



Anne Gassel Missouri Coalition Against Common Core

# The Cognitive Science Case Against Computers in the Classroom







The design of the learning machines Systems 1 & 2 brain function Interplay of long term & short term memory in reasoning

Effect of tech on behavior

Impact on teachers



### **The Vision of Machine Learning**

First US Patent granted to H. Chard in 1809 for a "Mode of Teaching to Read."

First real machine developed by Halcyon Skinner in 1866 for an "Apparatus for Teaching Spelling."





### What does machine learning mean?

A machine for "the teaching or testing of a pupils knowledge of arithmetic, reading, spelling, foreign languages, history, geography, literature or any other subject in which questions can be asked in such a way as to demand a definite form of words, or a definite arrangement or sequence of letters, figures, or other symbols by way of answer, all without the presence or aid of a teacher being necessary."





### We Aren't There - Yet





## Just Because We Can

# **Doesn't Mean We Should**









## **Computers Are Like Sugar**





## **Attention Economy**

Today's learning machines, tech in general, are designed to get and maintain our attention.

They are a marketing-based design <u>first</u> and teaching design second.



"Features like autoplay videos, endless scrolling, and gamification encourage constant use."

*Tristan Harris – former design ethicist at Google* 



Apps designed to maximize natural human function of scanning for new threats, and the endorphin release of positive feedback.

- Swiping down to refresh feed like pulling the arm on a slot machine
- As intuitive as scratching an itch

https://www.theguardian.com/technology/ 2017/oct/05/smartphone-addiction-siliconvalley-dystopia





# **Addiction To Tech**

Chris Marcellino - Push notification designer retraining to be a neurosurgeon.



Technologies can affect the same neurological pathways as gambling and drug use.

"These are the same circuits that make people seek out food, comfort, heat, sex."

https://www.theguardian.com/technology/2017/oct/05/smartphone-addiction-silicon-

## "Have Technology and Multitasking Rewired How Students Learn?"

Dan Willingham PhD Cognitive Psychologist

Common Claims of Ed Tech Developers:

- 1. Without the rapid changes and the multimedia experiences technology can provide, students will be bored; and
- 2. Students have [or will need to] developed the 21<sup>st</sup> century skill of multi-tasking

https://www.aft.org/sites/default/files/periodicals/willingham-summer-10.pdf



# 1. Without the rapid changes and the multimedia experiences technology can provide, students will be bored

Whiteboard Study 2010 by Bruce Torff and Rose Tirotta

### Do whiteboards improve motivation to learn?

**Conclusion**: Elementary kids interested in TECH, but the effect of tech on learning or interest in the SUBJECT was minimal.

Outcomes were also minimally affected – ie. No inherent benefit to presenting lessons on whiteboard. Content and organization are key.

http://www.sciencedirect.com/science/article/pii/S0360131509002152?via%3Dihub



**"Embedding ICT in the Literacy and Numeracy Strategies in Britain"** Higgins, Falzon, Hall, Moseley, Smith, Smith, and Wall,

## Findings:

- Both teachers and pupils <u>perceived</u> that learning was greater....BUT
- National mathematics tests scores in first year showed small improvement over non-WB classes
- Proportion of low achieving students decreased with WB use in language.
- Tests showed <u>no performance difference</u> in second year of use.
- No difference in effect between boys and girls

The flash of tech does **not** lead to greater understanding of complex topics.

http://dera.ioe.ac.uk/1617/1/becta\_2005\_whiteboardprimarypilot\_report.pdf



### System 1 & System 2 Brain Function

Daniel Kahneman "Thinking Fast & Slow"

### System 1

Operates automatically and quickly with little or no effort

### System 2

Allocates attention to the effortful mental activities that demand it including complex computations. The operations of System 2 are often associated with the subjective experience of agency, choice and concentration.

System 2 has some ability to change the way System 1 works by programming the normally automatic functions of attention and memory.



# What color are the words? Red Blue Yellow Black Blue Green Yellow Red

# Students have [or will need to] developed the 21<sup>st</sup> century skill of the ability to multi-task

- Tasks done sequentially while you switch between both.
- Speed and accuracy are lost
  - System 2 must step in to implement different set of "rules" or logical progressions
- Using tech does not allow young mind to be fully immersed in academic concept to really digest it
  - Using unfamiliar/new tech their brain is literally switching between understanding the subject and understanding how to use the tech meaning doing neither one as well as if they only focused on one activity at a time.



