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# Learning in the 21st Century

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# Content

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What has traditionally been the focus of education?

Metalurgy      Driver's Education  
Art History   Line Drawing   Calculus  
Educational Psychology      Choir  
English      Mobile Game Development  
Spanish   Video Production   Chinese  
Oil Painting      Geometry      History  
Chemistry      Java      Graphic Design  
Algebra 1      Woodworking      Biology

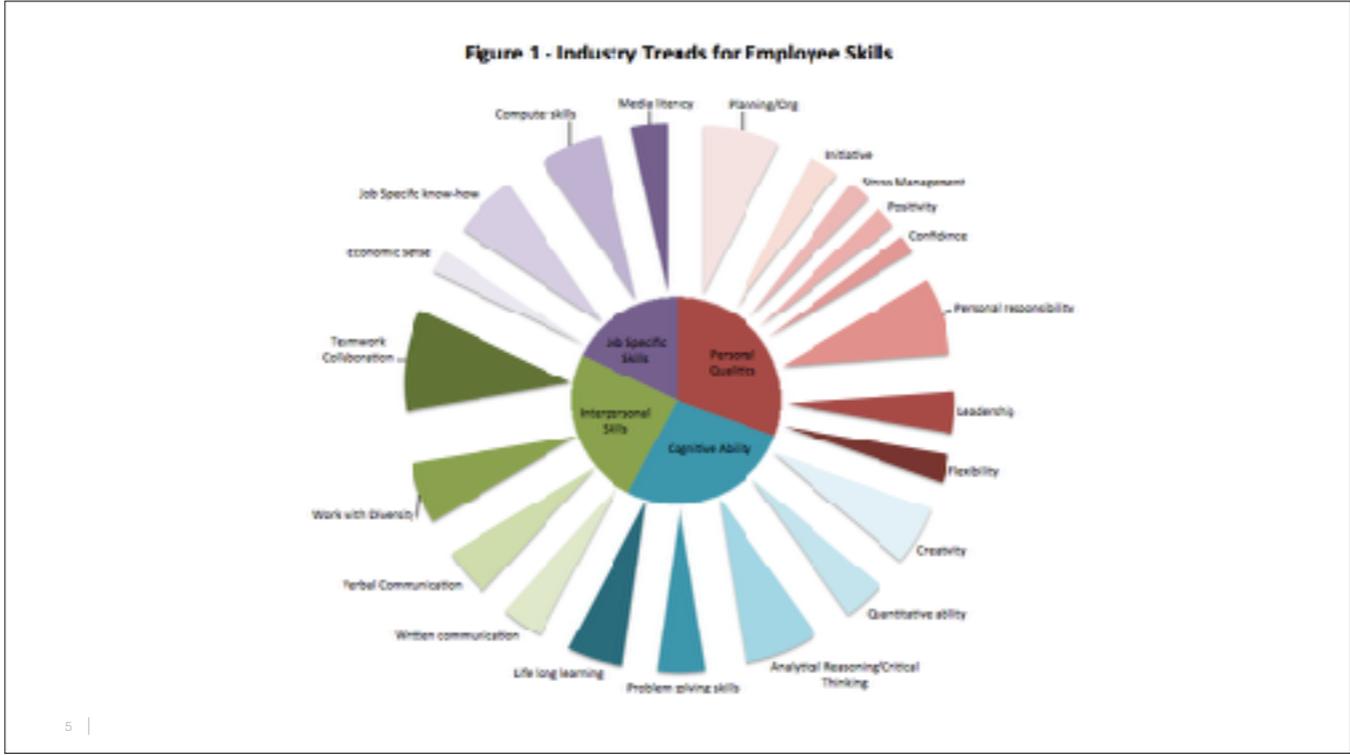
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The names of the course tends to give it away

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What was the easternmost  
city on the “Silk Road?”

While CONTENT is unquestionably important, it should not be the sole focus of education. We should no longer focus our teaching solely on questions that can be answered through a quick internet search (e.g, Baidu). 21st-century learning needs to go beyond content.



My colleagues and I recently reviewed studies conducted by industry professionals to determine the skills that employers are looking for in their employees.

# NEEDED SKILLS

Sources:  
Fidler (2016)  
Herk (2015)  
NCREL/METIRI (2013)  
University of Kent (n.d.)  
University of S. Florida (n.d.)  
US Chamber of Commerce and University of Phoenix (n.d.)

1. Teamwork/ Collaboration
2. Responsibility
3. Planning and organization
4. Analytical reasoning
5. Job-specific know-how
6. Computer Skills
7. Ability to work with diversity/  
challenge
8. Creativity
9. Lifelong Learning
10. Verbal Communication

We then looked at the 10 most requested skills across all of these. What do you notice about them? How many of these deal with content-specific knowledge?



In 2007, the A Partnership for 21st learning was formed that outlined important skills for today's learners. In addition to the content-based skills, they suggested we add what are called the "4 Cs: Communication, Collaboration, Critical Thinking, and Creativity.



# We're taking teaching and learning **Above & Beyond**

Today's students are moving beyond the basics  
and embracing the 4C's — "super skills" for the 21st century!



## Communication

Sharing thoughts, questions,  
ideas, and solutions



## Collaboration

Working together to reach a  
goal — putting talent, expertise,  
and smarts to work



## Critical Thinking

Looking at problems in  
a new way, linking learning  
across subjects & disciplines



## Creativity

Trying new approaches  
to get things done equals  
innovation & invention



For more 4C resources from  
the Partnership for 21st Century Skills,  
including the animated film ABOVE & BEYOND  
by Peter H. Reynolds & FableVision, journey to  
[www.p21.org/4Cs](http://www.p21.org/4Cs)



PARTNERSHIP FOR  
21ST CENTURY SKILLS





[show 4Cs video]

# Communication



Communication entails learning how to talk to people with differing ideas.

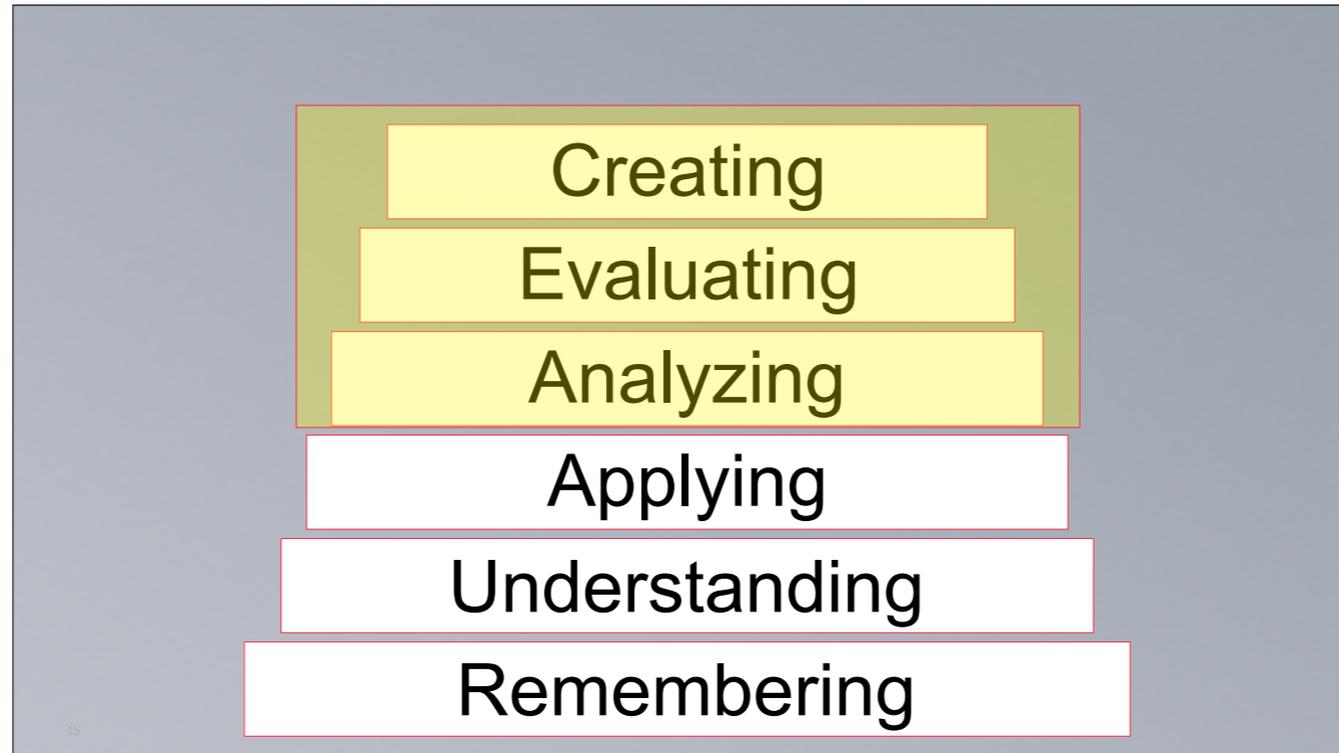
# Collaboration



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Collaboration is working together to solve problems that may not have 1 correct solution.

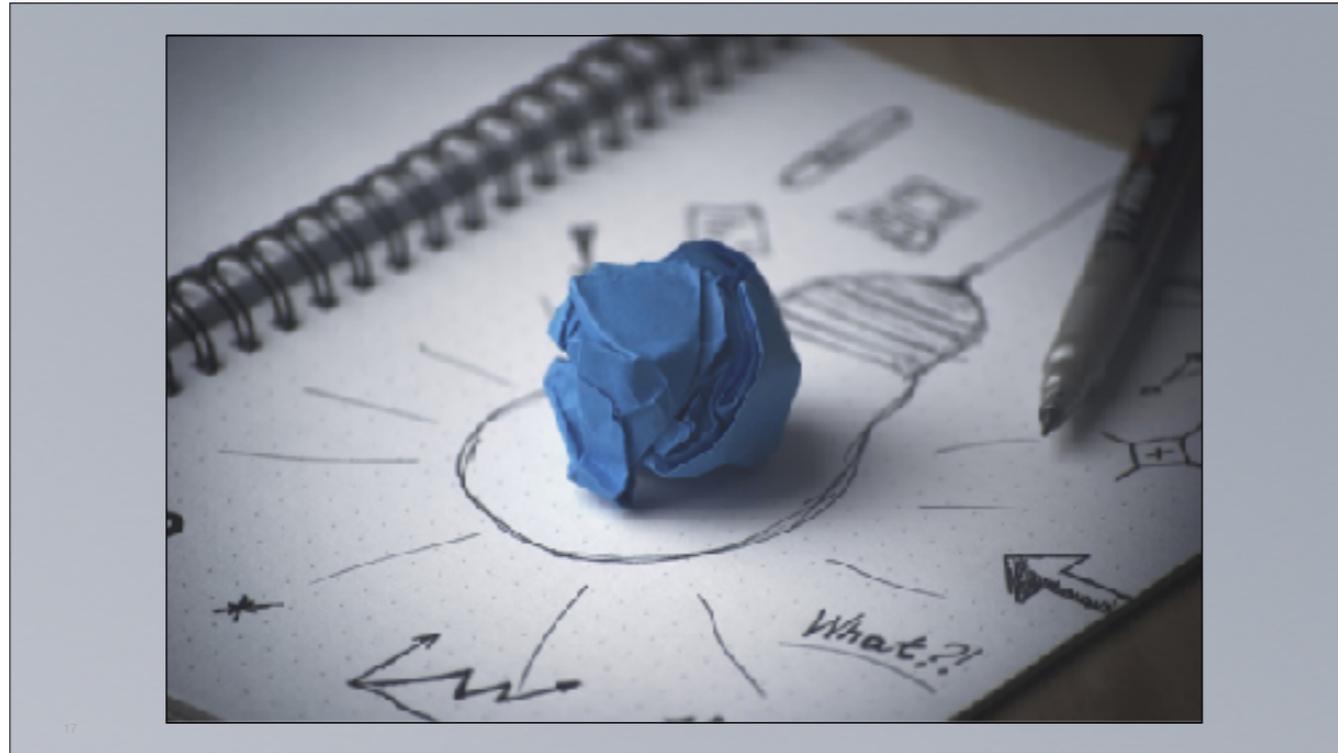
# Critical Thinking



“Critical thinking is the disciplined mental activity of evaluating arguments [information] or propositions and making judgments that can guide the development of beliefs and taking action” (Ennis, 1992). In the 1950s, educational researcher Benjamin Bloom and his colleagues outlined the different ways of engaging students cognitively. At the lower levels were tasks that merely require students to remember and understand information and to following specific steps. Critical Thinking requires these three higher-order thinking activities. Learning should engage students in analyzing, evaluating and creating.

