens

Technological literacy involves a vision where every person has a degree of knowledge about the nature, behavior, power and consequences of many aspects of technology from a real world perspective.

- Refers to one's ability to use, manage, evaluate, and understand technology.
- Understands what technology is, how it works, how it shapes society and in turn how society shapes it.
- Have abilities to “do” technology that enables them to use their inventiveness to design and build things and to solve practical problems that are technological in nature.
- Comfortable with and objective about the use of technology, neither scared of it nor infatuated with it.

ITEEA
Technology and Engineering bring STEM to Life!

AAAI (Association for the Advancement of Artificial Intelligence)

CSTA (Computer Science Teachers Association)

With funding from National Science Foundation ITEST Program (DRL-1846073)

Carnegie Mellon University
School of Computer Science

Steering Committee

Dave Touretzky
Carnegie Mellon
AI for K-12 Working Group Chair

Christina Gardner-McCune
University of Florida
AI For K-12 Working Group Co-Chair

Fred Martin
UMass Lowell
CSTA Chair of Board of Directors

Deborah Seehorn
Co-Chair of CSTA Standards Committee

Mission

- Develop national guidelines for teaching AI in K-12
  - Modeled after the CSTA standards for computing education.
  - Four grade bands: K-2, 3-5, 6-8, and 9-12
  - The 9-12 band will be further differentiated for CS students in Y2
  - What should students know?
  - What should students be able to do?
- Develop a curated AI resource directory for K-12 teachers
- Foster a community of K-12 AI resource developers

Why is this the right time to be teaching AI in K-12?

1. AI is playing an increasingly prominent role in society:
    - Intelligent assistants
    - Self-driving cars
    - Autonomous robots in the workplace (and someday the home)
2. Informed citizens need to understand the basics of AI as our society faces important public policy decisions surrounding AI technologies.
3. AI technologies will cause job loss in some areas, and gains in other areas.
4. There is a growing need for AI-literate workers. Students should be encouraged from a young age to consider STEM careers.

K-12 Computing Education

- Worldwide, we are making progress on integrating computing into K-12
- We are not as far along when it comes to AI, but many countries are trying: China, UK, Thailand, Korea, and EU Countries
- The 2017 CSTA Computing Standards contain just two sentences about AI.
    - Both are for the 11-12 grade band. Nothing for younger students.

Overview of AI for K-12 Guidelines

Working Group & Advisors

Working Group (K12 CS Teachers)

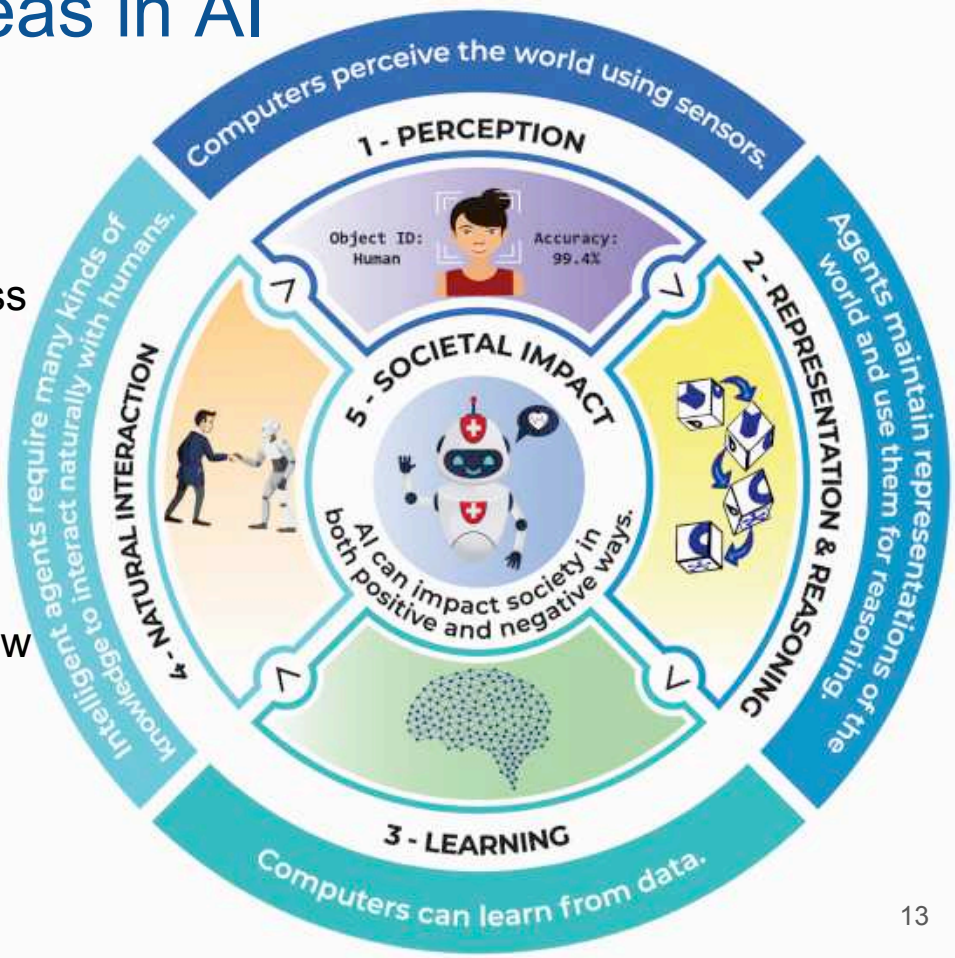
- Grades K-2 (RI, CA, GA, PA)
- Grades 3-5 (IL FL, TX, NY)
- Grades 6-8 (MA, WA, NC, CA, CT)
- Grades 9-12 (CA, MN, IL, VA)

