Welcome to the National Girls Collaborative Project National Webinar

Universal Design for Learning: Strategies for Teaching to Students of All Abilities

November 2, 2017
Agenda

• NGCP Vision and Goals
• Universal Design for Learning
• Questions and Closing
NGCP Vision

The National Girls Collaborative Project (NGCP) brings together organizations that are committed to informing and encouraging girls to pursue careers in science, technology, engineering, and mathematics (STEM).
NGCP Goals

1. **Maximize access** to shared resources within organizations interested in engaging girls in STEM.

2. **Strengthen the capacity** of programs by sharing exemplary practice research and program models.

3. **Use the leverage of a network** to achieve gender equity in STEM.
National Network of Collaborative Teams
Speaker

Maya Israel,
Associate Professor, Department of Special Education
and Research Director. Creative Technology Research Lab
University of Illinois-Urbana Champaign
Teaching Computer Science to Students with Disabilities

Maya Israel

misrael@illinois.edu

@misrael09
Roadmap

• Introduction
• What makes computing challenging for students with cognitive disabilities (specifically learning disabilities and autism spectrum disorders)?
  – Student-specific challenges
  – Instructional challenges
• Universal Design for Learning & Strategies to address these challenges
Personal Background

• Teaching:
  – I taught special education in co-taught math and science

• University Faculty at the U of Illinois-Urbana Champaign:
  – I have 2 NSF projects related to CS education and academically diverse learners, including those with disabilities
  – I teach within the special education program
  – My research is in accessible instructional practices in CS/CT.
Teaching CS to All students, including those with disabilities

- Why?
- How?
- What?
Some Stats about Students with Disabilities in Public Schools

- Approximately 6.5 million students w/disabilities are in U.S. public schools-- ~13% of students (NCES, 2016).

- The largest category of students w/disabilities receiving special education services is Learning Disabilities (LD) category (approx. 35%)

- The next largest categories are Speech/language, Other health impairments, and Autism.

- Most of these students spend at least 80% of their days with their peers in general education.
IDEA description of Disability

- “Disability is a natural part of the human experience and in no way diminishes the right of individuals to participate in or contribute to society. Improving the educational results of children with disabilities is an essential element of our national policy of ensuring equality of opportunity, full participation, independent living, and economic self-sufficiency for individuals with disabilities”

- [IDEA, 20 U.S.C. Sec. 1400(c)(1)]
Instructional Challenges

• Students w/disabilities might:
  – Struggle with
    • generalizing what they know to new situations
    • Working with peers
    • Multi-step problem solving
  – May be taken out of CS class during entire time or in the middle of class

• CS teachers:
  – May not fully understand disabilities and/or accommodations
  – Have an entire class of students to teach
  – Do not have access to pedagogical approaches that are helpful to SwD
Findings: Inaccessible Technology and Instructional Practices

• Struggle with programming languages
  – Challenges with “decoding” the code
  – Challenges with comprehending the code

• Struggle with multi-step complex problem solving
  – Challenges with debugging
  – Challenges with strategically planning programs from the beginning to end
Students w/disabilities are being set up for failure
(and a bit of success)
Where do we start?
Communication regarding curriculum and student needs

CS Teacher

Paraeducator  ⇔  Special Educator
What else can we do?

• Universal Design for Learning

• Reducing barriers to learning AND engagement
  – Cognitive
  – Cultural
  – Physical
Universal Design for Learning

**Recognition Networks**
The "what" of learning

How we gather facts and categorize what we see, hear, and read. Identifying letters, words, or an author's style are recognition tasks.

**Strategic Networks**
The "how" of learning

Planning and performing tasks. How we organize and express our ideas. Writing an essay or solving a math problem are strategic tasks.

**Affective Networks**
The "why" of learning

How learners get engaged and stay motivated. How they are challenged, excited, or interested. These are affective dimensions.
Universal Design for Learning (UDL)

• Provide computing instruction using multiple means of representation (e.g., pictorial representations, multimedia)

• Provide options for students to demonstrate understanding in multiple formats

• Allow students to engage with the material in different ways
Engagement=Attention + Commitment

• It’s not enough to make activities fun.