Ennis, R. H. (1992). John McPeck's Teaching critical thinking. *Educational Studies*, 23 (4), 462-472.

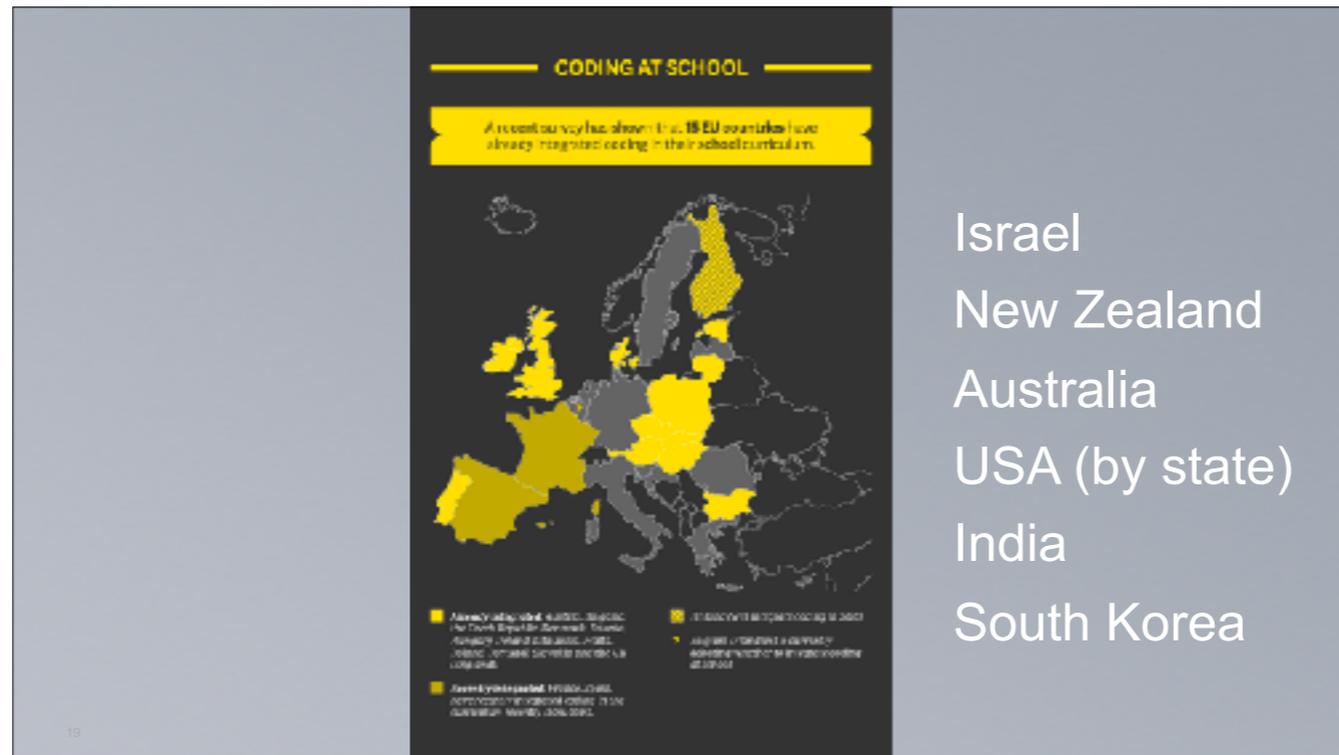
# Creativity



Creativity gives flavor to critical thinking. Through fostering creative ideas, we enable students to think beyond immediate answers. We encourage them to see the world differently. My wife did this for me. I was a long-time doodler; She also liked to draw. One day, when we were dating, we both had our drawing pads. She challenged me to draw a hand holding a stick. I did so and I thought I did a good job. She looked at it and said, "that's a good hand, but it's not this hand." I had gotten into the habit of looking once and drawing something from memory. She taught me that I needed to keep looking, and to look at things from different angles. After that moment, I started looking at everything differently. I looked at ugly bushes and trees and saw beauty in them I had been missing. Creativity is not just for fun; creativity helps us to open our eyes, to consider what we haven't, to see things anew, and to see the beauty in the mundane. Creativity opens eyes.

# Computing

The 5th C—Computing—is quickly becoming the newest and most important content addition to 21st century learning



Already, many countries across Europe have integrated coding into their curriculum. Outside of Europe, we see several other countries adding computing as part of their core curricular experiences.

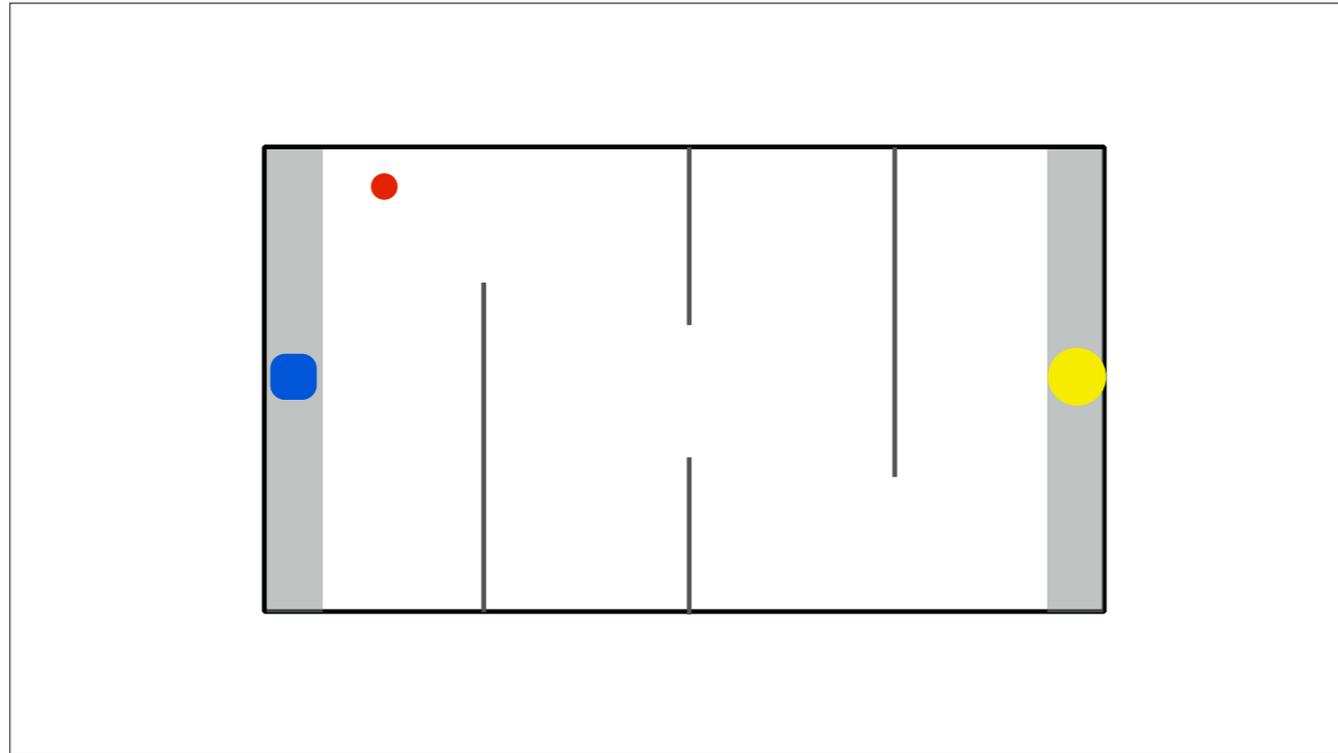
# COMPUTATIONAL THINKING

Breaking down the problem  
Finding patterns  
Creating Algorithms  
Automating the process  
Analyzing data