Advisors (Industry/Academia)

- MIT
- Google
- Microsoft
- IBM
- ISTE
- AI4ALL
- AAAI
- MSOE, WI
- USCD, CA
- Getting Smart
- Roehampton University, UK
- Chinese Univ. of Hong Kong
- U.S. Department of Defense

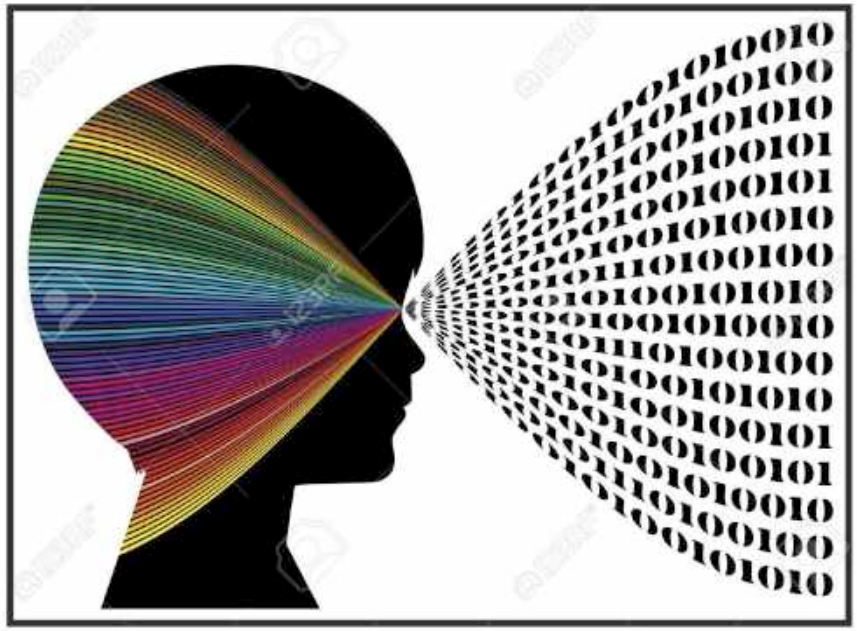
Five Big Ideas in AI

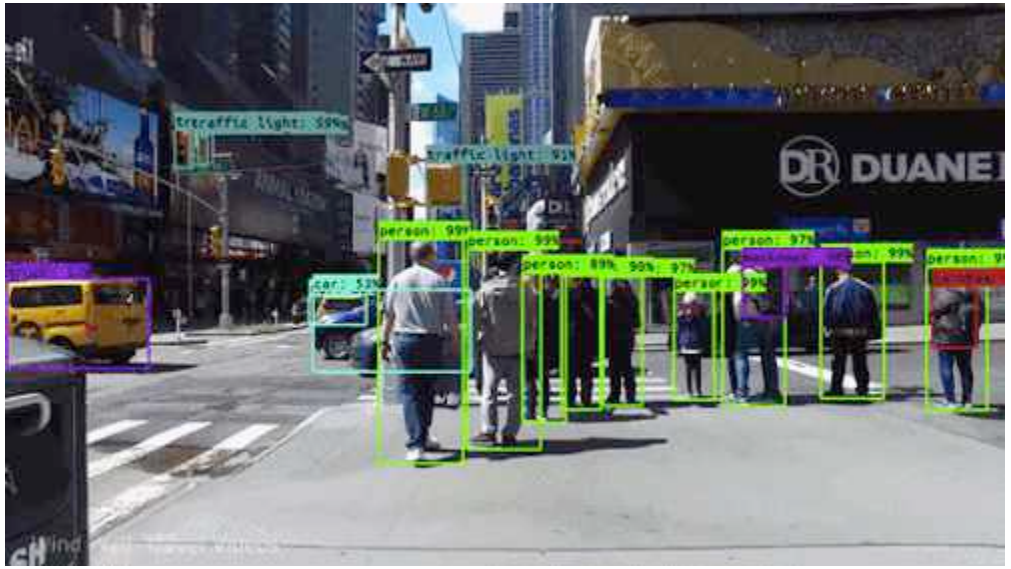
- Organizing framework for the K-12 guidelines.
- 5 big ideas are enough to cover the richness of the field, but small enough to be manageable by teachers.
- CSTA experience shows 5 is a good number.
- Not necessarily the way AI practitioners view their field, but appropriate for the needs of the K-12 audience.
- Working group is focused on: vocabulary, examples, concepts, activities & outcomes.



Big Idea #1: Perception

Computers perceive the world using sensors.





Perception is the extraction of *meaning* from sensory signals.

Big Idea #1 – What should students be able to do?

Grades K-2:

- Identify sensors on computers, robots, and intelligent appliances.
- Interact with intelligent agents such as Alexa or Siri.

Grades 6-8:

- Explain how sensor limitations affect computer perception.
- Explain that perception systems may draw on multiple algorithms as well as multiple sensors.
- Build an application using multiple sensors and types of perception (possibly with Scratch plugins, or Calypso).