• We have to think about how to help kids maintain persistence and effort.

• How can we do that?
  – We need to help kids be self directed.
  – We can start this by giving students options and choice.
Representation=How can content be delivered to capitalize on students’ strengths?

– Reading directions in the curriculum
– Watching videos
– Text-to-speech software
– Seeing simulations
Expression=How can student demonstrate their understanding in a way that capitalizes on their strengths

• Different ways of demonstrating understanding
Historic and Current Context

History of UDL

• Began in architecture with physical accessibility (e.g., curb cuts)

• Movement towards cognitive accessibility of instructional materials and delivery (e.g., text to speech for digital text)

Current Movement in UDL

• Every Student Succeeds Act (reauthorization of the ESEA)
  – UDL and assessment
  – UDL and technology adoption

• National Education Technology Plan (2016)
  – Equity and access
# Universal Design for Learning Guidelines

## I. Provide Multiple Means of Representation
1. Provide options for perception
   - 1.1 Offer ways of customizing the display of information
   - 1.2 Offer alternatives for auditory information
   - 1.3 Offer alternatives for visual information
2. Provide options for language, mathematical expressions, and symbols
   - 2.1 Clarify vocabulary and symbols
   - 2.2 Clarify syntax and structure
   - 2.3 Support decoding of text, mathematical notation, and symbols
   - 2.4 Promote understanding across languages
   - 2.5 Illustrate through multiple media
3. Provide options for comprehension
   - 3.1 Activate or supply background knowledge
   - 3.2 Highlight patterns, critical features, big ideas, and relationships
   - 3.3 Guide information processing, visualization, and manipulation
   - 3.4 Maximize transfer and generalization

## II. Provide Multiple Means of Action and Expression
4. Provide options for physical action
   - 4.1 Vary the methods for response and navigation
   - 4.2 Optimize access to tools and assistive technologies
5. Provide options for expression and communication
   - 5.1 Use multiple media for communication
   - 5.2 Use multiple tools for construction and composition
   - 5.3 Build fluencies with graduated levels of support for practice and performance
6. Provide options for executive functions
   - 6.1 Guide appropriate goal-setting
   - 6.2 Support planning and strategy development
   - 6.3 Facilitate managing information and resources
   - 6.4 Enhance capacity for monitoring progress

## III. Provide Multiple Means of Engagement
7. Provide options for recruiting interest
   - 7.1 Optimize individual choice and autonomy
   - 7.2 Optimize relevance, value, and authenticity
   - 7.3 Minimize threats and distractions
8. Provide options for sustaining effort and persistence
   - 8.1 Heighten salience of goals and objectives
   - 8.2 Vary demands and resources to optimize challenge
   - 8.3 Foster collaboration and community
   - 8.4 Increase mastery-oriented feedback
9. Provide options for self-regulation
   - 9.1 Promote expectations and beliefs that optimize motivation
   - 9.2 Facilitate personal coping skills and strategies
   - 9.3 Develop self-assessment and reflection

---

© 2011 by CAST. All rights reserved.

APA Citation: CAST (2011) Universal Design for Learning guidelines version 2.0. Wakefield, MA: Author.
So How Do We Plan CS activities with UDL in Mind?

UDL Instructional Planning Process

**UDL Planning Process:**

**Step 1:** Establish Clear Outcomes

**Step 2:** Anticipate Learner Variability

**Step 3:** Measurable Outcomes and Assessment Plan

**Step 4:** Instructional Experience

**Step 5:** Reflection and New Understandings

Step 1: Establish Clear Outcomes

- What are the big ideas that we want all students to achieve?
  - Example: Students will test and debug a program or algorithm to make sure it runs as expected.

- What barriers, misconceptions, or challenges do we anticipate students will have?
  - Example: Students often have misconceptions about the flow of program execution and how conditional statements are composed and evaluated.
Step 2: Anticipate Learner Variability

• What are students’ learning preferences?
  • Example: Most students enjoy having choice in projects. They also really like having unplugged activities prior to plugged activities.

