Computational Thinking in the Classroom

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Today's Plan

- Computational Thinking: **What? Why? How?**
- Some of **my experience** and some of **yours**
- *Make it a discussion as much as needed*

Computational Thinking

What?
Why?
How?

+ What is Computational Thinking?

- Meet your two neighbors and [10 minutes]:
- 1/ Each of you shares to his/her group what they think CT is
- 2/ Discuss differences if any
- 3/ Do you use it in your classroom?

Computational Thinking?

- **A way of:**
  - Solving problems,
  - Designing systems, and
  - Understanding human behavior that draws on concepts fundamental to computer science.
- **Not limited to** computing or computer science

+ Computational Thinking [cont'd]

- A **problem solving process** that includes a number of characteristics, such as
  - **logically ordering and analyzing data** and
  - creating solutions using a series of **ordered steps** (or algorithms), and dispositions,
  - such as the ability to confidently deal with complexity and **open-ended problems**.

- Essential to the development of computer applications, but it can also be used to support problem solving
  - **across all disciplines**, including math, science, and the **humanities**. Students who learn CT **across the curriculum** can begin to see a relationship between subjects as well as between school and life outside of the classroom.

[from Google for Education: https://edu.google.com/resources/programs/exploring-computational-thinking/]

Computational Thinking [cont’d]

- To flourish in today's world, **CT** has to be a **fundamental part** of the way people think and understand the world.

[from Carnegie Mellon University]

Computational thinking [cont'd]

- Algorithmically solving problems
  - Solving problems applies to **any discipline**
- Formulating problems such that computers can assist
  - In our digital age, **knowing what can, cannot, should, etc. be done** will be extremely valuable
- Analyzing and logically **processing data**
- Generalizing and applying this process to other problems
  - **Abstraction**, reusability, versatility

Computational Thinking… Why?

- Being able to solve problems is **relevant to many disciplines**
  - Law, medicine, engineering, etc.
- Problem-based learning has proven to be very **successful**
- Exposing students to problem-solving and possibly computer science will give them **more options for careers**

+ Computational Thinking… How?

- Obviously, this is central to **Computer Science** ☺
- **Mathematics**: posing problems and using the right tools to solve them
- But not only… What else?
- QUESTION: What do you do in your own classes? (or would like to do)
  - Take 5 minutes in your groups
  - Then share with the whole group

Simple examples

- **Computer science:**
  - Emphasize problem solving rather than putting sole focus on coding
    - More and more focus on this
    - UTEP collaboration with Google
  - CS unplugged
  - Kodu or similar

- **Mathematics:**
  - Posing problems rather than executing operations, repeating
    - Putting activities in context yield higher engagement and content retention
  - Show that many ways exist to solve a given problem, so that students have to think, pick, discuss
  - Use simple robots (e.g., for geometry)