Grades 3-5:

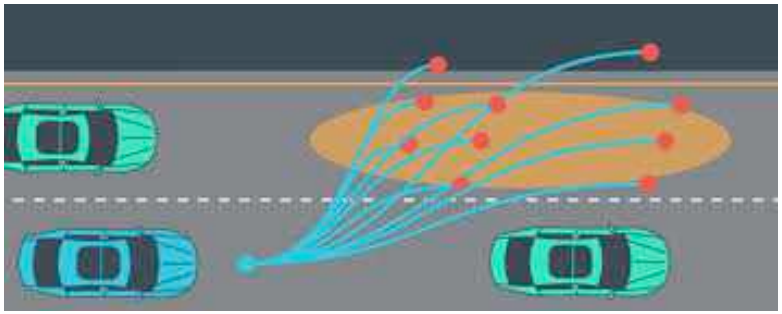
- Describe how sensor inputs are converted to analog or digital signals.
- Demonstrate a limitation of computer perception.
- Build an application using perception (possibly with Scratch plugins, or Calypso).

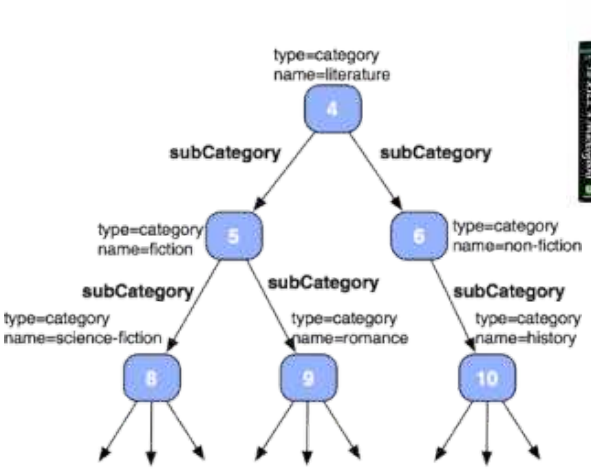
Grades 9-12:

- Describe the domain knowledge underlying different forms of computer perception.
- Demonstrate speech recognition difficulty in handling homophones and other types of ambiguity.

Big Idea #2: Representation and Reasoning

Agents maintain representations of the world, and use them for reasoning.





Taxonomy of Literature

Big Idea #2 – What should students be able to do?

Grades K-2:

- Construct a model of something and compare it to the thing being modeled
- Use a decision tree to make a decision

Grades 6-8:

- Design a graph model of their home or locations in their community and apply reasoning to determine the shortest path to key locations on their map
- Create/design a representation of an (animal) classification system using a tree structure.

Grades 3-5:

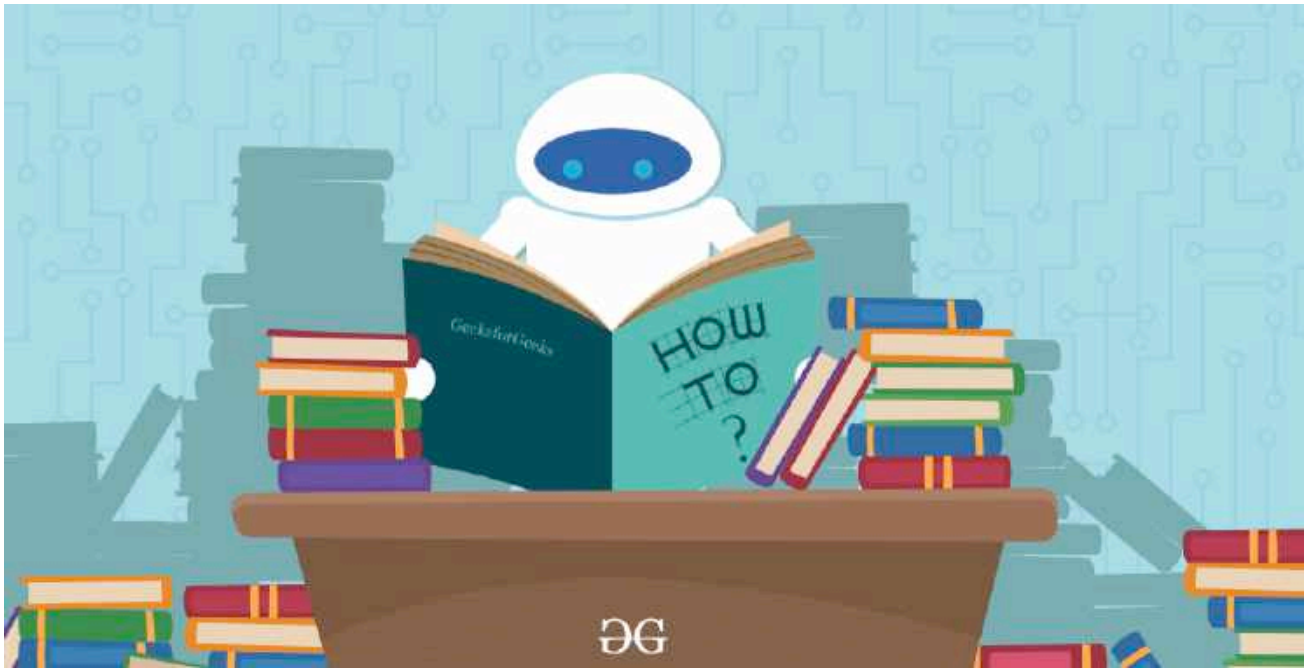
- Create/design a representation of an (animal) classification system using a tree structure.
- Describe how AI representations support reasoning to answer questions

Grades 9-12:

- Draw a search tree for tic-tac-toe
- Describe the differences between types of search algorithms

Big Idea #3: Learning

Computers can learn from data.



Big Idea #3 – What should students be able to do?

Grades K-2:

- Learn from patterns in data with “unplugged” activities
- Use a classifier that recognizes drawings. Use Google Autodraw or Cognimates Train Doodle to investigate how training sets work to identify images and discuss how the program knows what they are drawing

Grades 3-5:

- Describe and compare the three different machine learning approaches: supervised, unsupervised and reinforcement learning.
- Modify an interactive machine learning project by training its model..
- Describe how algorithms and machine learning can exhibit biases.