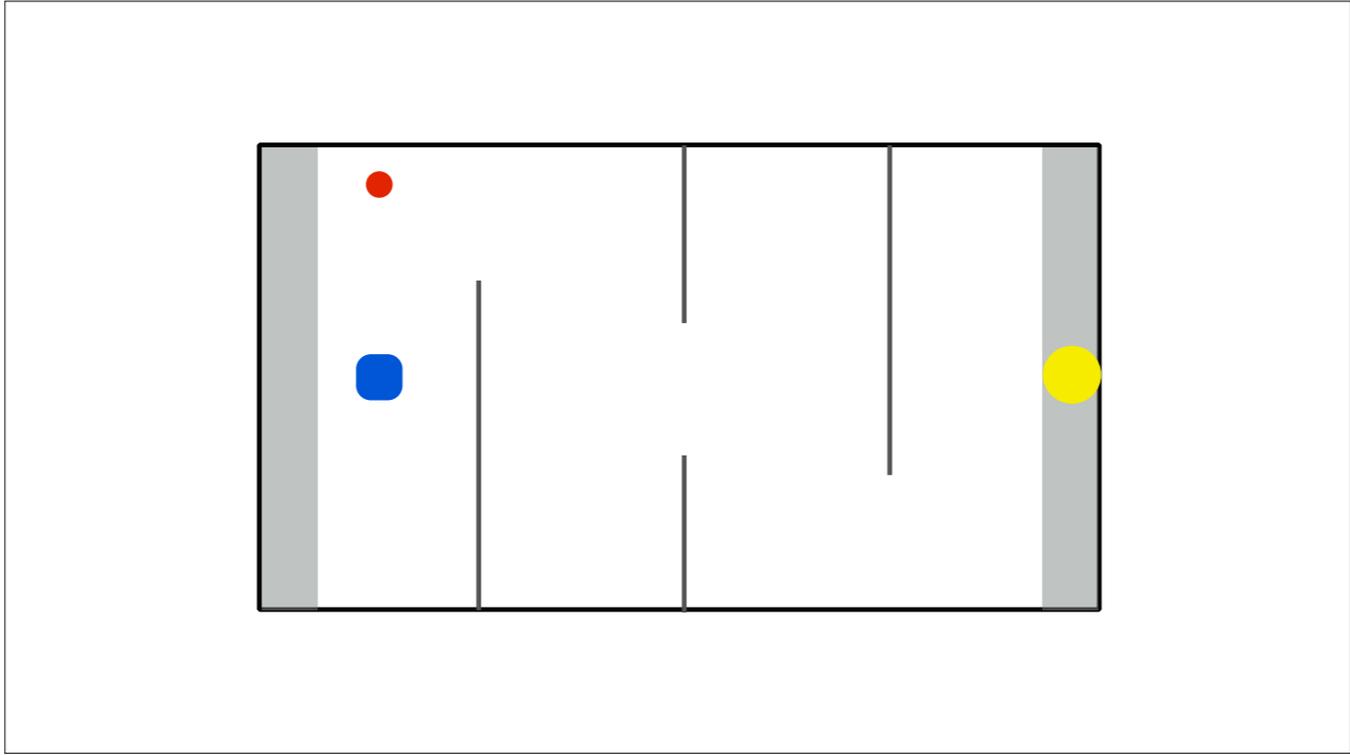


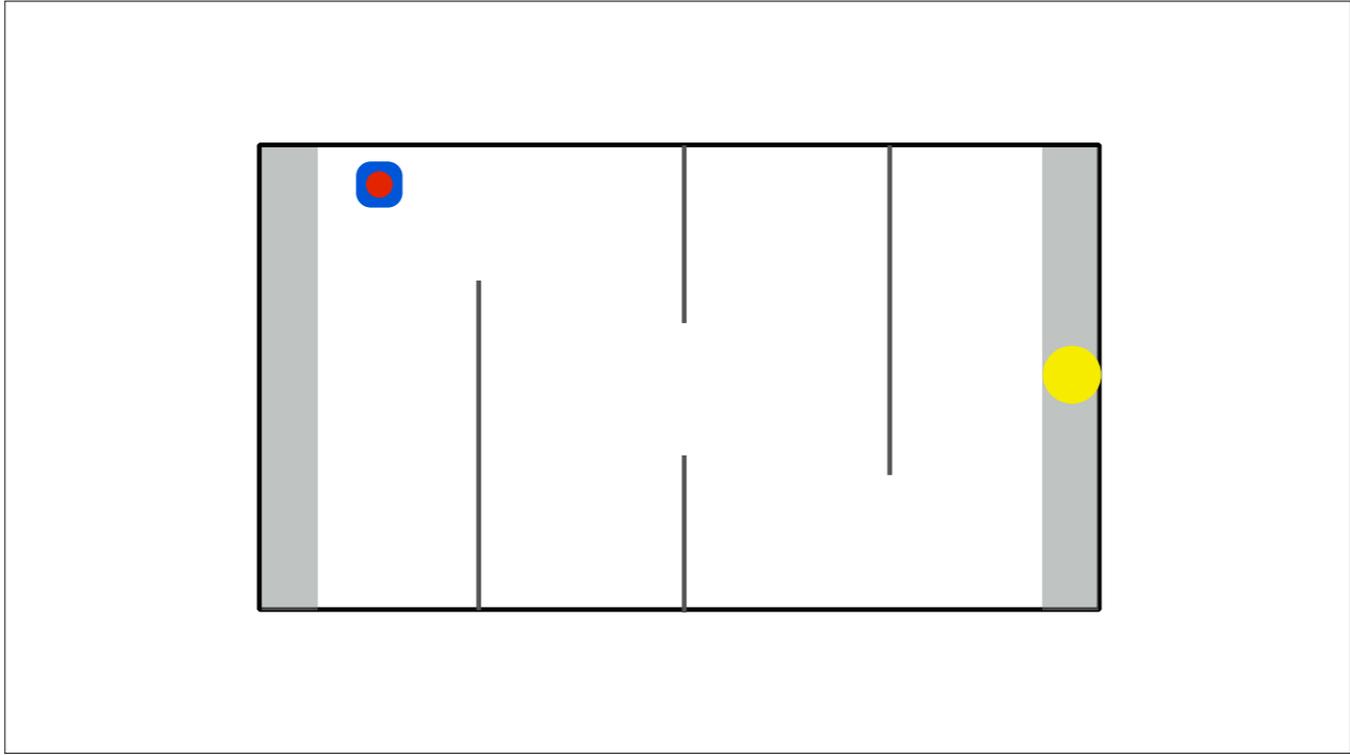
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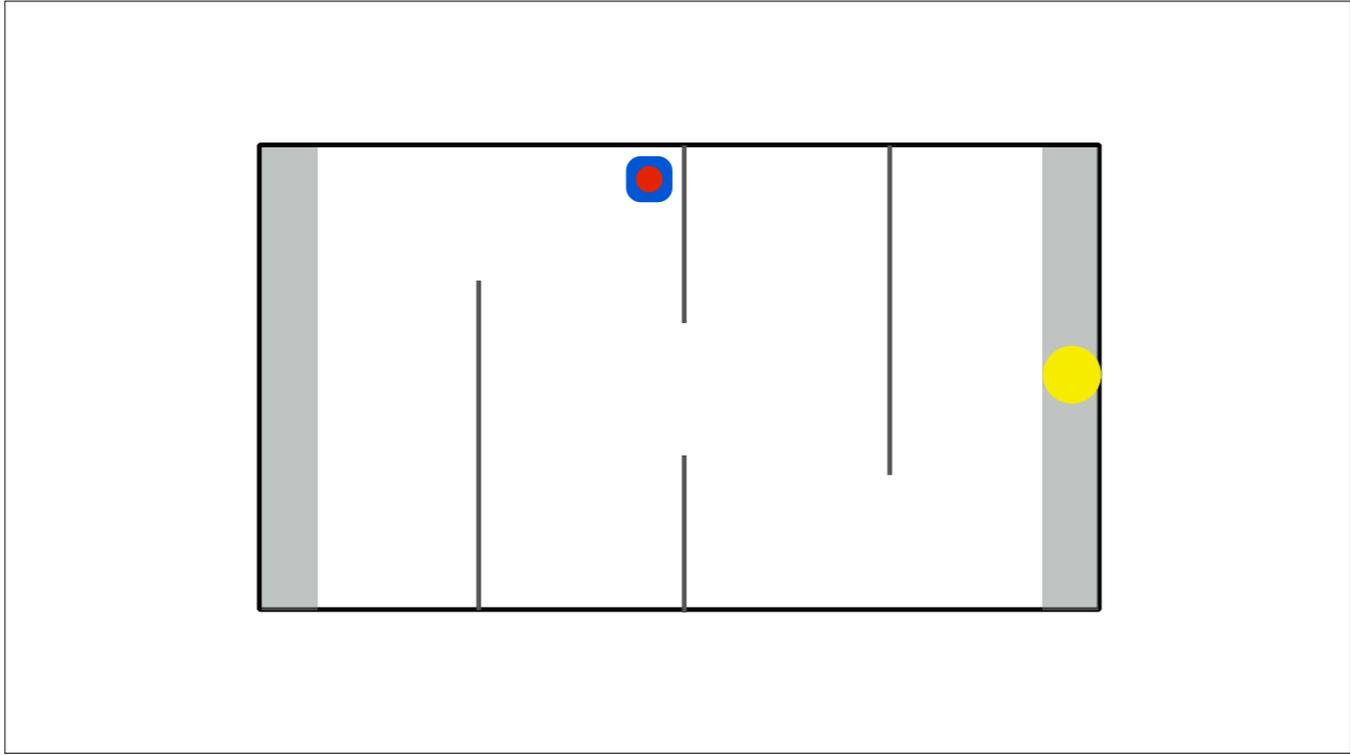
Computing is important not just because it enables people to communicate, collaborate, and create using today's tools; learning computing helps with so many other skills. Jeannette Wing (2006) demonstrated how computational thinking is a skill used across many disciplines. Computational Thinking helps people to break down a problem, find patterns, create algorithms, automate processes using technology, and to then analyze data.

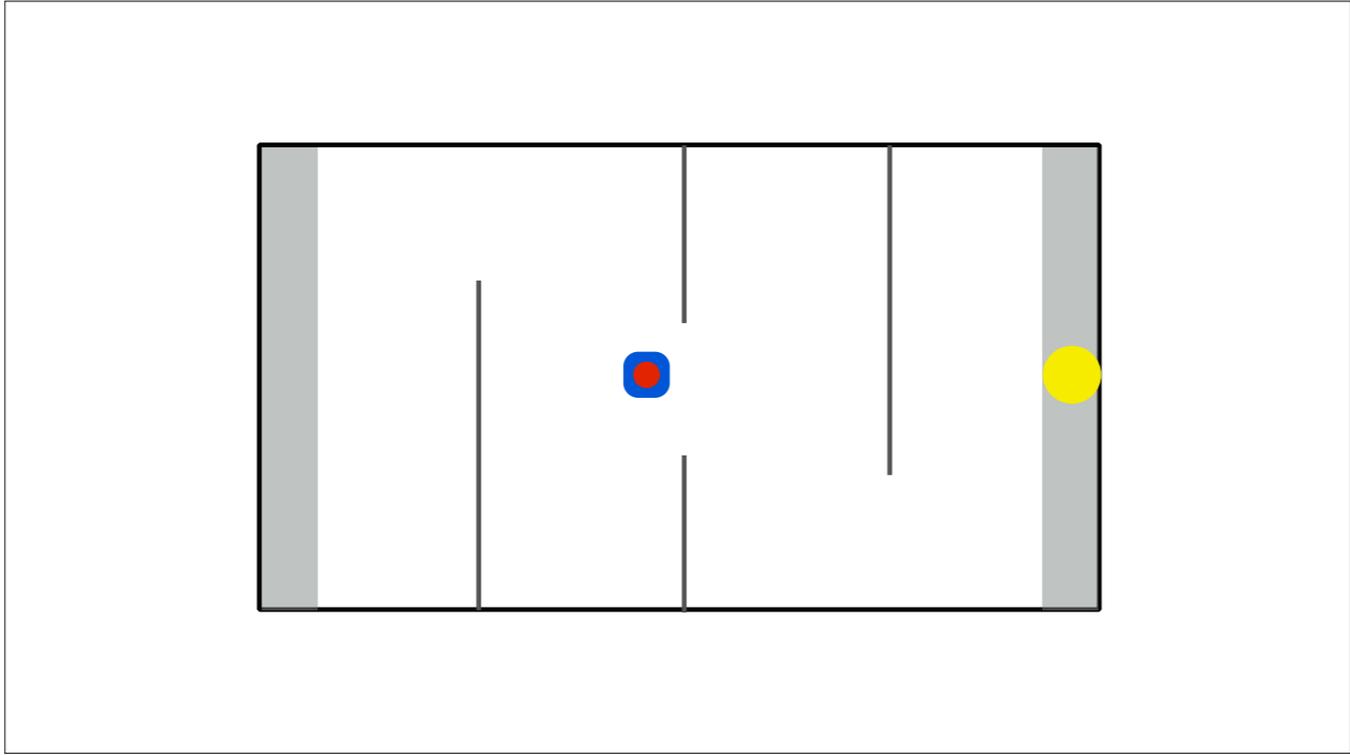


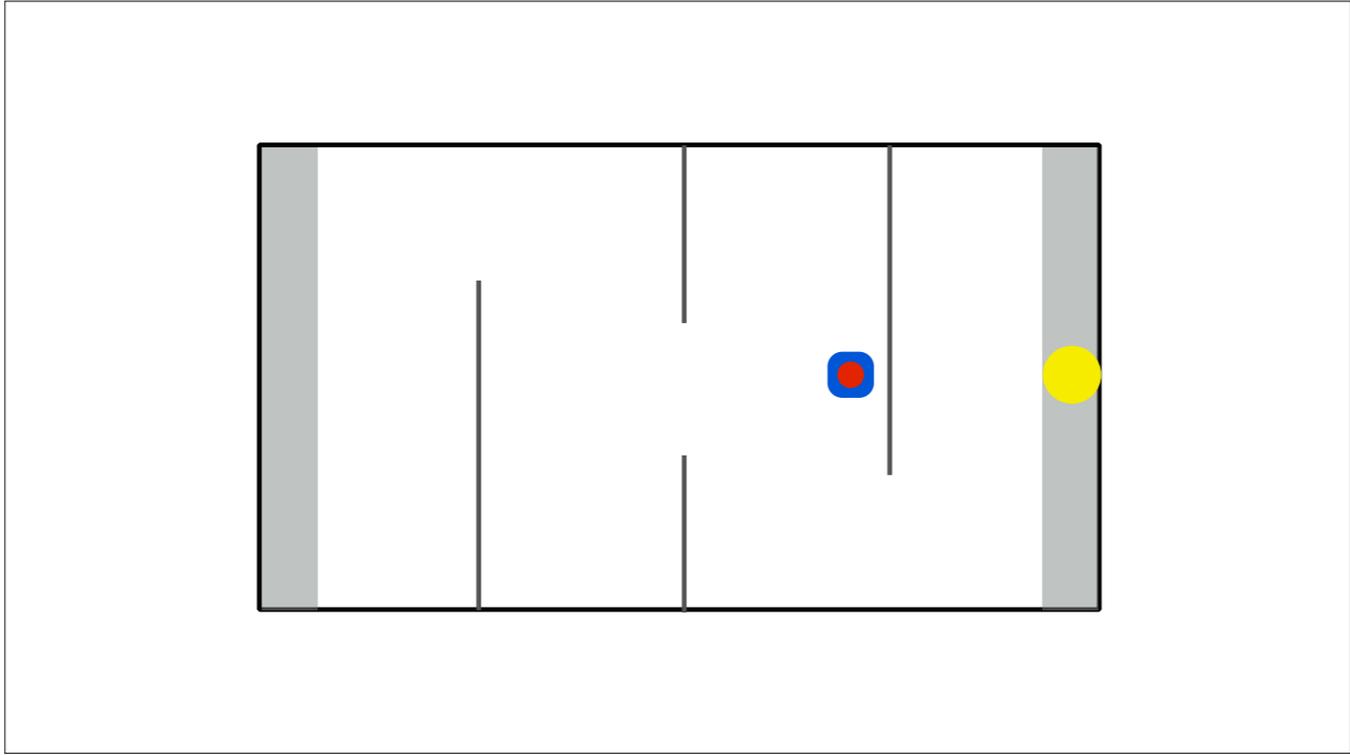
One way we are currently promoting computational thinking is by using robotics. Consider a current challenge some of our students are working to complete. In this challenge, students need to get a robot to pick up a ball, work its way through a simple maze of walls, and place the ball in a container at the end of the maze.

