CTiCPS 2020

CPS in Computing Education: Current Trends

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What is CPS

❖ "Cyber-physical systems (CPS) are engineered systems that are built from, and depend upon, the seamless integration of computation and physical components." [NSF]

❖ "CPS technologies are transforming the way people interact with engineered systems, just as the Internet has transformed the way people interact with information." [NSF]
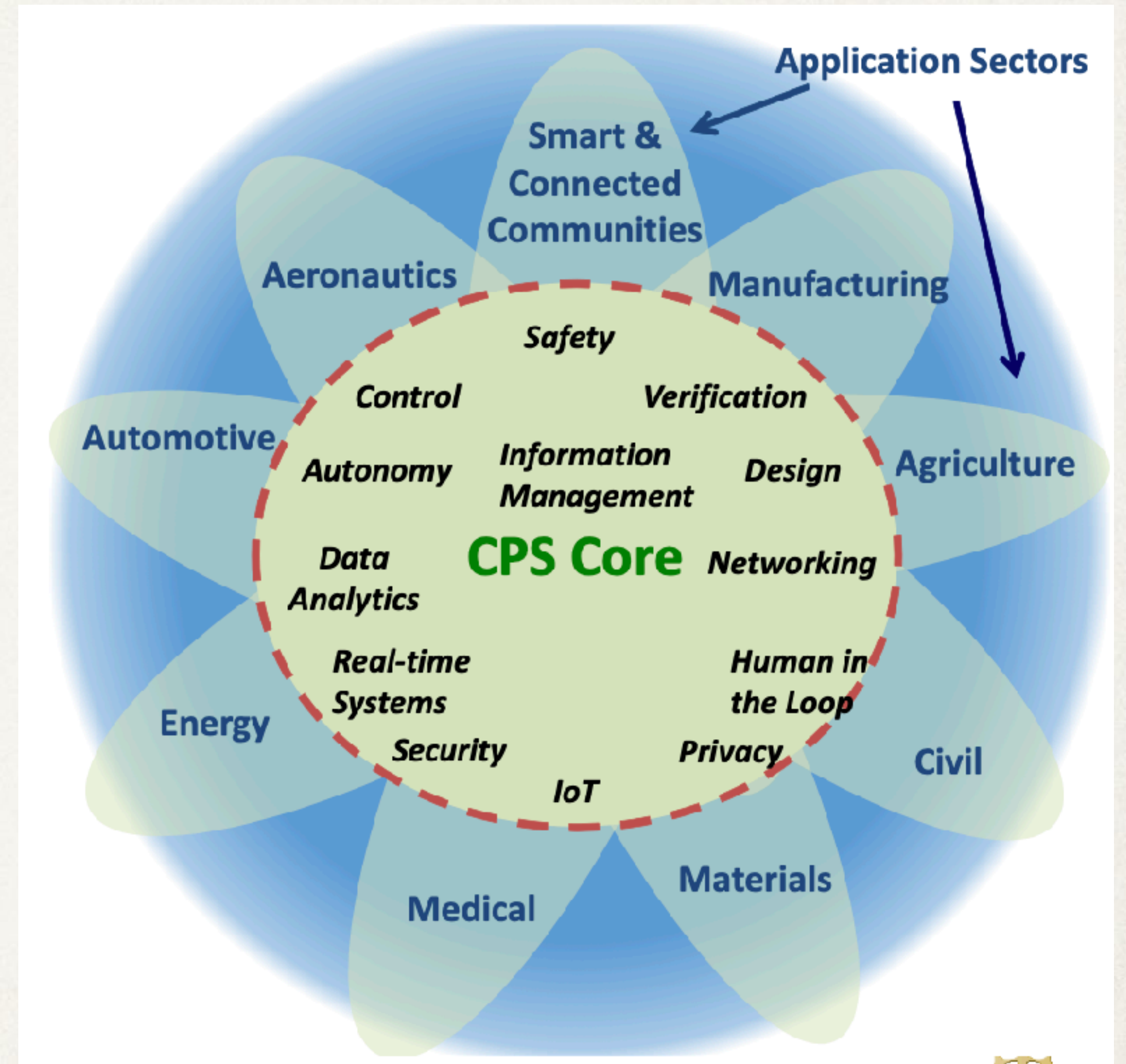

Image: NSF workshop slides

What is CEd(R)

an abstraction of the computer that one can use for thinking about what a computer can and will do

✤ "Computing education research is about understanding how people develop robust models of notional machines, and how we can help them achieve those mental models." [Guzdial, 2012]

✤ "CEd can and should cover far more than just coding. It just hasn't historically." [Ko, 2016]

Why CPS in Education

* Learning things using *new* technology

  ICT got us here to some extent

* Learning things in a *new way*

  Different students have different backgrounds, skills, strengths and weaknesses

* Learning *new* things

  Future jobs will use technology / domains not even invented yet

Why CPS in Computing Education

✤ Young children and certain demographics [Horn & Berns, 2019]

  ✤ Conventional programming is mostly text based

  ✤ Requires other skills

  ✤ "Not cool"

  ✤ Concerns about screen time

KIBO

- [Sullivan & Bers, 2016]

  - N=60, K–2 students

  - 8-week robotics curriculum

  - Preschoolers were able to create programs

- [Kazakoff & Bers, 2012]

  - N=54, Kindergarteners

  - Improved sequencing skills

Dr. Marina Bers, Co-founder and Chief Scientist for KinderLab Robotics

https://youtu.be/lJQDQsueZO8

KIBO

✣ [Albo-Canals, et al., 2018]

   ✣ N=12, ages 4-7, students with ASD

   ✣ RQ: Are children with ASD engaged
     with the KIBO robot (asking questions,
   sharing their work, or appearing
     interested)?