Grades 6-8:

- Identify bias in a training data set and extend the training set to address the bias
- Hand-simulate the training of a simple neural network

Grades 9-12:

- Train a neural net (1-3 layers) *TensorFlow Playground*
- Trace and experiment with a simple ML algorithm

Big Idea #4: Natural Interaction

Intelligent agents require many types of knowledge to interact naturally with humans.

Humans are among the hardest things for AI agents to understand.

Big Idea #4 – What should students be able to do?

Grades K-2:

- Identify words in stories that have positive and negative connotations.
- Recognize and label facial expressions into appropriate emotions (happiness, sadness, anger) and explain why they are labeled the way they are
- Experiment with software that recognizes emotions in facial expressions

Grades 6-8:

- Construct a simple chatbot
- Explain and give examples of how language can be ambiguous
- Reason about the nature of intelligence, and identify approaches to determining whether an agent is or is not intelligent.

Grades 3-5:

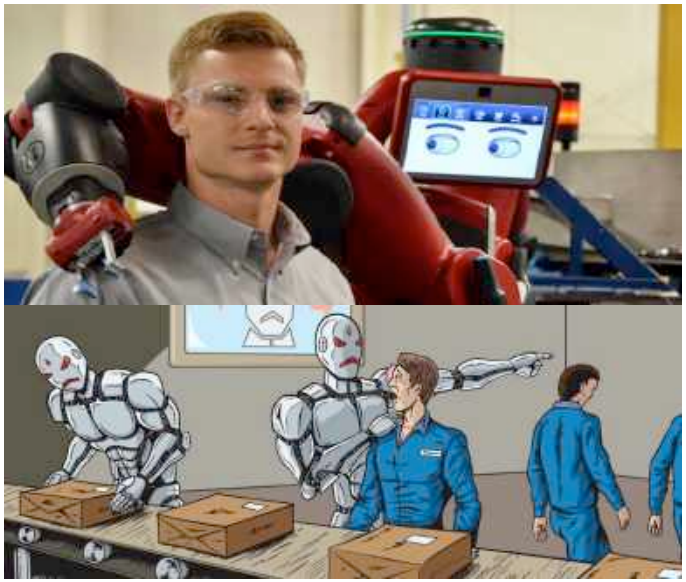
- Identify how humans combine multiple inputs (tone, facial expressions, posture, etc) in order to understand communication.
- Describe some tasks where AI outperforms humans, and tasks where it does not

Grades 9-12:

- Demonstrate how sentence parsers handle ambiguity
- Explore the Google Knowledge Graph
- Identify and debate the issues of AI and consciousness

Big Idea #5: Societal Impact

"Artificial Intelligence can impact society in both positive and negative ways."



Big Idea #5 – What should students be able to do?

Grades K-2:

- Identify common AI applications encountered in their daily lives
- Discuss whether common uses of AI technology are a good or bad thing

Grades 3-5:

- Explore how behavior is influenced by bias and how it affects decision making
- Describe ways that AI systems can be designed for inclusivity

Grades 6-8:

- Explain potential sources of bias in AI decision making
- Understand tradeoffs in the design of AI systems and how decisions can have unintended consequences in the function of a system

Grades 9-12:

- Critically explore the positive and negative impacts of an AI system
- Design an AI system to address social issues (or explain how AI could be used to address a social issue)

Teaching AI in K-12 Classrooms

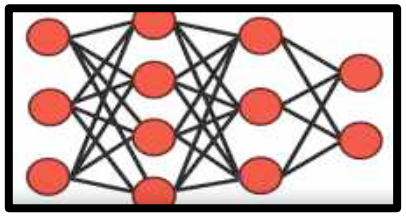
Guidelines for supporting K-12 students

1. **Use transparent AI demonstrations** *that help students see what is going on inside the black box: it's not magic!*
2. **Help students build mental models** of *what is happening under the hood in AI applications.*
3. **Encourage students to develop AI applications** *using AI services.*

X

X

X



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Student Activity Considerations

- **Experiment with AI agents** to investigate their behavior
- **Hand simulate** AI algorithms
- Encourage students to **build their own AI applications**
- **Explore case studies of AI-related societal issues** from multiple perspectives

These activities promote understanding of:

- How AI works
- Limitations of AI
- Systems thinking (AI systems are built from smaller components)
- Sources of bias in AI
- Societal impacts of AI systems

National guidelines, Resource Directory, Professional Community

AI-4-All.org

Summer camps, career support for alumni, open learning platform

ISTE: AI Professional Development course for teachers.

Teaching AI: Exploring New Frontiers for Learning, by Michelle Zimmerman.

Curiosity Machine AI Family Challenge (program of Iridescent)

At-home challenges for young children & parents

Google /
Hal Abelson (MIT)
ML Course

Machine learning for high school students.

ReadyAI.org: WAICY Competitions

Check Out the Resource Library:

AI Tools & Resources for K-12

www.AI4K12.org

It’s time for all of us to think about AI in K-12.