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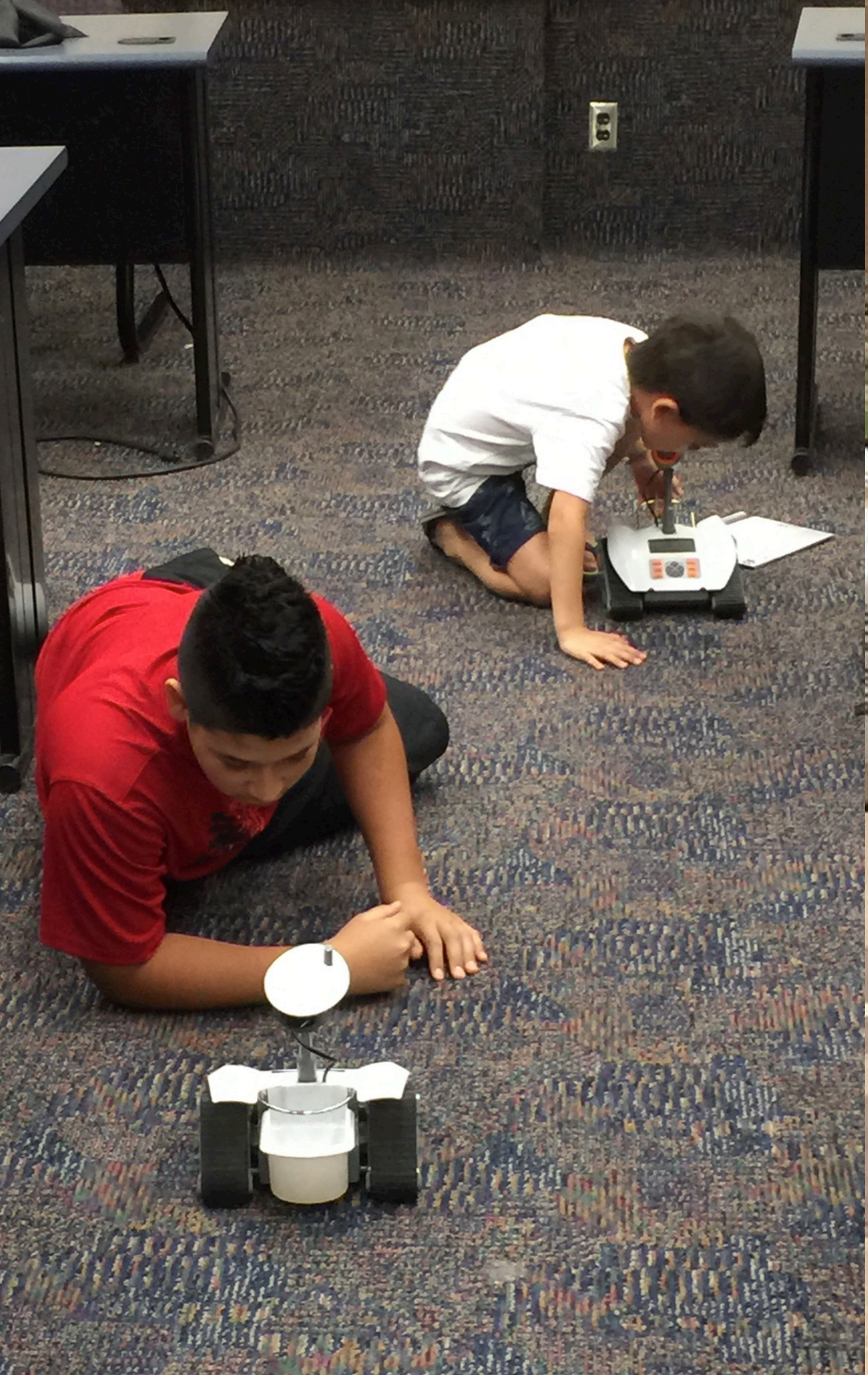