• Consider individual needs and preferences.
  • Example: Rachel has strong social skills and loves expressing herself through art. It would be great to leverage creative projects in Scratch that allow her to illustrate her creative artistry.
Step 3: Have measurable outcomes and assessments

• Embed formative and summative assessments to check to student understanding

  Example: Use project planning guides that allow students to plan their projects, share those plans, and get feedback on plans from teachers and peers.

• Include assessment options for some students who may need more explicit feedback.

  Example: Have options for different planning guides with more or less feedback mechanisms.
Step 4: Instructional Experience

• Engaging students:
  – Choice in activities
  – Help cards for managing frustration
  – Teaching and encouraging collaboration

• Representing content:
  – Teaching some content more explicitly if needed
  – Using “I do, we do, you do”
  – Having video tutorials, online resources, and other resources

• Allowing students to demonstrate their understanding flexibly
  – Presentation of programming projects, code walks, creating flow charts, using pseudo-code
Using the Universal Design for Learning framework during instruction

Israel et al. (2015)
[https://goo.gl/1qLn3A](https://goo.gl/1qLn3A)

<table>
<thead>
<tr>
<th>Multiple Means of Representation</th>
<th>Multiple Means of Action and Expression</th>
<th>Multiple Means of Engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Provide options for perception</strong></td>
<td><strong>4. Provide options for physical action</strong></td>
<td><strong>7. Provide options for recruiting interest</strong></td>
</tr>
<tr>
<td>-Model computing lessons using an interactive whiteboard, videos, or already created templates</td>
<td>-Provide teacher’s codes or use partially completed code as templates</td>
<td>-Give students choices (project, topic, display of project).</td>
</tr>
<tr>
<td>-Give access to modeled code while students work independently</td>
<td>-Include unplugged activities that teach through physical representations of abstract computing concepts</td>
<td>-Allow students to make projects relevant to culture and age</td>
</tr>
<tr>
<td>-Provide access to video tutorials of computing tasks</td>
<td>-Use assistive technology including larger/smaller mice, touch-screen computers, screen readers</td>
<td>-Minimize common “pitfalls” for both computing and integrated content by considering barriers to learning from the beginning of the planning process.</td>
</tr>
</tbody>
</table>
Example Engagement Strategy: Metacognitive Self-Regulation

- What did I want my code to do?

Did I read my code block-by block?  YES  NO

Does ANY part of my code work?  YES  NO

Do I know which block/set of blocks is the problem?  YES  NO

Do I know what the problem block(s) do?  YES  NO

Do the problem block(s) belong?  YES  NO

If a variable block, did the numeral in the block make sense?  YES  NO

Debugging Detective Questions
What do I do when I am stuck?
Finding the “suspect” in our code.

Using these questions, students are encouraged to work with friends to solve the problem.
Example Representation Ideas for Conditional Statements

Frayer Model

<table>
<thead>
<tr>
<th>Student-Derived Definition</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Different blocks of code run depending on whether the statement is true or false</td>
<td>Cause and effect</td>
</tr>
<tr>
<td></td>
<td>Can allow users to interact with programs</td>
</tr>
</tbody>
</table>

**Concept: Conditional Statement**

<table>
<thead>
<tr>
<th>Examples</th>
<th>Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Simon Says!</td>
<td>![Picture of conditional statement]</td>
</tr>
<tr>
<td>- Passwords</td>
<td></td>
</tr>
<tr>
<td>- Change a sprite’s color after it touches the edge of a screen</td>
<td></td>
</tr>
<tr>
<td>- Change the direction of a robot using sensors to detect an object.</td>
<td></td>
</tr>
</tbody>
</table>

If `<______________________________>` then

[__________________________________________________________]
Example Expression Ideas: Student Examples of Making “Mystery Fraction Problems”
Suggestions regarding collaboration

- Structure helps when open/natural collaboration is not enough

- Computer supported collaborative learning (CSCL) literature points towards promise of scripted collaboration as a launching point for authentic interactions

- Explicitly teach and model HOW to collaborate (see handout) (Park & Lash, 2014)
Step 5: Reflection and New Understandings

- Did the learners obtain the big ideas and desired outcomes for CS/CT components of the lesson? (What data support your inference?)
- What instructional strategies worked well? How can instructional strategies be improved?
- What strategies and tools provided for multiple means of representation, action/expression, and engagement?
- What additional tools would have been beneficial to have access to and why?
CT/CT and UDL Instruction and Refinement Framework

Teach using emerging universally designed CT pedagogy.