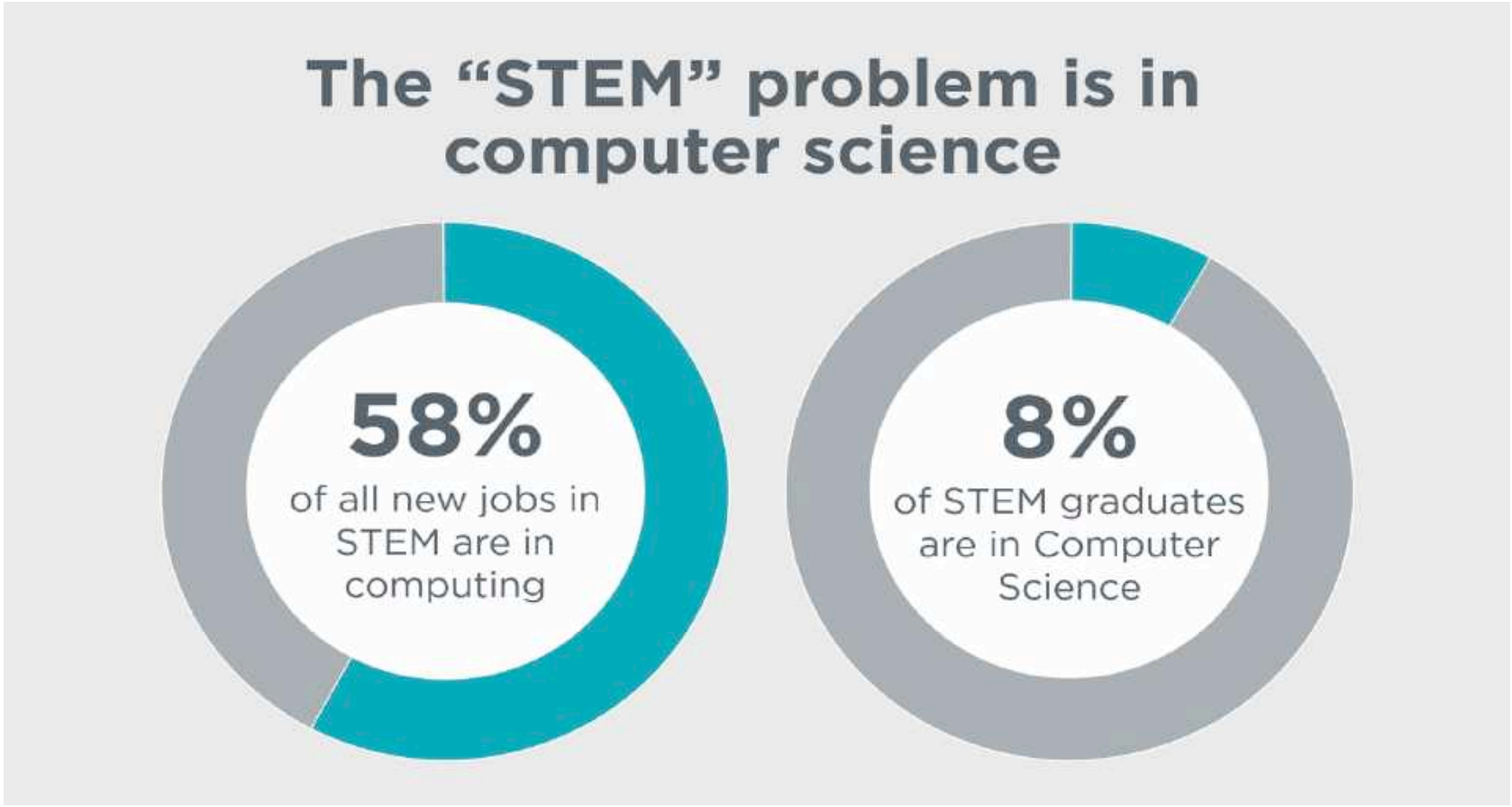
Visit us:
http://AI4K12.org

Join the mailing list:
Send mail to ai4k12@aaai.org

Rethink What's Possible at MSOE

Diercks Hall

- 68,000 square feet (approx.)
- Leveraged by all students across programs areas
- NVIDIA Supercomputer
- Lab space
  - Design
  - Data Analytics
  - Robotics
  - Augmented Reality
  - Virtual Reality
  - Machine Learning
  - Artificial Intelligence
- Collaboration Hubs
- Corporate Partnership Suite



https://code.org/promote

CS/SE at MSOE

- MSOE is differentiated by its commitment to small class sizes and a focus on applied learning
- Both programs are informed by an Industry Advisory Council
- First year of CS and SE majors are the same.
- Students in both majors have access to the same electives
- CS undergraduate majors are required to take coursework in AI, ML, DL and a Data Science practicum
- As seniors, CS majors are able to choose between an undergraduate research project OR a senior design project.
- Enrollment across CS/SE is exceeding expectations

STEM at MSOE Today

MSOE serves over 5,000 students annually from the Milwaukee area with a variety of programs intentionally designed to support a strong talent pipeline.