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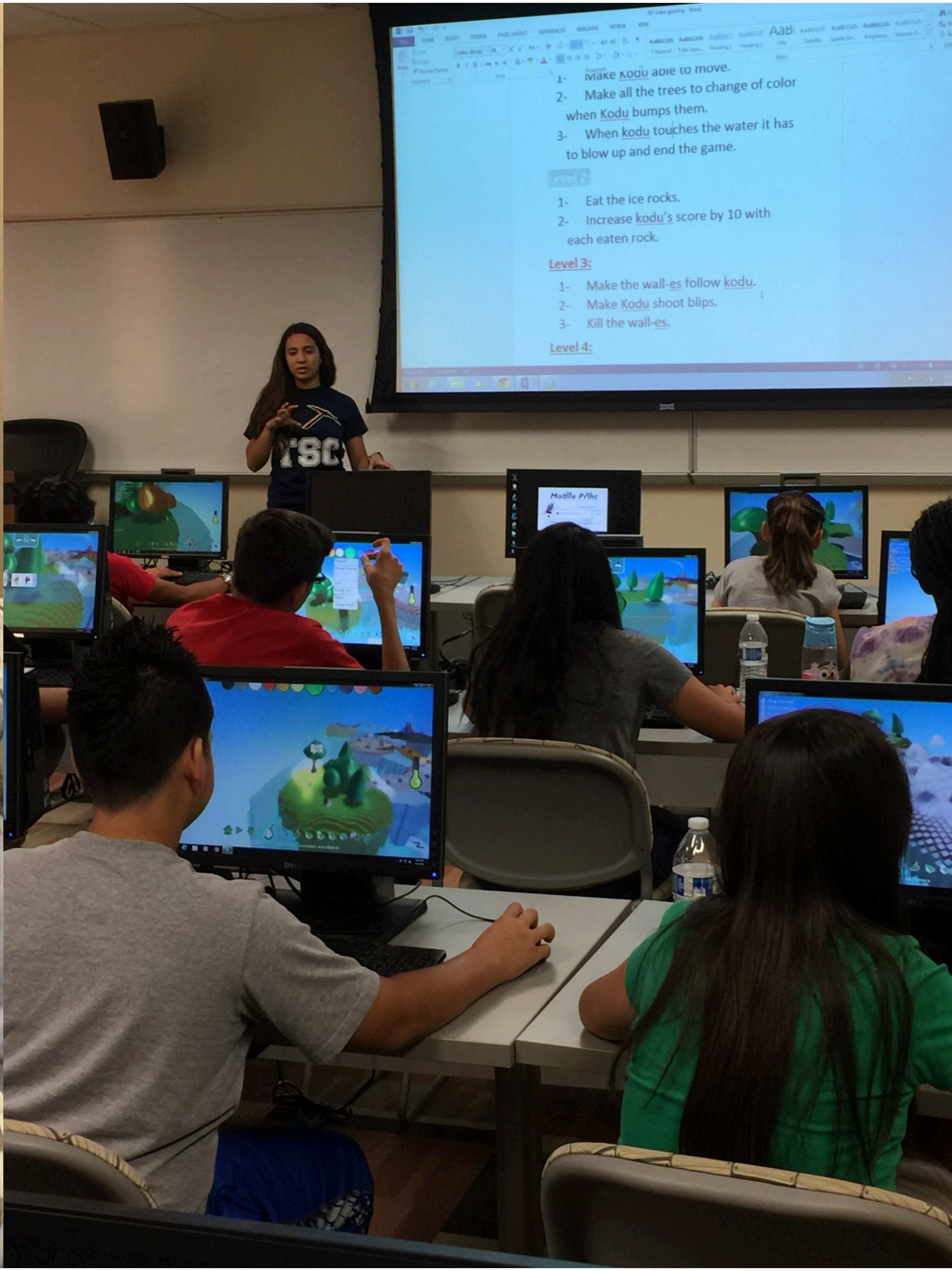

1- Make Kodu able to move.

2- Make all the trees to change of color when Kodu bumps them.

3- When kodu touches the water it has to blow up and end the game.

Level 2:

1- Eat the ice rocks.

2- Increase kodu's score by 10 with each eaten rock.

Level 3:

1- Make the wall-es follow kodu.

2- Make Kodu shoot blips.

3- Kill the wall-es.

Level 4:

Examples outside CS or Math

- **General activity (e.g., elementary school):**
  - The unplugged robot
  - Makes students think sequentially
  - Depending on the students' level, discussion about:
    - The elements of their solution
    - The risks of their solution
    - How to make it better
    - What they would need to actually "plug" it
    - Etc.

Examples outside CS or Math

- **Social Studies:**
  - Pose (somehow) **open-ended problems** and have the students work on a **systematic approach** to solving them → e.g., the IDEAL framework
  - Ask students to **design a video, create a video game, design an app**, etc. that addresses a problem presented in social studies
    - You can use programs like Scratch
    - More advanced (more time): robots, lego mindstorm?
    - E.g., identifying a problem, designing and building a solution

Examples outside CS or Math

- **Music:**
  - Plug it in an animated video
  - Have students design music with computers: creation of scales, etc.
- **Languages:**
  - Same as with music but with text for practice
  - English as a Second Language: using a simple programming language (like scratch or logo or even python turtle) can help students manipulate English at different levels (programming language, but also their project)