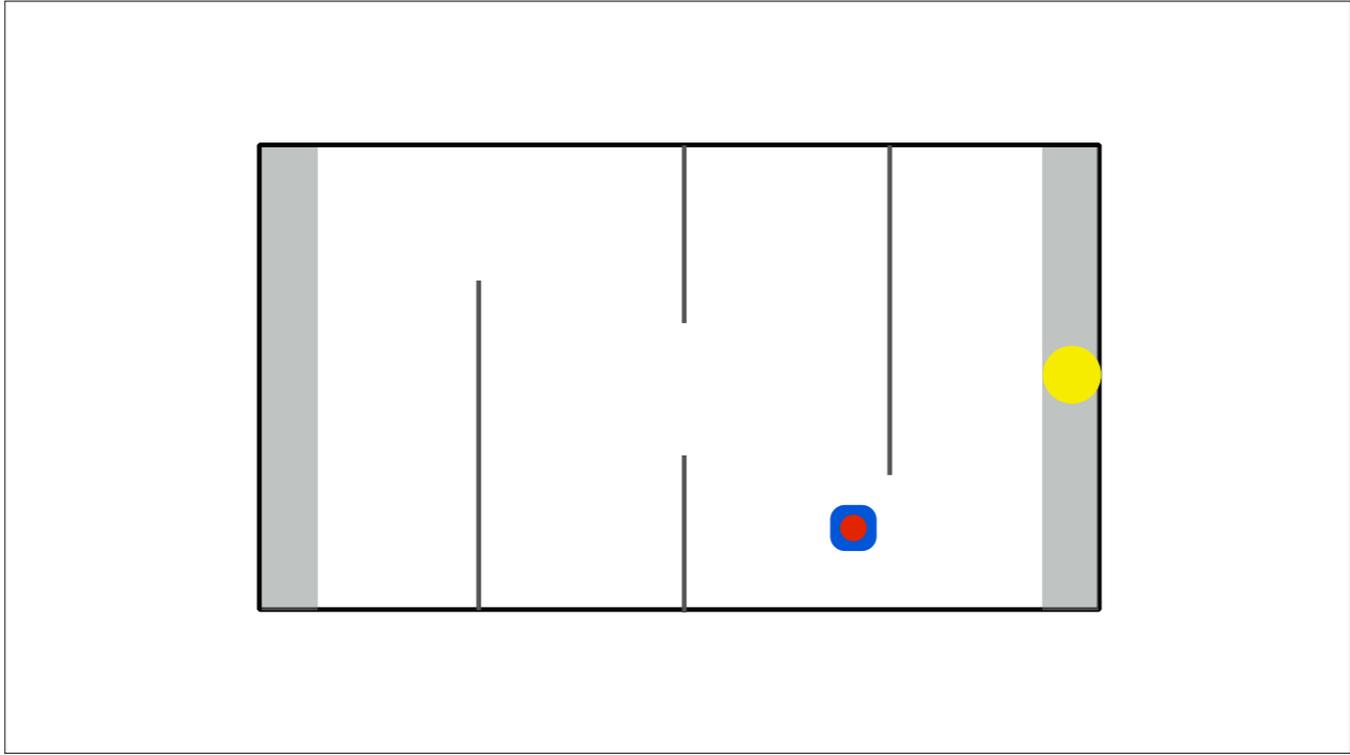


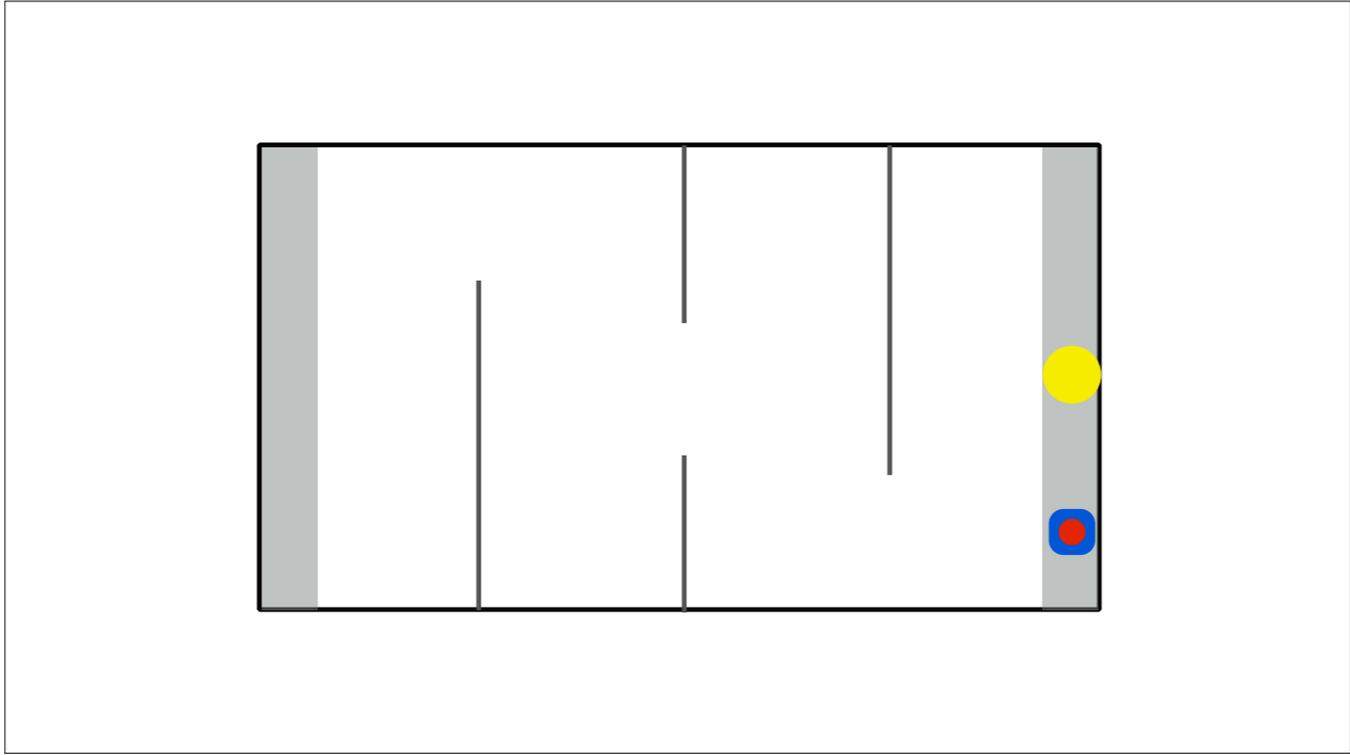


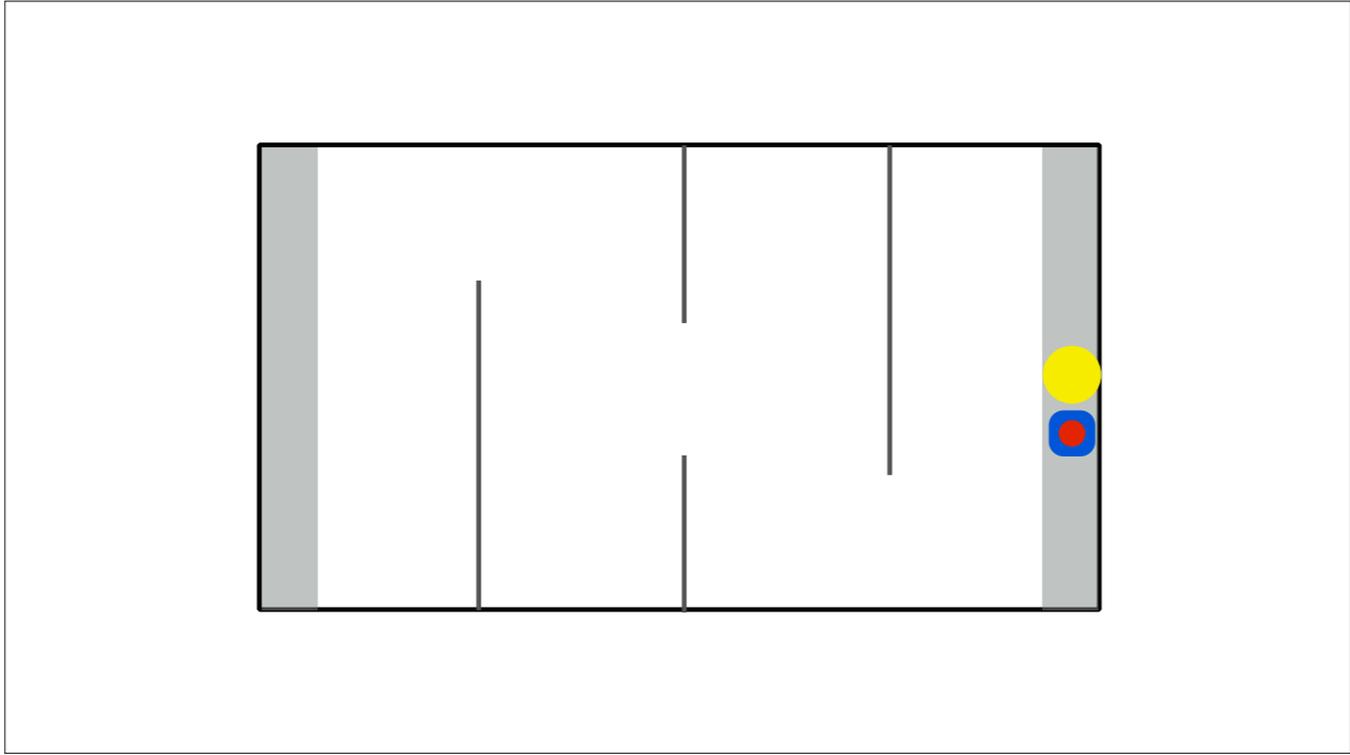












Need to get the robot to move

Pick up a ball

Detect if there's a wall in front of the robot

Put the ball down

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**BREAK PROBLEM DOWN**

Use Ultrasonic sensor to see if there's something X inches in front of me

If there is, turn right 90°

Go forward 24 inches

Repeat 3x

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**CREATE ALGORITHMS**

Simple machines

Problem-solving apps (e.g., Tinkerbox, Cargo-bot)