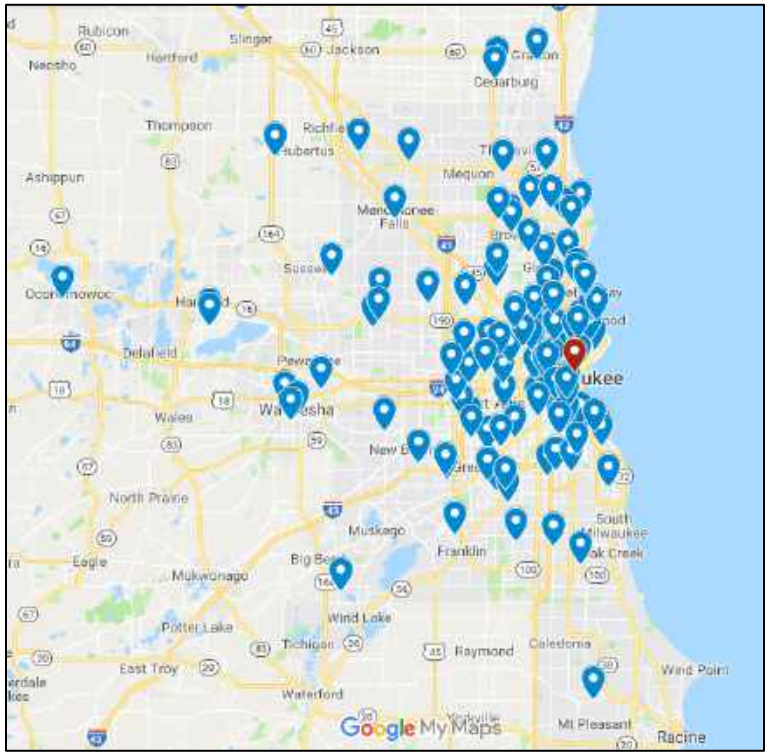
	Elementary	Middle School	High School
Academic Year	STEM on Site		
	FIRST Robotics Ambassadors		
	Destination Imagination Instant Challenge Workshop		
		Scouting BSA STEM Tech	
		Girls Who Code	
	Girl Scout STEM Day		
	Girl Scout Goldie Blox	STEM to Stern	WI Regional Science Bowl
	Cub Scout STEM Fair	Beyond STEM	FLAME
	Engineering Explorers	Engineering Impossible	OP Computers
		Fluid Power Challenge	OP Science
			OP Math
Summer	FIRST Robotics Ambassadors		
		Aspire IT Workshop	
		Catalyst for Future Success	Discover
		GE Girls	Explore
		Maydm Adventures in Coding	Focus
		Girls STEM Academy	

Spans multiple school ranges

STEM at MSOE Today

These interactions support students at all levels of background knowledge.

Students from any neighborhood or school have pathways to connect with MSOE



Why AI in STEM Outreach?

Our Vision Challenges Us.

MSOE will set the standard for preparing leaders to solve the diverse technical challenges of the 21st century.

…we cannot realize our vision without it!

Why AI in STEM Outreach?

- With a shortage of CS educators, MSOE is actively aligning its STEM strategy to provide tech-based opportunities to get students the skills they need for jobs of the future
- MSOE is the only institution in the Milwaukee area with a supercomputer to support high powered AI operations. Equipping future students with core concepts in AI gives them a head start to leverage this technology in their degree programs
- AI curriculum and components can be cost prohibitive, and our commitment to ensuring every student can get exposure to and develop skills in AI hinges on leveraging best practices of our internal and external communities

Getting Started in K-12 AI

How do we integrate AI into our STEM programs without requiring AI expertise?

- Leveraging resources such as AI4K12 to understand big ideas
- Assessing current program footprint for AI integration
- Identifying resources that non-CS individuals can lead
- Understanding and assessing who we want to serve and how we ensure programs are accessible to ALL students

How MSOE Supports AI Opportunities

- Partnerships with national organizations such as NCWIT
- Scaling existing AI competencies and activities to K-12
- Investing in proven curriculum and equipment to enable MSOE students to easily learn and execute programming
- Ensuring alignment to national models – such as AI4K12 Big Ideas – to provide cohesion to other AI opportunities

Our biggest takeaway? Without hands-on integration with AI, activities are not as impactful to students. Enabling and empowering students to make real world connections is even better!

NCWIT AspireIT Program

NCWIT AspireIT is designed to teach K-12 girls programming fundamentals and computational thinking in fun, creative, and hands-on environments. AspireIT participants are ultimately encouraged to contribute their unique perspectives and ideas to future innovations, and its impact is undeniable:

- Since 2013, **more than 9,500 girls** have received an estimated **295,000 instruction hours** through 436 AspireIT programs in 43 states — many of whom did not have prior computing experience.

- And, **75 percent** of participants express interest in taking a future computing class.

NCWIT AspireIT Program

MSOE serves a partner organization for AspireIT, which means AspireIT leaders can apply to partner with us to offer programming while they receive funding from NCWIT

In partnership with Isabelle Kramer, Homestead HS student & the MSOE Computer Science department, we were able to offer a two-day AI covering computer vision, machine learning, deep learning, and neural networks.

Hands On Application: Students utilized Google AIY vision kits to build their own intelligent camera to see & recognize objects using machine learning.

NCWIT AspireIT Program

Girls Who Code – Intro to AI

Utilizing ReadyAI's middle school premade curriculum, MSOE students are able to lead classes of 15 students in Intro to AI coursework leveraging Cozmo robots.

Topics covered over 8 weeks include:

- Object recognition
- Facial & speech recognition and speech generation
- Landmark-based navigation
- Moving & manipulation of the Cozmo robot

Girls Who Code – Intro to AI

Participant feedback on this program has been immensely positive:

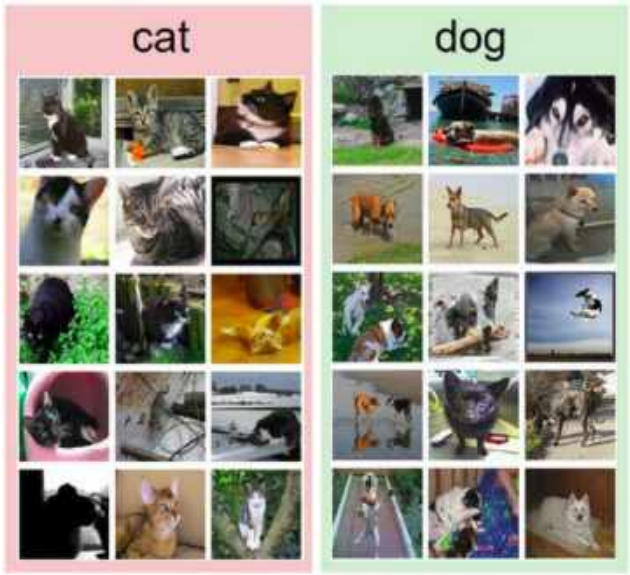
- Students are able to discuss and try out real world applications of AI using Cozmo
- Students are empowered to try their own solutions through project-based learning after knowledge of core principles is gained
- Feedback is immediate – within an hour session students are able to learn, apply, and try out what they learned and see if it works

Hands On Application: Utilization of Cozmo robots for every AI concept

Summer Girls STEM Academy

- Modified Nvidia Deep Learning Institute Computer Vision Workshop (Normally delivered to corporate and undergraduate audiences)
- MSOE Faculty modified and facilitated for 30 MPS students (No prerequisite knowledge required)
- Training a neural network to recognize dogs and cats
- Learning the basics of deep learning

Hands On Application: Programming onsite and seeing immediate feedback throughout activity



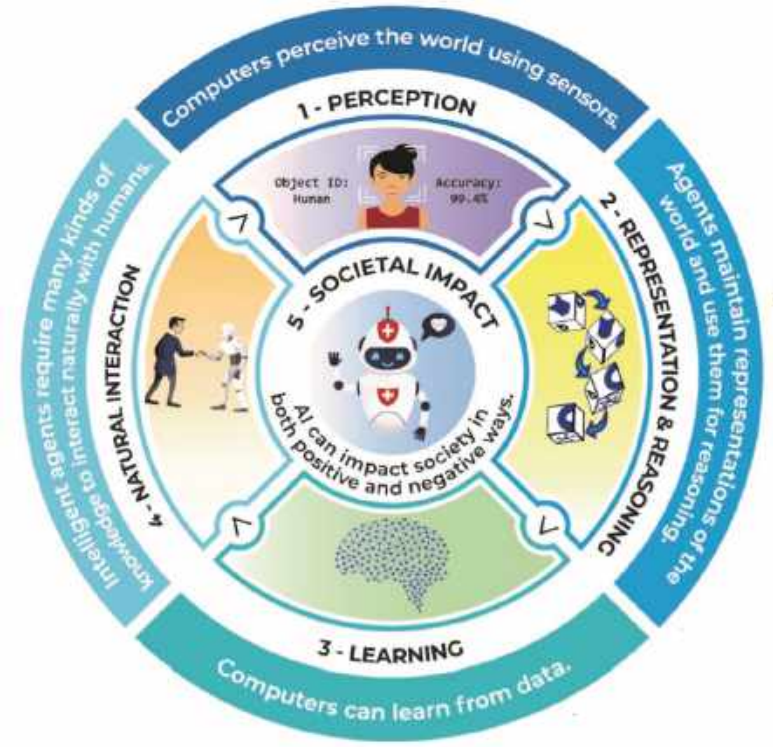
Summer Girls STEM Academy

Connecting to AI4K12 Big Ideas

- These programs currently employ all of these concepts in some form. Many programs will focus on one area and then bring it back into context with the other 4.

- However, **societal impact** is one area our K-12 programs tend to be most interested in.

  For example, our Intro to AI course wraps up most classes talking about the applications of the AI skill they learned into society, and is a high point for attendees



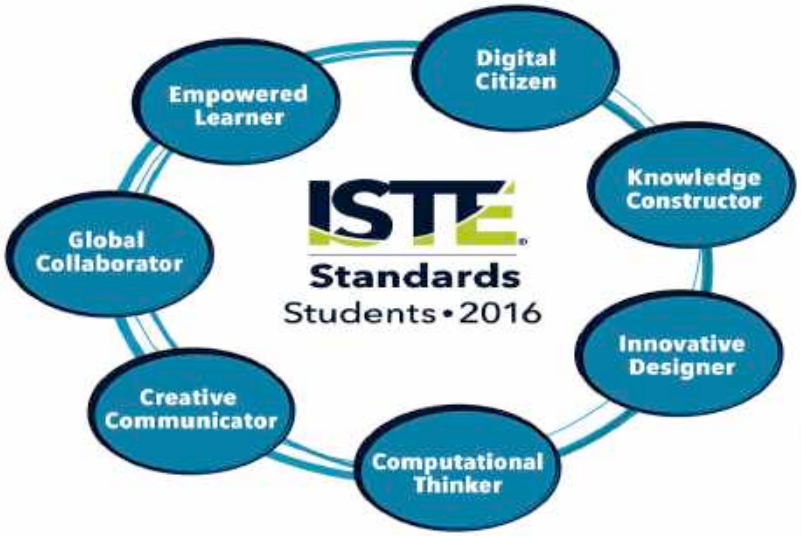
What We've Learned

- A students leading students model is better received by participants and provides valuable leadership opportunities
- Hands-on integration is essential, and real-time feedback is the next best thing
- Without talking about AI in the context of societal impact, we fail to engage **all** students
- Knowledge of CS will always be helpful, but isn't required to take the first step

Integrating AI at Secondary Level: Case Study

Technological Literacy Step 1:

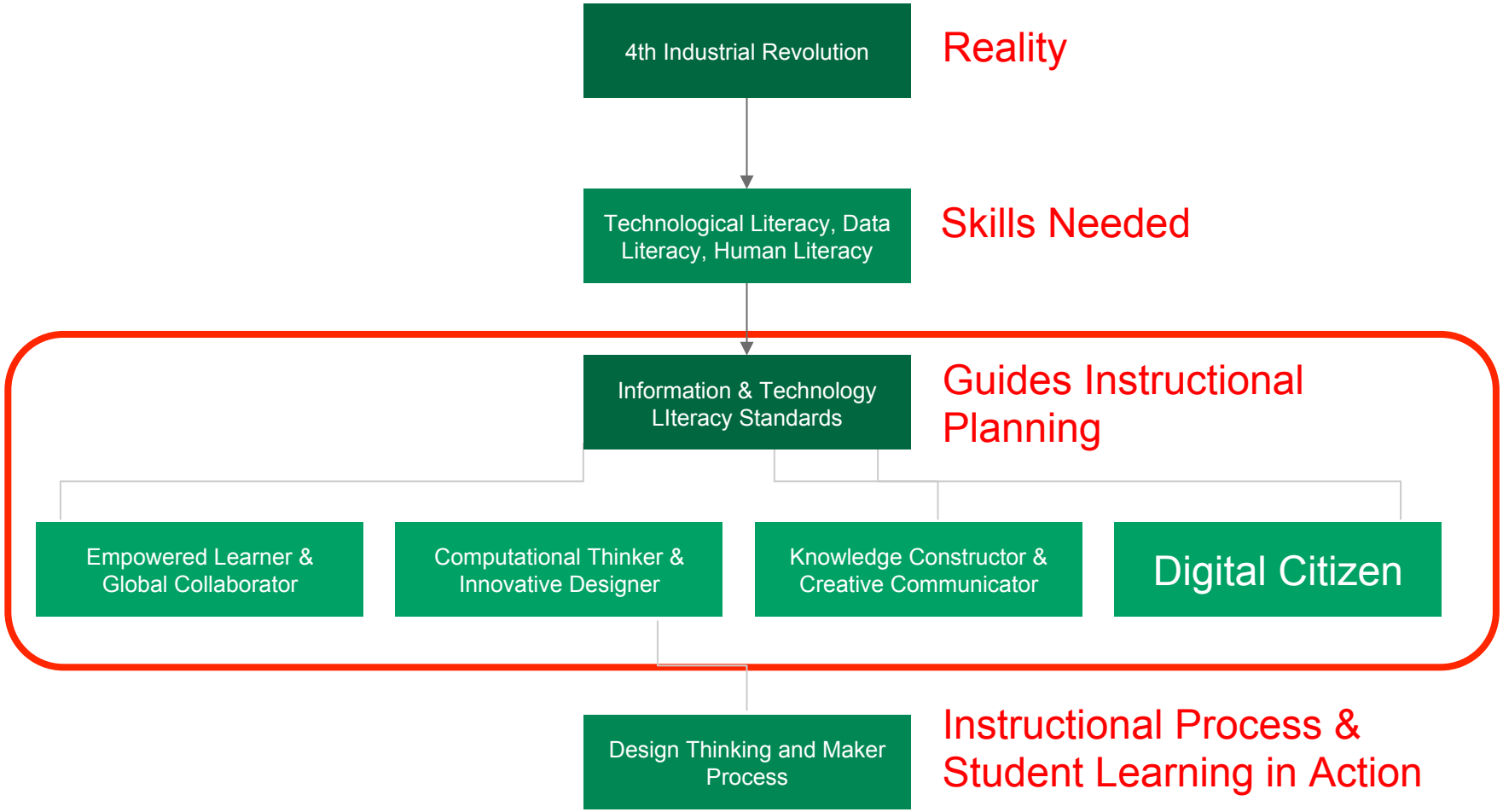
Why Now?



WISCONSIN ACP
Academic and Career Planning

K12 COMPUTER SCIENCE FRAMEWORK

CORE CONCEPTS


4th Industrial Revolution
Reality
Technological Literacy, Data Literacy, Human Literacy
Skills Needed
Information & Technology LIteracy Standards
Guides Instructional Planning
Empowered Learner & Global Collaborator
Computational Thinker & Innovative Designer
Knowledge Constructor & Creative Communicator
Digital Citizen
Design Thinking and Maker Process
Instructional Process & Student Learning in Action

Technological Literacy Step 2:

How is it different?

How is Technological Literacy different than Digital Learning Practices & Technology Integration?

Digital Learning and Educational Technology / Instructional Technology...

- Is mainly concerned with the narrow spectrum of technologies used for communication, collaboration and the dissemination of information.
- Is teaching through technology, instructing students in the use of a relatively small set of tools developed by technology.
- The primary goal of Educational Technology in grades K—12 is to enhance the teaching and learning process.

Technological Literacy

- Technological literacy focuses on learning about current and emerging technologies *(Artificial Intelligence, Robotics, Problem Solving with technology etc.)*
- Technological literacy relates to using a broad spectrum of technology, which is any innovation, change, or modification of the natural environment to satisfy perceived human needs and wants, and how technology accomplishes this through the interrelated disciplines of math, science, engineering, and others.
- Technological literacy is the ability to use, manage, understand, and evaluate technology in general.

How will we know if students are Technologically Literate?


WHAT
NOW?

Here is how to get started!

- Consider where ISTE standards for students and teachers are being met in general education classes (not all students will become CS students)
- Join the #AI4K12 mailing list via www.ai4k12.org
- Review the resources and select the items that make sense for you
- Determine a champion in your district who will support you – you may need to be your own champion
- Partner with other organizations who can you help build capacity
- Provide us with your feedback so that we can build out capacity in SE WI!

Questions?

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