My Own Experience + Activities

My own experience

In CS:

- I teach CS1: intro to CS & I designed and taught a new Problem Solving course (along with Google)
- In **CS1**: problem-solving and programming (because we solve pbs on computers ☺)
- In **Problem-Solving**: pure strategy, no coding, no implementation

Outside CS:

- Worked with a French teacher (using Scratch)
- Worked with ESL teacher

Main Goals

- Keeping the interest of the students up:
  - **Motivation**: purpose and relating topics to their everyday lives
  - **Acknowledgment**: they know a lot already. I am just there to help them make sense of their skills → *asset-based* teaching
- Providing valuable training to my students
  - Equipping them with skills of **value across disciplines**

How can we do this?

- **Purpose:**
  - Use ***videos*** to show students what Computer Science is: code.org is a great resource
  - Show what is done in other fields as well that relates to CT
  - Give students projects that are relevant (they could pick them)
- **Relevance:** Share with them the accomplishments of people in CS -- or other fields (make sure to *include diversity*: women, other minorities, and *culturally-relevant* environment)
- **Acknowledgment of their prior skills:** relate the topics to "real-life" common tasks and activities + be casual (show trust)
  - **E.g.,** algorithms: unplugged activities, robots
  - Recursion, repetitions: CS unplugged
  - Arrays and Linked-lists: rows of houses vs Treasure Hunt, Monkeys in a barrel
  - Etc.

Examples of Activities

- Activities to do together in the classroom:
  - 1. **Robot activity:** it makes them stretch and work in teams
  - 2. **Recursion:** *counting together, checking a condition*
  - 3. **Looking for an element in an array** (logic & storage): *looking for an image on a computer screen for instance*
  - 4. **Linked-lists manipulations:** monkeys in a barrel, balloons, linked-list of students (like a network of friends), etc.
  - 5. **Sorting** people, papers, etc.
- And you can come up with many more!

Computer Science rests on computational thinking (algorithms, problem-solving). So you can teach it mostly without computers!

You can also use these in non-CS classes, even in PE

The trick is: "do it and tell later"

Examples of Activities

- Let's go over:
  - **Recursion:** *counting together*
  - **Linked-lists manipulations:** *adding, removing elements in a chain.*
- QUESTION: What else could you do? Share with your team:
  - What you teach, what you have done in CT, how you did it, what you'd like to do
  - What you wish you could do but do not know exactly how to do

Getting Started!

How to get you started?

- Visit the resources mentioned in this presentation
- But I am also happy to:
  - **Help you design activities** to get you started on your individual courses
  - Provide **tutorials on tools and frameworks you can use**
  - Provide **workshops on how to design class activities** around computational thinking
  - Build an **interest group of teachers**
  - Let me know: contact me (mceberio@utep.edu)

Existing Opportunities

- **School Districts can partner** with Code.org
- **Exploring CS**: summer professional development
- **EngageCSEdu**: a Google and NCWIT initiative → resources for the classroom
- The **Hour of Code**: First week of December
- **After-school** programs
  - E.g., with Little Bits: http://littlebits.cc/education
  - NCWIT AspireIT
- **Code.org**: curricula and ad-hoc activities available

Why is all of this important?

  - We need to **inform young students about what CS is**: so they can make informed decisions
  - We **need more people in CS**: many jobs (and even more going forward) will require knowledge of CS, or at the very least strong computational thinking
  - We **need diversity in CS** (currently not diverse)

- But mostly because:
  - Technology is all around
  - We need people with a general understanding of CT to discuss and design the tools of the next generation
  - We **need skilled people**
  - We need **SKILLED THINKERS**

Thank you!

- Questions?

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Presentation available at: http://martineceberio.fr under Outreach

References

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- Little Bits After-school program: http://littlebits.cc/education
- NCWIT AiC: http://aspirations.org
- NCWIT AspireIT: https://www.ncwit.org/project/aspireit-k-12-outreach-program