Robotics (Lego, Vex)

Code.org

ISTE computational thinking materials

Programming games

CSTE computational thinking standards

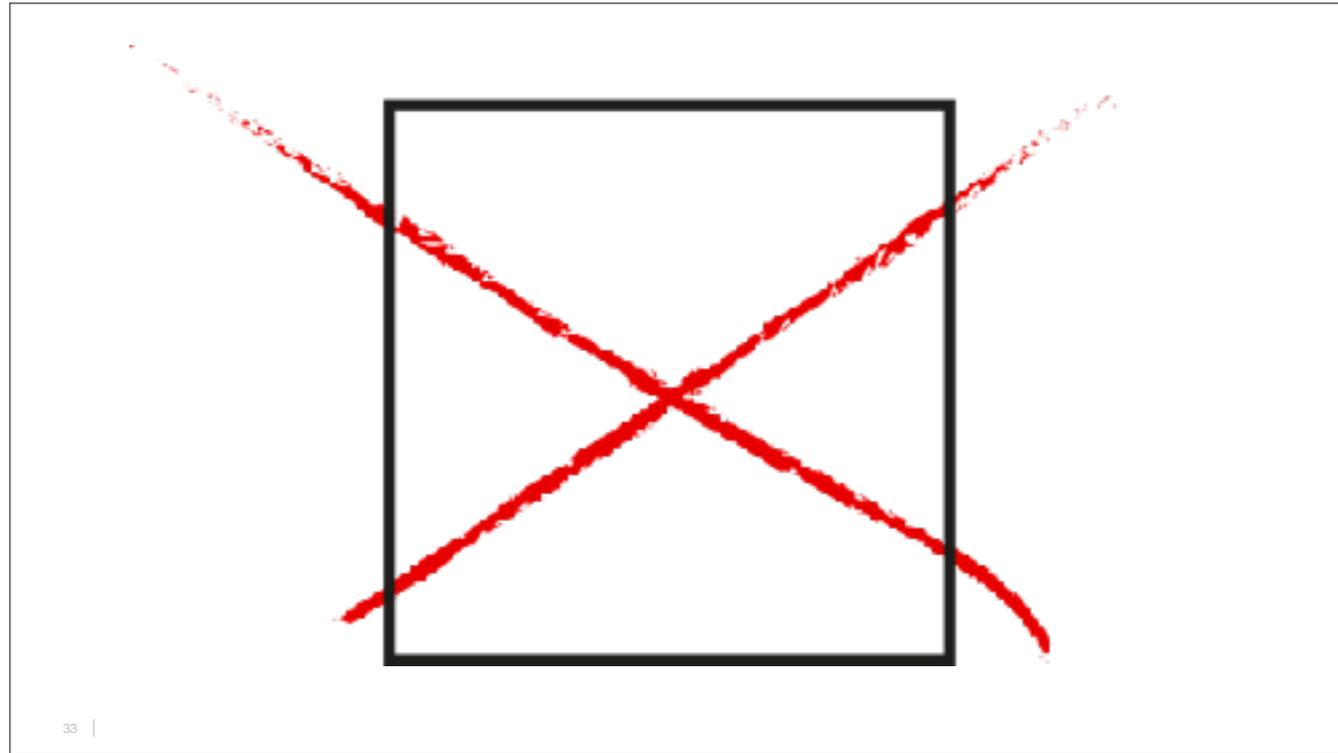
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## **BUILDING UNDERSTANDING THROUGH COMPUTATIONAL THINKING**

There are now many “games,” that encourage children to use computational thinking to solve on-screen problems.

Children can move to programming using a drag-and-drop-based language such as Scratch, Tynker, Alice, and so on.

By middle school, students could easily be using textual programming languages to create presentations, web pages, and the like as a means of solving problems



One area that computing may be especially helpful is in encouraging students to become more resilient as they deal with failure. We recently conducted a worldwide study of teachers who are teaching young children to code. When they talk about the changes they noted in students since learning to code, many teachers noted that students were more resilient in the face of failure. Here are a few quotes:

“Students are more confident, less worried about getting it wrong. They have better skills to figure out problems, so they don't mind if they don't get it right the first time.”

“Increased willingness to try things multiple times if they don't succeed the first time. Better ability to break down a problem into smaller pieces rather than looking at something as a whole.”

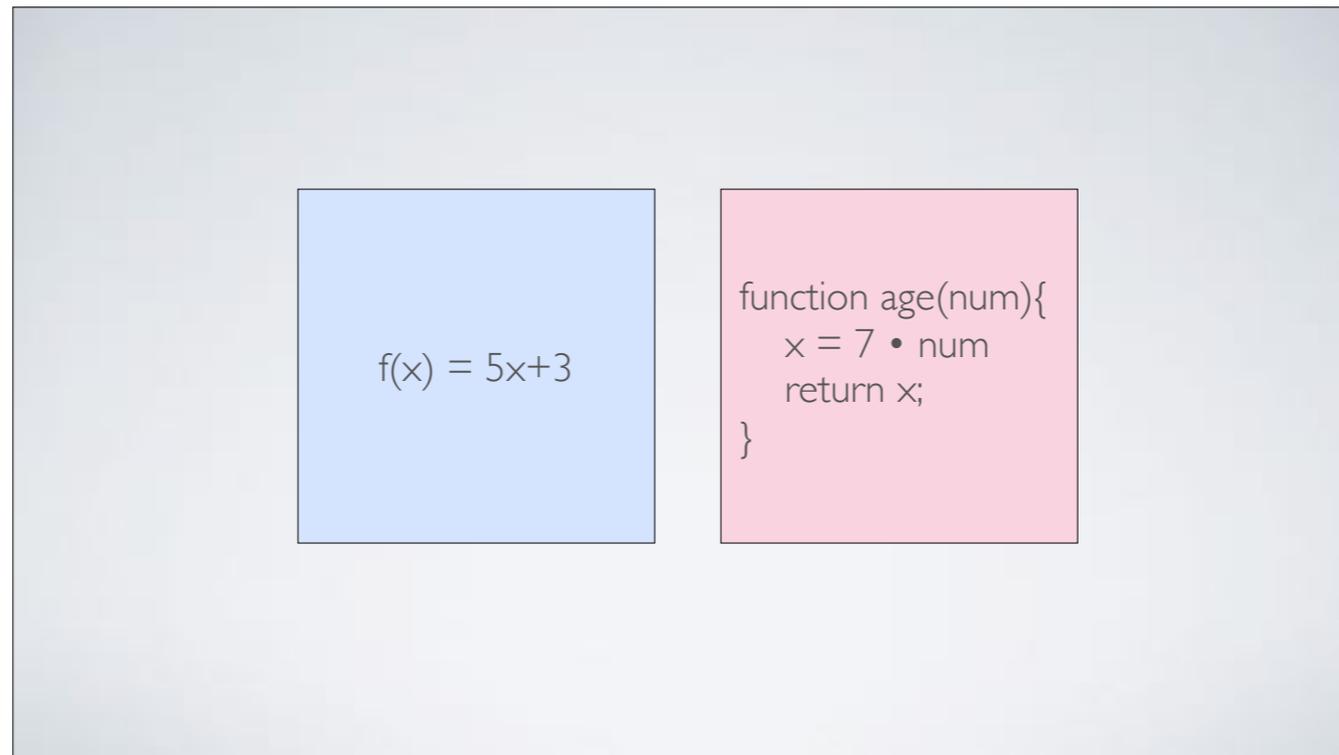
“Persistence at problem solving has increased - students are better able to work out problems they are having on their own, they don't ask for my help as much.”

“They are not easily discouraged”

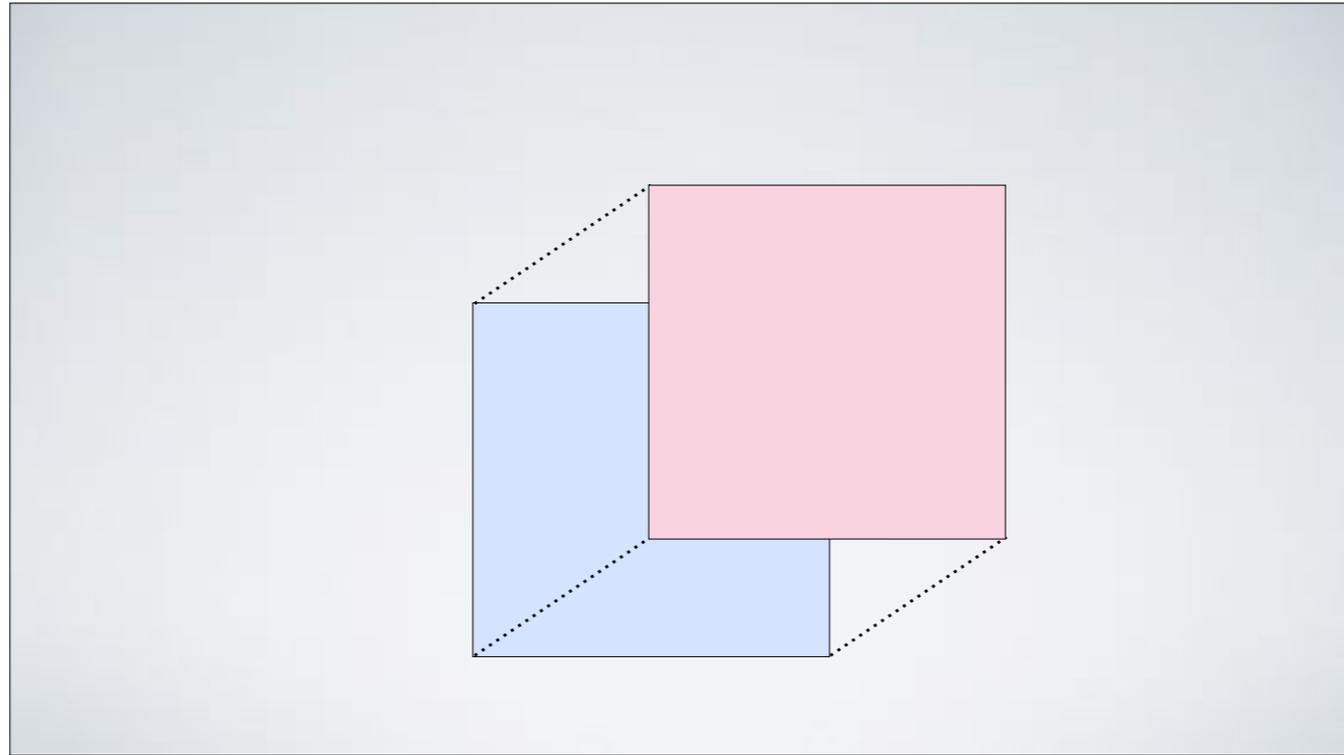
“I notice that it's taught kids that failure is ok, not to give up and to keep trying, even when things get challenging.”