Revise CT pedagogy to improve alignment with UDL and/or add CT-specific supports as needed.

Evaluate for engagement and learning for all students.

Reevaluate for engagement and learning for all students.

For students with disabilities, provide student-specific supports as needed.

Snodgrass, Israel, & Reese (2016)
Other Suggestions

• Communicate with the special educators about what works in other content areas
  – What strategies work during math and science?
  – What accommodations are provided?
  – How can supports from other content areas be applied to CS?
  – How can the paraeducators/aides best be used to support the student?
Balancing Explicit Instruction and Open Inquiry

• Computing is inherently open-ended, complex, and student-driven.

• Explicit instruction is a systematic and direct way of teaching. This is teacher directed.

• Can we balance these two approaches?
Least to Most Prompting

**Least**
- Clarify directions
- Encourage peer collaboration

**More**
- Use strategic questioning (open and close ended questions)
- Verbal prompting of steps, strategies, etc.

**Most**
- Model for the student using your own computer rather than the student’s device.
- Physical prompting: Hand over hand
## Examples of Explicit Instruction in CS Education
*(Israel et al., 2015)*

<table>
<thead>
<tr>
<th>Explicit Instruction</th>
<th>Definition in CS Education</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Focus instruction on critical content</td>
<td>Teach skills &amp; concepts associated with CS ideas</td>
<td>Decide which CS skills to teach (e.g., using conditionals to create an animated story)</td>
</tr>
<tr>
<td>Provide step-by-step demonstration to break down</td>
<td>Model procedures including think-alouds</td>
<td>Model a particular code (such as using conditionals) step-by-step with examples</td>
</tr>
<tr>
<td>complex tasks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provide numerous opportunities for practice</td>
<td>Provide more scaffolding initially and reduce those over time</td>
<td>Include supports (such as guiding questions) as students try coding. Encourage risk taking and independent problem solving.</td>
</tr>
</tbody>
</table>
Balancing Explicit Instruction and Open Inquiry

Explicit model by teacher

Student artifact 1

Student artifact 2
Paraeducators/instructional aides often:

• Have deep knowledge of students with disabilities with whom they work

• BUT....

  – Have little or no background in CS
  – Often do not have access to lesson plans, and
  – Receive little guidance in how to help students on their case load in CS instruction
Suggestions for Instructional Aides/Paraeducators

• Environmental Considerations: Placement Matters
  – If possible, SWD should be seated alongside peers rather than segregated together in the back of the class. This sets the stage for peer collaboration.

• Professional Knowledge:
  – Ask the CS teacher to see lesson plan ahead of time if possible.
  – Clarify the big ideas of the lesson.
  – Communicate with the special ed teacher about how accommodations and supports from other content areas (e.g., math and science)
UDL TACTICal Brief (and others)

https://goo.gl/eSBkYD
Other Resources

- **CAST**
  - [http://www.cast.org/](http://www.cast.org/)

- **National Center on UDL**
  - [http://www.udlcenter.org/](http://www.udlcenter.org/)

- **UDL Implementation and Research Network**

- **Creative Technology Research Lab at UIUC**
  - [https://ctrl.education.illinois.edu/](https://ctrl.education.illinois.edu/)
Parting Advice

• Start small and build upon emerging knowledge. Including students with disabilities in CS is not an “all or nothing” process. It takes time!

• Collaborate with your special education colleagues!
For More Information:

misrael@illinois.edu
@misrael09

http://ctrl.education.illinois.edu/
References & Resources


- Lab website: [http://ctrl.education.illinois.edu/](http://ctrl.education.illinois.edu/)
Get Involved with NGCP

- Follow us on social media, @NGCPProject
- Attend local events and national webinars
- Join your local Collaborative leadership
- Collaborate to serve more girls in STEM
Thank you for joining us today!