Dr. Marina Bers, Co-founder and Chief Scientist for KinderLab Robotics

https://youtu.be/IJQDQsueZO8

Why CPS in Education

Computing

[Horn & Berns, 2019]

✤ [Ko et al., 2011]: most programs written today are not by professional software developers but non-professional "end-users."

   ✤ Smart homes

   ✤ Musicians, DJs often write live codes

✤ Informal learning—museum exhibit

TuneTable introduces users to computational elements
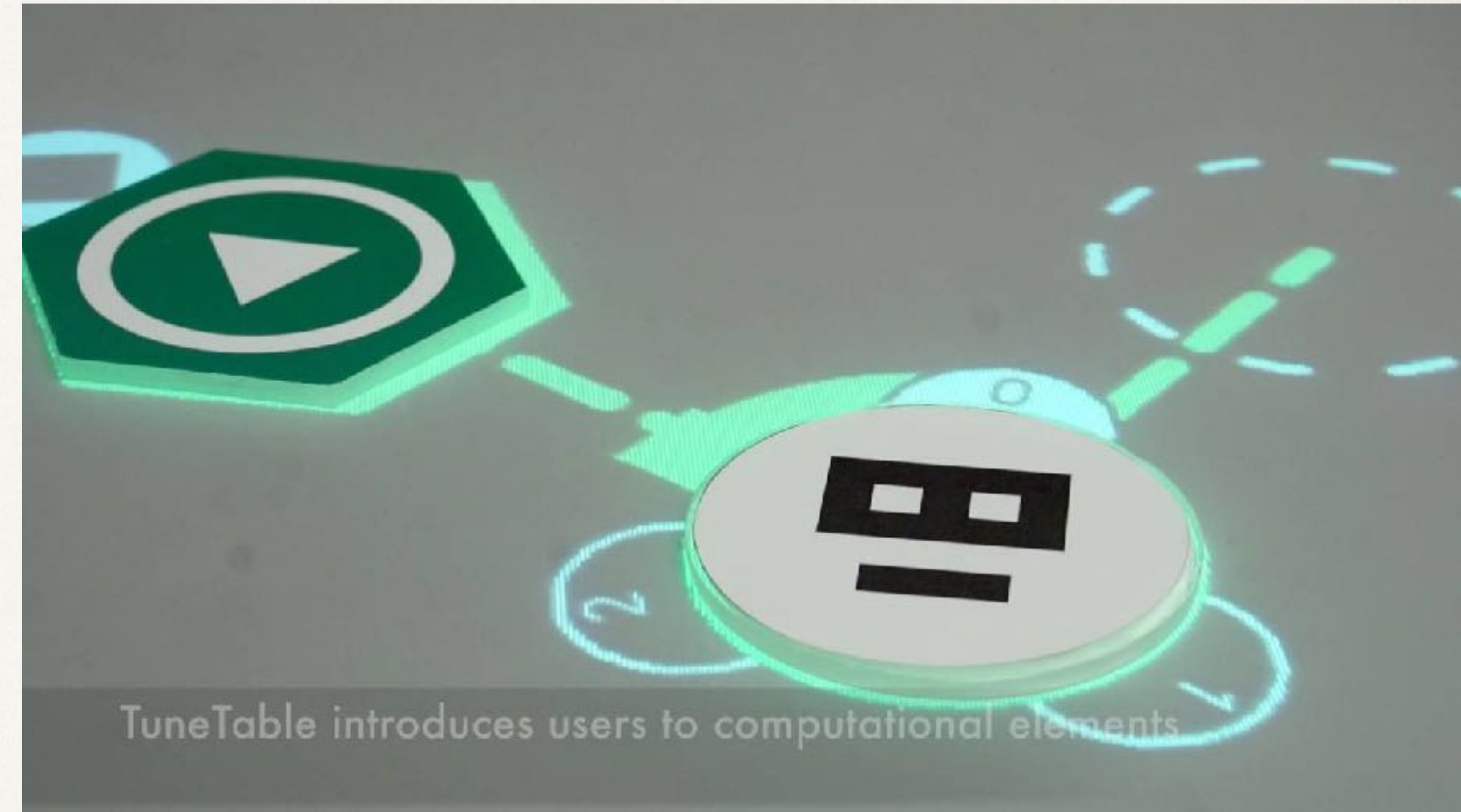
TuneTable: https://youtu.be/zWzNpUXp-sE

Tangible Music Programming Blocks for Visually Impaired Children

✤ [Sabuncuoglu, 2020]: N=14, 7 M + 7 F, M_{age}=12.5, Visually impaired

✤ Specially designed blocks with grooves

✤ Place on a specially designed board ("rack")

✤ Scan with a smartphone NFC—with the help of a mentor

✤ Play the music

✤ Video (via ACM DL) https://dl.acm.org/doi/10.1145/3374920.3374939

Limitations

✤ Cost—production, maintenance, upgrade is v. expensive (compared to ICT)

✤ Saving-restoring or Copy-Pasting program bits is very difficult

✤ Perception that *real* coding is in text-based languages

✤ But

  ✤ Advances in manufacturing technology and the benefits of CPS in education can help overcome some of these limitations

References

✤ National Science Foundation CPS Program. https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=503286

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Thank you

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