“Greater resilience and confidence, more focussed on how to solve a problem rather than "doing it right””

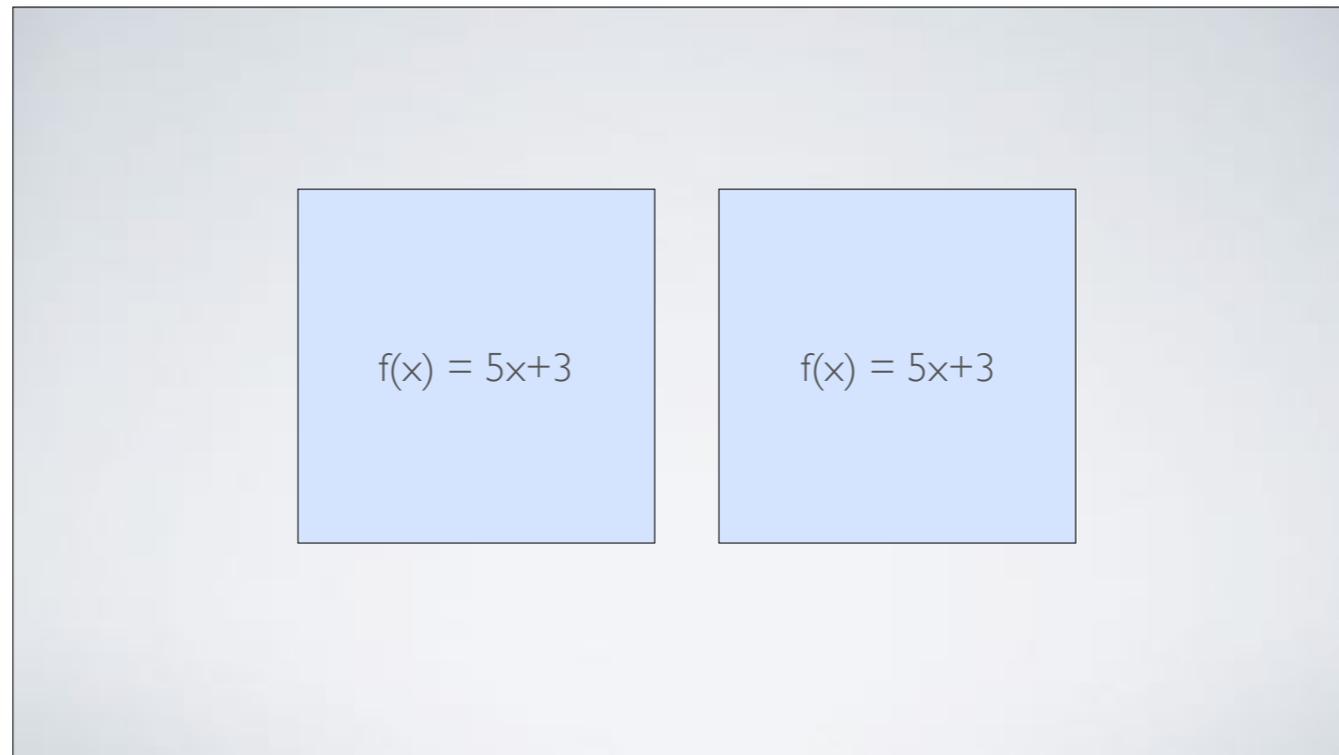
“Less quick to give up, more interested in problems, more logical thinkers”



Why might programming in this way might help mathematics? Consider that this blue shape represents the idea of a function in algebra. And let's suppose this red shape represents the idea of a function in javascript. Individually, we see each of these shapes as a square...



...But if we have the ability to see both at the same time, what do we see? We might recognize that each is a side of a shape with greater dimensions.



Understanding what a function is from its many different angles might just be more useful than spending more time looking at it from a single direction repeatedly. Instead of giving students who struggle with mathematics an additional hour of the same thing, perhaps showing them...

```
function age(num){  
  x = 7 • num  
  return x;  
}
```

...a different side of the cube will help them to understand it better.

## Preparing Preservice Teachers to teach Computing

1. Learn to code
2. Create lessons
3. Integrate to the core

Creativity  
Communication  
Collaboration  
Critical Thinking  
Computing

Are these  
sufficient?



There are many games today that make incredible use of these skills. Multi-player online battle arena (MOBA) games is a growing and profitable industry. Players come together to collaborate, solve problems using critical thinking, come up with creative solutions, and communicate with people they may have never met in person.

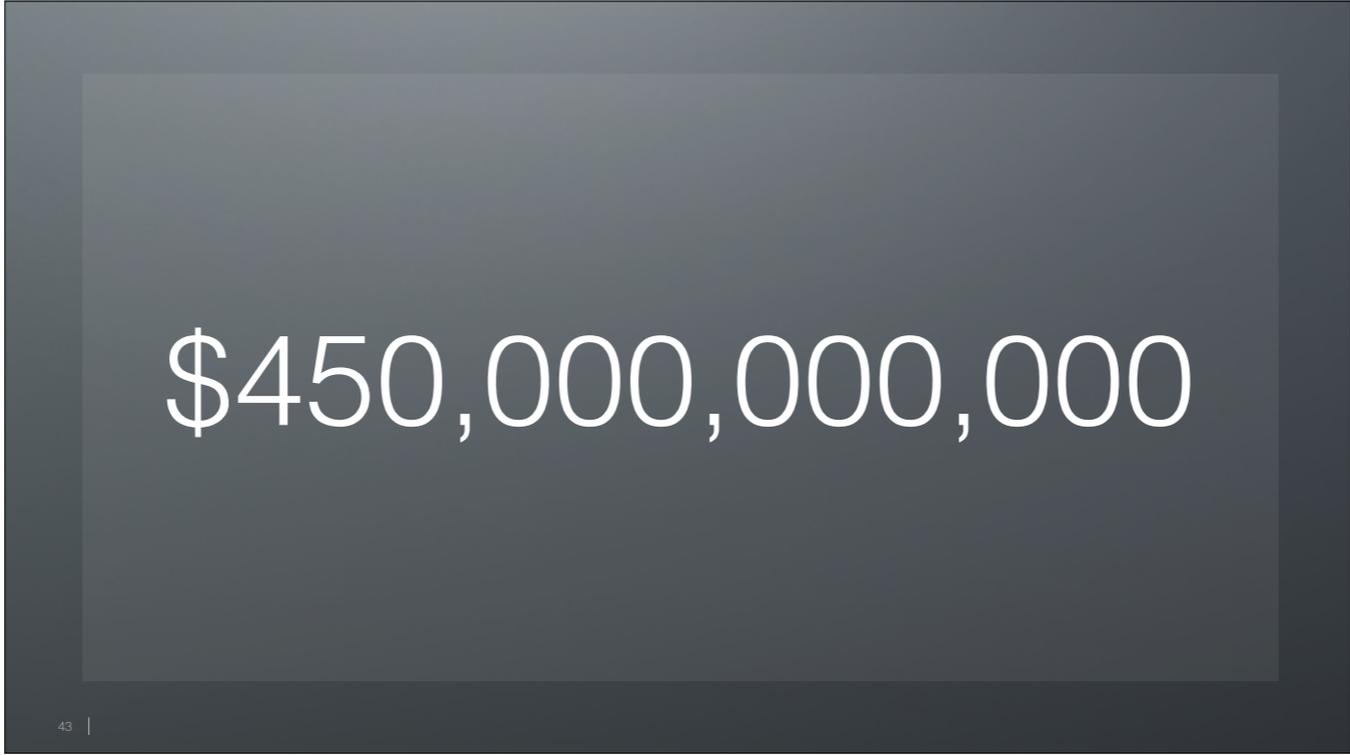
So, they're engaging in the 4Cs, but are they good? I would ask, how have these games benefitted the world? And how have they benefitted the players engaged in them? In some ways, they bring people of diverse backgrounds together. But, I would contend that spending hours up late at night to fight imaginary monsters sells these important 21st-century skills short.



42 |

From 1930-1933, my grandfather, Russel Rogers Rich, was a missionary in Germany. During that time, he kept a journal. One day, he wrote that he had the opportunity to listen to a local political leader by the name of Adolf Hitler. He wrote that the man was a master at moving the crowd. My grandfather also noted that it was scary how convincing his ideas were because they were also very inhumane. Hitler was a great communicator.

He clearly brought together others to collaborate in his catastrophes. He demonstrated critical thinking in devious ways, many of which certainly demonstrated creativity. Imagine what evil he could have wrought had he possessed access to today's computers.



\$450,000,000,000

43 |

Any guess what industry last year made this much money? Cybercrime. This is the estimated amount of money stolen last year by those who engage in cybercrime. The thing is, they are collaborative, communicative, creative, and critical thinkers. The “dark web” is a collaborative environment where cyber hackers go to market and purchase malicious software to steal sensitive information from individuals all over the world. These cyber hackers must find ways to critically think about how to subvert law enforcement and current mechanisms meant to protect this information. Their solutions are truly creative.

Source: [https://www.ted.com/talks/caleb\\_barlow\\_where\\_is\\_cybercrime\\_really\\_coming\\_from](https://www.ted.com/talks/caleb_barlow_where_is_cybercrime_really_coming_from)

# Compassion

44 |

Both of these prior examples demonstrate that, on their own, these 5 Cs are insufficient. Every single attribute mentioned here is dangerous without the attribute of compassion. The last thing this world needs more of are intelligent, creative individuals who collaboratively communicate their evil and self-serving ideas. Whatever we learn, we ought to do so in the service of bettering our own world and the circumstances of those in it.



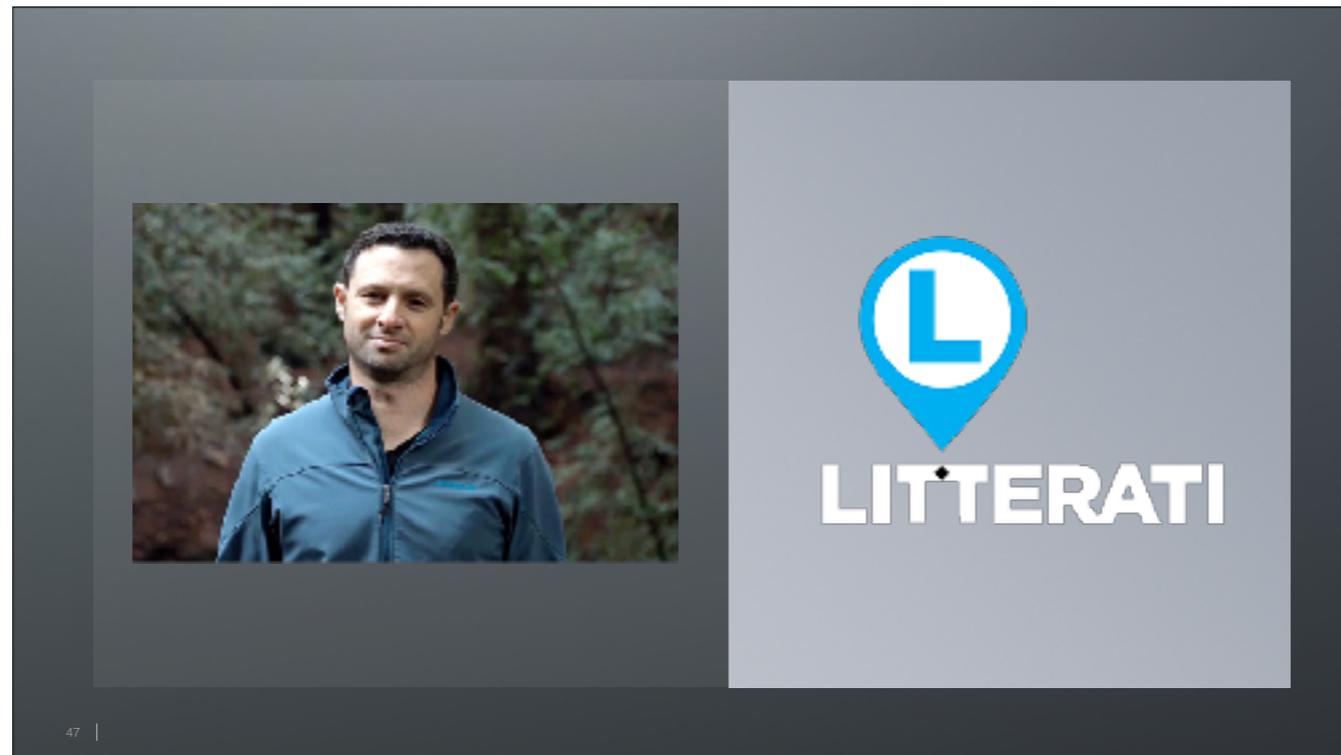
Imagine using the power of collaboration, creativity, and critical thinking to solve scientific problems instead of to hunt down imaginary monsters. Foldit was an effort by Biochemists to make the folding of proteins into a game. They gathered “players,” who were ordinary people, from around the world and presented to them a problem that they hadn’t been able to solve. As stated in their research report of this effort, “Remarkably, Foldit players were able to generate models of sufficient quality for successful molecular replacement and subsequent structure determination. The refined structure provides new insights for the design of antiretroviral drugs.”