## What happens when we load System 2?

System 1 has more influence on behavior when System 2 is occupied.

People who are cognitively busy are more likely to:

- Make selfish choices
- Use inappropriate (e.g. sexist) language
- Make superficial judgments in social situations

# **Critical Thinking**

# **Problem Solving**

## **Real World Applications**

# Fear Of Missing Out

Dr. Jean Twenge

- 2009 year when more than 50% of Americans had smart phones
- iGen childhood shaped by smartphones/tablets
- Trends appear among teens poor and rich; of every ethnic background; in cities, suburbs, and small



Latest Book:

"iGen: Why Today's Super-Connected Kids Are Growing Up Less Rebellious, More Tolerant, Less Happy—and Completely Unprepared for Adulthood—and What That Means for the Rest of Us"

towns



Cognitive overload leads to worse social behavior.

Depression		Suicide
	Bullying	
<b>Over-eating</b>		Lack of kindness
		towards others

We now must provide "character education" to counter these unintended consequences.



# Is limiting tech access enough?

### Smartphone just being nearby affects performance

2015 Center For Economic Performance Study Just having phone nearby lead to distraction and lower scores.

- Computers/digital access is a siren song to kids.
- When used as reward systems, kids focus on doing the bare minimum in order to get the reward.

NYU psychologist Adam Alter "There are very few examples of humans doing a good job exerting self-control for very long periods of time."



### Long Term Memory v. Short Term Memory



The cognitive science model for reasoning is based on the interaction between a long- term memory (LTM), where elements of knowledge are organized, and working memory (WM) where elements are processed.



Long Term Memory: Where procedures (sequenced steps for processing) and facts are stored as small elements of knowledge. Practically limitless.

**Working Memory**: Where the brain thinks, plans, and solves problems. 3-5 novel slots available. Resident ~30 seconds



**Automaticity:** "The fast, implicit, and automatic retrieval of a fact or a procedure from long-term memory."

https://arxiv.org/ftp/arxiv/papers/1608/1608.05006.pdf



## Impact of Hyperlinked Text

**Educators claim**: Hypertext enables readers to develop rich, highly interconnected knowledge structures.



#### BUT

Fig. 1. A process model for hypertext reading.

*Cognitive load in hypertext reading: A review - Diana DeStefano, Jo-Anne LeFevre* 

In an attempt to fill in experience gaps, the tech actually leads to greater disparity in comprehension.

https://benjaminvw.files.wordpress.com/2009/01/destefano.pdf



### Handwritten Notes Are More Effective Than Typed Ones

Researchers at Princeton University and the University of California, Los Angeles (UCLA) P. Mueller, D. Oppenheimer

"Laptop use can negatively affect performance on educational assessments, even—or perhaps especially—when the computer is used for its intended function of easier note taking,"

Handwritten	Typed
More of a summary	Tend to be verbatim
Requires more engaging process of rewording and summarizing information	Requires relatively shallow cognitive processing
Scored higher on conceptual tests immediately after lecture	Scored lower on conceptual tests immediately after lecture
Good recall of factual info	Good recall of factual info
Scored higher on conceptual tests 1 week after lecture	Scored lower on conceptual tests 1 week after lecture

#### 65% of students perceive that they take better notes with a computer

https://www.boston.com/culture/health/2014/06/05/take-note-of-this-handwritten-notes-are-more-effective-than-typed-one



RAND Corporation study of PL - "new evidence to suggest that customizing instruction for every student can generate <u>modest</u> gains in math and reading scores,"

2017 Study by Stanford University's Center for Research on Education Outcomes revealed reading (-0.10) and math (-0.25) performance <u>decreased</u> for students in virtual charter schools regardless of what network they a part of.

https://www.rand.org/pubs/research\_reports/RR2042.html



# **Impact On Teachers**

More time preparing lessons:

- collecting media/content
- loading assessments
- entering student info
- pulling reports



More time troubleshooting technology:

- Software frequently being changed
- Upgrades and revisions
- Beta testing no settling down in sight
- Hardware malfunctions (e.g. dead batteries, broken microphones, no wifi connection)