Khatib, F., DiMaio, F., Cooper, S., Kazmierczyk, M., Gilski, M., Krzywda, S., . . . Baker, D. (2011). Crystal structure of a monomeric retroviral protease solved by protein folding game players. *Nat Struct Mol Biol*, 18(10), 1175-7. doi:10.1038/nsmb.2119

# Codeando México

46 |

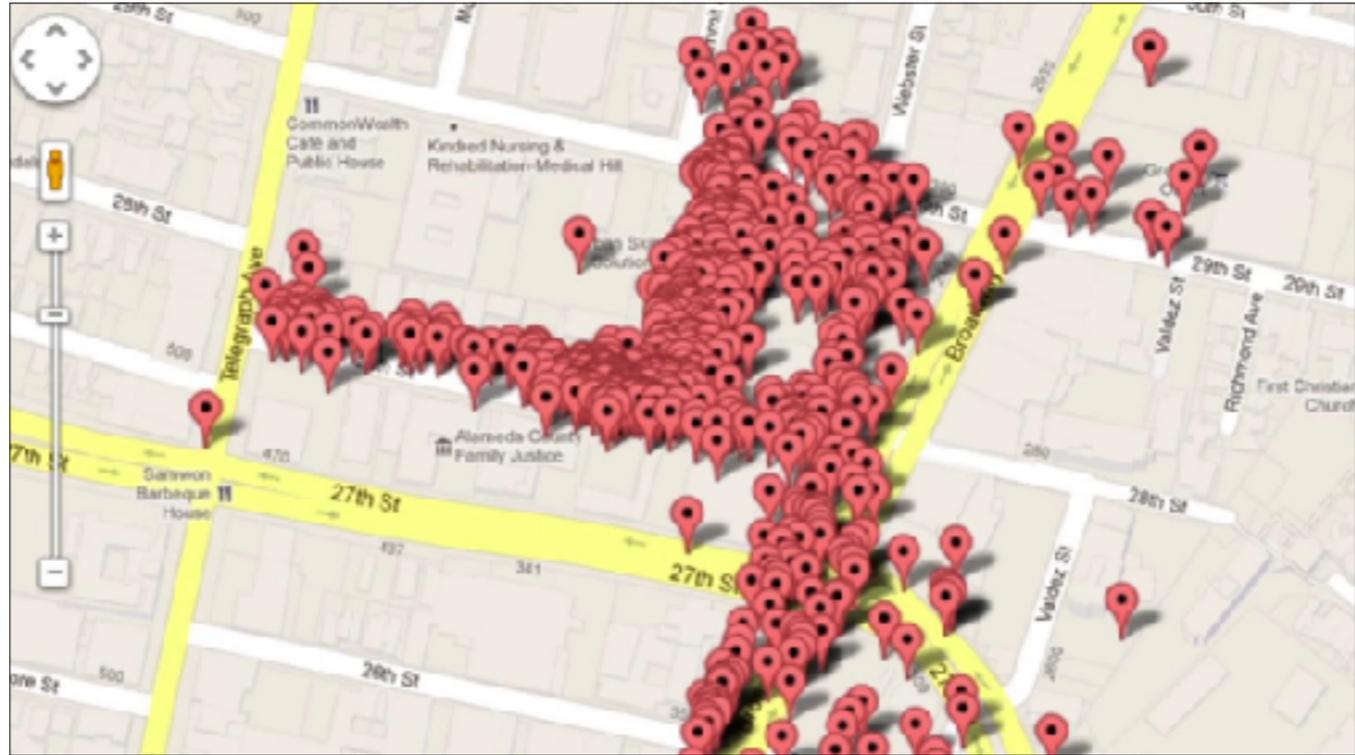
Or how about the case of codeando México? Where the Mexican government contracted with a local software firm for \$9.3 million dollars to help legislators track bills. When a group of citizens realized the government was about to spend a large amount of money on a simple app, they issued an open challenge to developers to build a better app for a prize of only \$9,300, 10,000x cheaper than the 2-year app! What's more, they only gave developers 10 days to build the app. In that time, 173 apps were submitted, 5 of which were chosen and made freely available. This is what open collaboration and computing skills can accomplish, saving people millions of dollars!



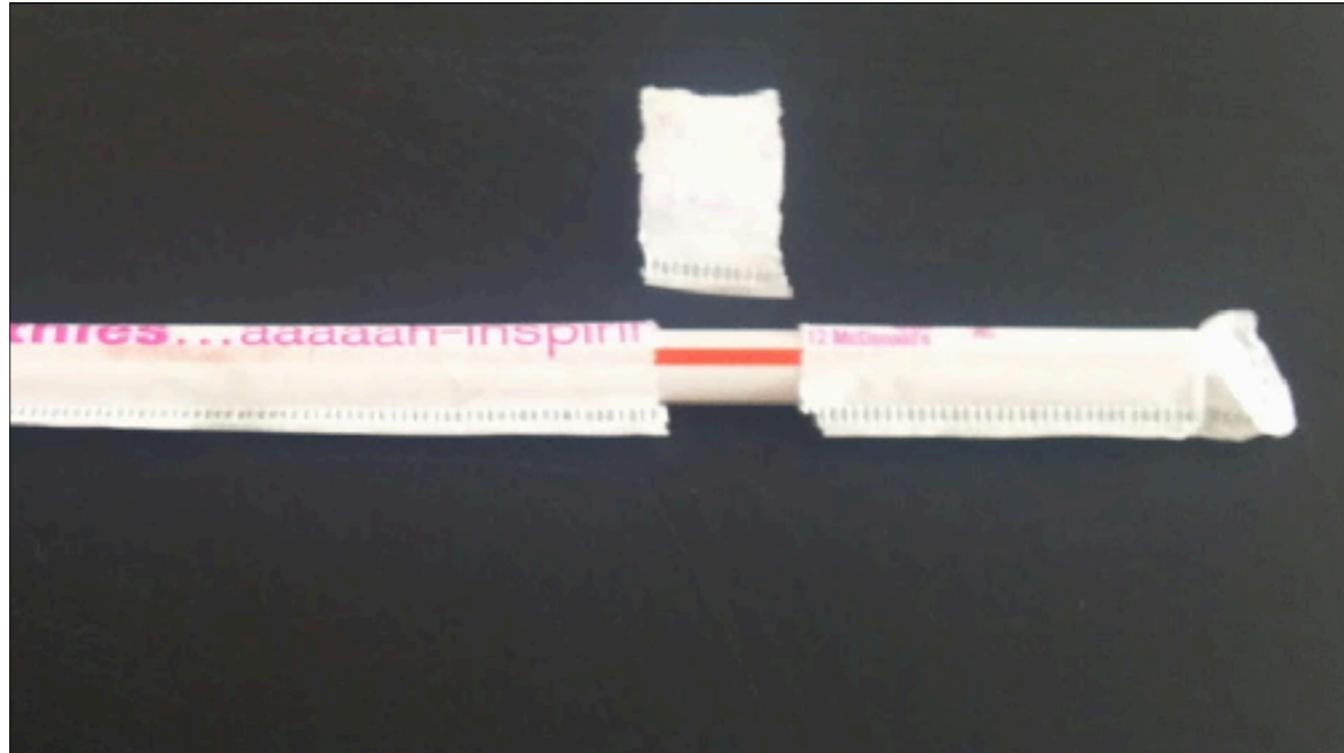
Consider the case of Jeff Kirschner, the creator of Litterati.



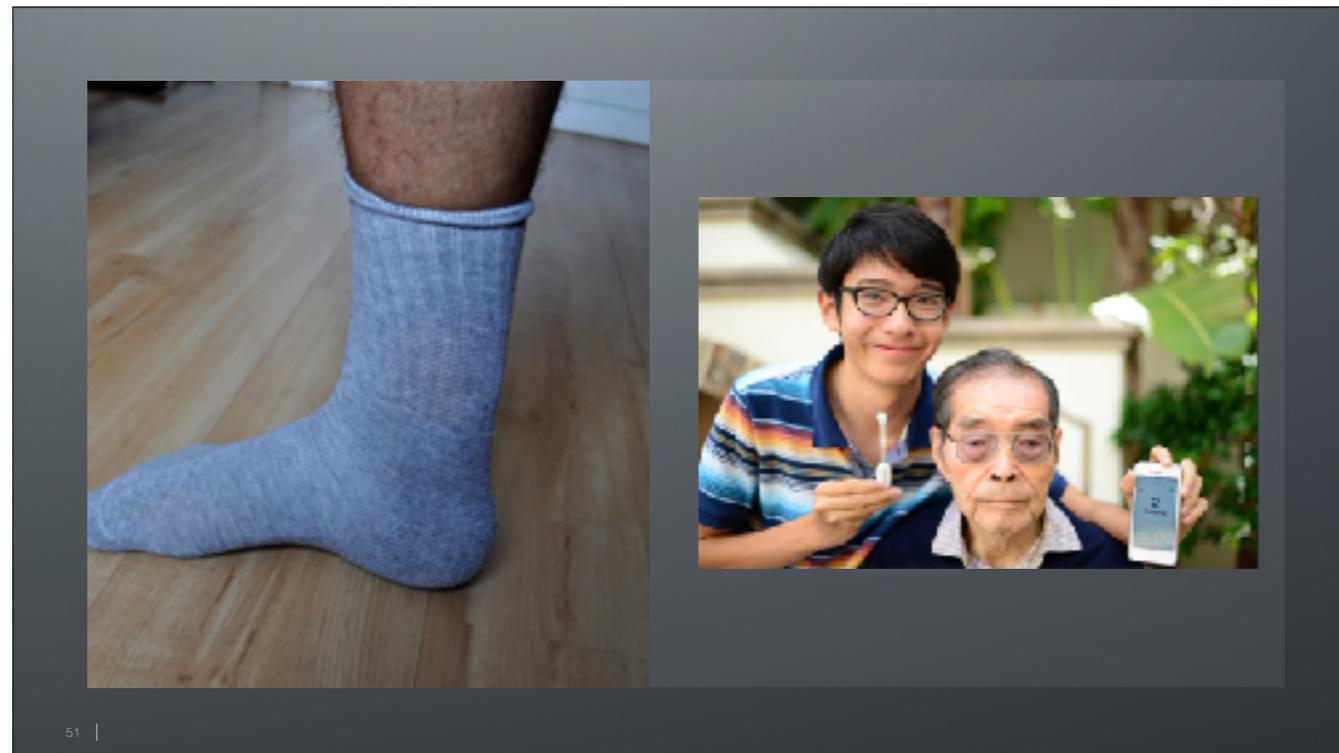
Jeff was out walking in the woods with his children, when they noticed trash on the ground. They asked about it and it got him thinking. “Hey, what if we were to create an app that tracked where we found and picked up trash?” So he created the app. Soon, others got involved and soon, he had a thriving community of people who were tracking where they found trash, what kind of trash it was, and that they’d picked it up.



This map shows what happened around the school where his kids attended. Students got involved and started logging their trash. You know what they found the most of?



Drinking straws! Most of them were from the school and the kids threw them out. In fact many of them were used. So, the kids provided this data to the schools and now the school not only saves money by not buying drinking straws, but is also clearer of trash!



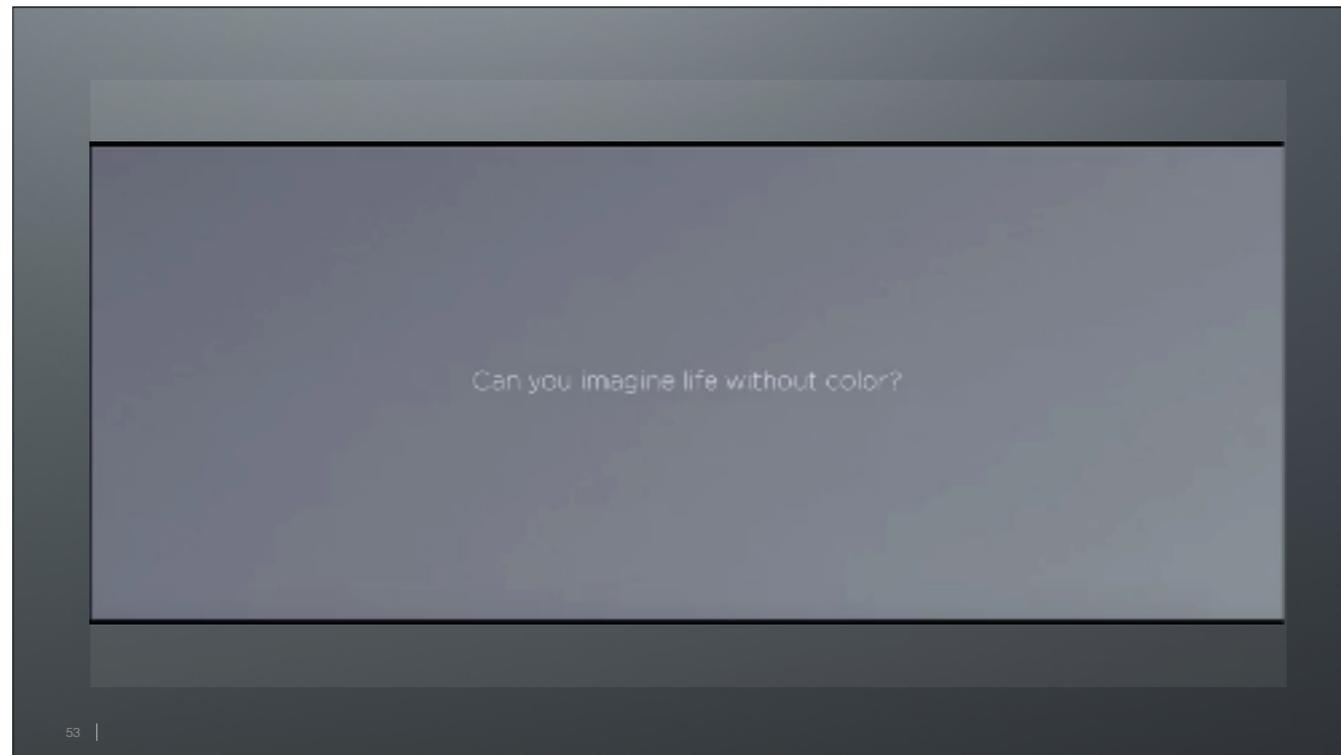
51 |

Or consider the case of Kenneth Shinozuka. His grandfather had developed Alzheimer's disease. His grandfather would wander out of bed and in other places, putting a lot of stress and worry on his family. One day, he noticed that his grandfather wore his socks to bed and, he had the idea of putting a sensor in his socks that would communicate with an app to let the family know when his grandfather was up and wandering around.

Image from: <http://www.safewander.com/in-the-news/>



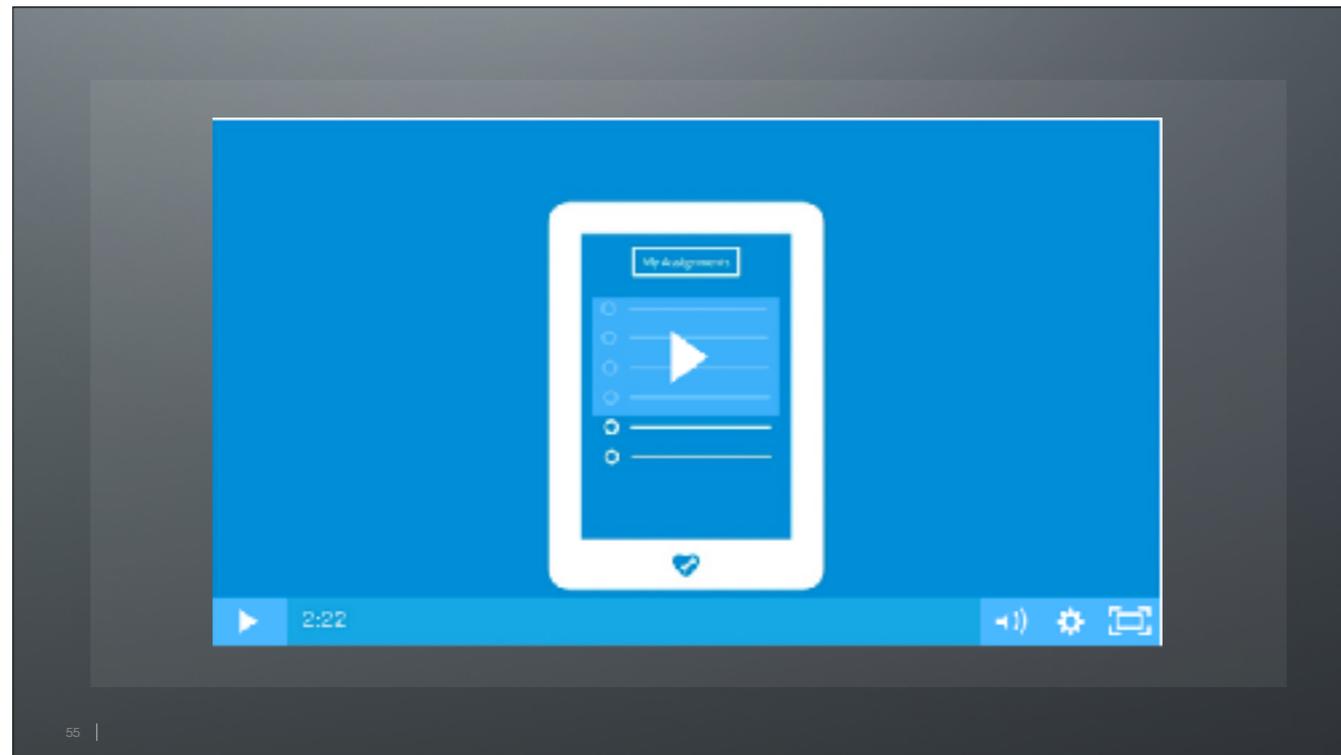
This led to the creation of SafeWander, a simple app that allows for the monitoring of individuals with Alzheimer's disease.



Valspar creation of glasses for colorblind. About 8% of men and .5% of women have some level of color blind deficiency. Why would a company target such a small part of the population? Compassion!



This young man from Utah recently invented the “bat hat.” Upon visiting his grandparents at their care home, he noticed that there were several people walking around with sticks. He thought this was odd and asked his parents why they used sticks. His parents told them that the people were blind and they used sticks to help them not run into things. But upon talking with them, he discovered that even with their walking sticks, blind people still run into things ~10x/day. As a solution, he created the “bat hat,” which has a simple sensor that detects if a walker is getting close to an obstacle. If they are, then the hat beeps. The close they get, the faster the beeps become. He developed this using simple code and tested it with the blind. He found that those with his hat ran into objects only about 5x/day. He cut their accidental run-ins in half!



SeeClickFix lets citizens report, track, and discuss municipal issues in their neighborhoods



“She and her team are succeeding with innovative, big-data algorithms that aim both to improve the efficiency of Didi's service and to ease the congestion on roadways. By analyzing commuter patterns the way oceanographers track the tides, Didi may help traffic jams go the way of the flip phone.

In over 400 cities across China, Jean has also built a company that is dedicated to serving the community around it. Guiding Didi to this higher purpose, and giving back to the places where it does business, she shares my belief that companies can and should measure themselves by more than just the bottom line.”

Tim Cook, CEO of Apple

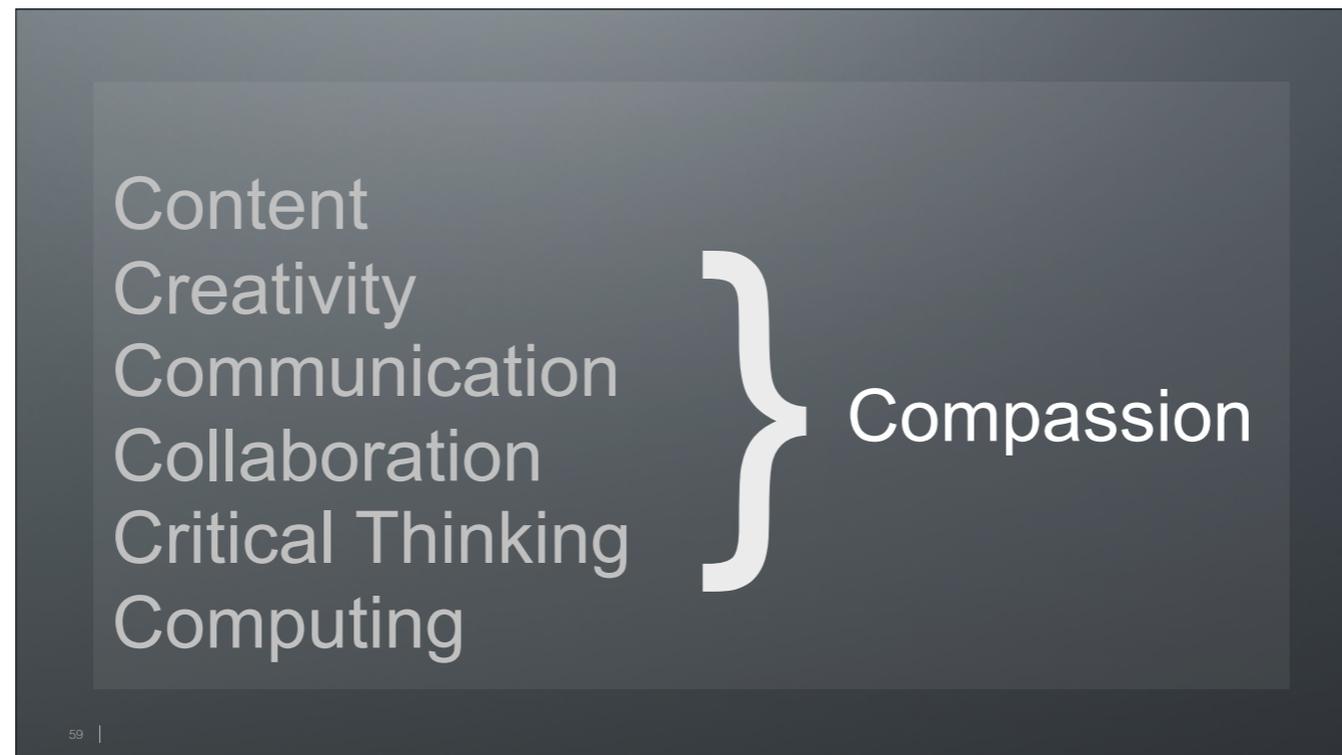
Didi Chuxing (Liu Qing) is creating algorithms to reduce or eliminate traffic jams in China.



Finally, let's consider Manu Prakash and his frugal science efforts. Frugal science is the idea that we create solutions to worldwide problems that can be accessed and utilized by all people.



INSERT FRUGAL SCIENCE VIDEO



The 5cs of 21st century learning are so very important. And so is the content that we have drilled people on for so long. But unless we have COMPASSION, there is danger that we will not make the best of these important skills.

What good will you create?

60 |

So, I leave you with this one question. With all of these in place: content, creativity, collaboration, communication, critical thinking, computing, and compassion, what good will you create?

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