Creative Technology Research Lab

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Project TACTIC: Teaching All Computational Thinking through Inclusion and Collaboration

TACTICal Teaching Brief

Utilizing the Universal Design for Learning Framework in Computer Science Education

Introduction

The Universal Design for Learning (UDL) framework provides guidelines that can help teachers proactively plan for the academic diversity present in classrooms. This is especially important when it comes to CS education due to the historic underrepresentation of women, people from backgrounds with low historical representation, and people with disabilities in CS fields. If we can think about ways of meaningfully engaging ALL learners through the UDL framework, then we can address the barriers that are inherent in my CS activities.

UDL is a proactive approach to planning of curricular opportunities. A UDL approach takes into account learner variability when considering goals, methods of instruction, assessments and materials. It is organized around the principles of providing students with multiple means of representation, expression and engagement with their learning.

Scenario

Mr. Gibson is going to be teaching CS within his mathematics instruction this year. At the beginning of the school year, he attended a school-wide professional development (PD) workshop on Universal Design for Learning . In this workshop, Mr. Gibson learned about how the three UDL principles could be used in planning instruction that is engaging and accessible to all his students, including those with disabilities. He wonders how he might apply these principles to the CS activities that will take place this year with all of his students, including three students with disabilities who are included in his 3rd grade class.

- Rachel has a learning disability related to math;
- Roberto has a social communication disorder that kept him from verbally expressing his needs; and
- Connie has an emotional behavior disorder as well as a speech/language impairment and often does not interact with her peers.

Mr. Gibson also realizes that beyond the needs of these three students, his class has a lot of academic, social, and cultural diversity. Meeting each of the students' individual needs will be a challenge this year! In thinking about the PD he attended this summer and the students in this class, he wonders how UDL can help him plan his integrated math and CS lessons in a way that will engage all his students, including Rachel, Roberto, and Connie. Because Ms. Gomez, the special education teacher, helped lead this PD, Mr. Gibson decided to meet with her to brainstorm some ideas about how UDL might be leveraged to provide greater opportunities for success for all learners, including those with disabilities.

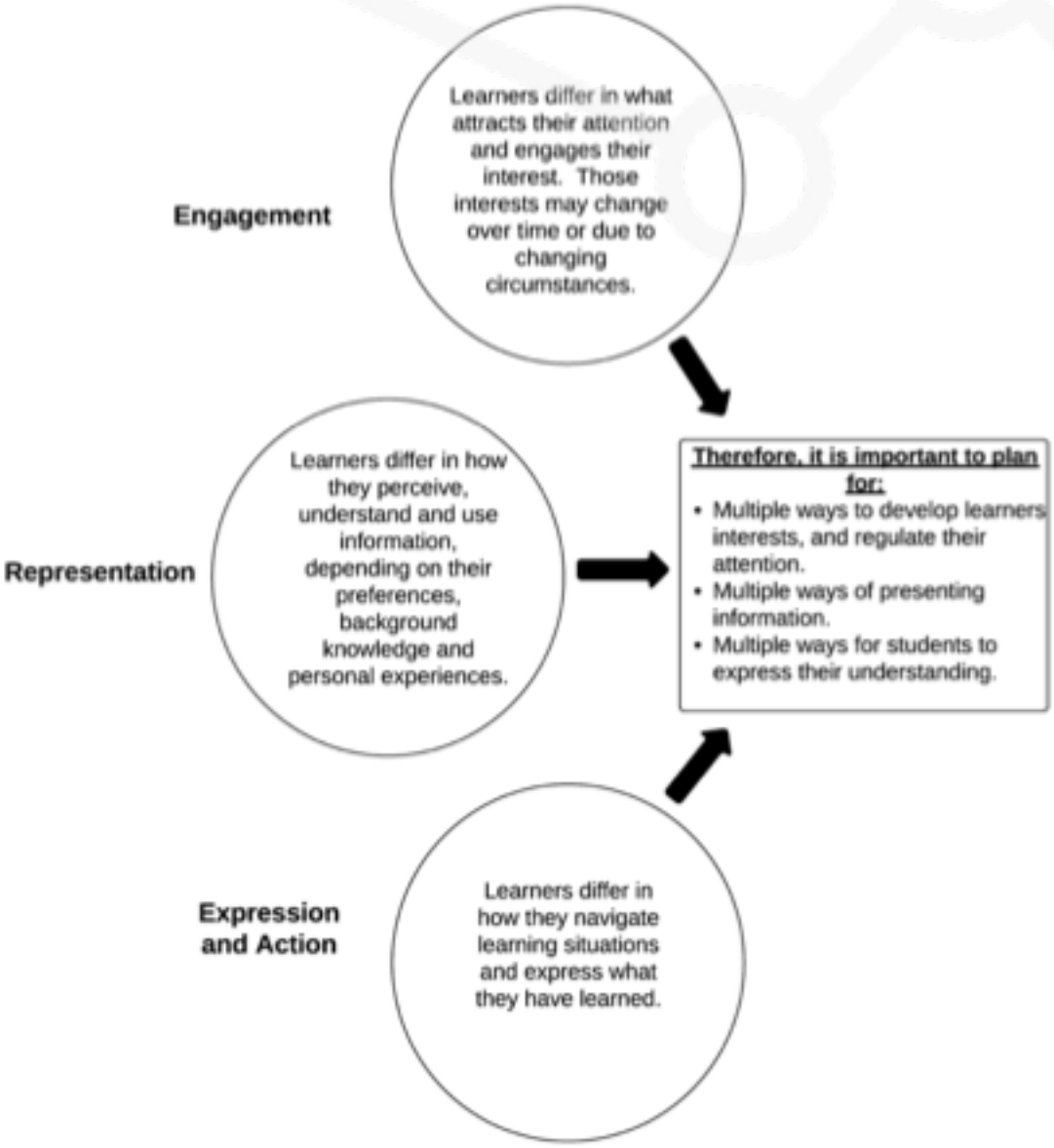

Figure 1. The Three Principles of UDL

Adapted from National Center on Universal Design for Learning: The Three Principles of UDL

Do any of these challenges sound familiar?

Can you relate to any of these?

Common Challenges

- Teachers believe that UDL is important, but do not know where to start or how to find time to plan in this manner. It looks really time consuming.
- Although UDL is intended to address whole-class instruction, it is unclear how individual student needs fit within this framework.
- UDL seems to make sense conceptually, but it's hard to see how it would apply in CS activities.

Universal Design for Learning within Computer Science Education

Multiple Means of **Representation**

Provide options for perception

- Model computing using physical representations as well as through an interactive whiteboard, videos.
- Give access to modeled code while students work independently.
- Provide access to video tutorials of computing tasks.
- Selecting coding apps and websites that allow to adjust visual settings (such as font size & contrast) and that are compatible with screen readers.

Provide options for language mathematical expressions and symbols

- Teach and review content specific vocabulary
- Teach and review computing vocabulary (e.g., code, animations, computing, algorithm).
- Post anchor charts and provide reference sheets with images of blocks or with common syntax when using text.

Provide options for comprehension

- Active background knowledge by making computing tasks interesting and culturally relevant.
- State lesson content/computing goals.
- Encourage students to ask questions as comprehension checkpoints.
- Use relevant analogies and make cross-curricular connections explicit (for example, computing iterative produce development to the writing process).
- Provide graphic organizers for students to "translate" programs into pseudocode.

Multiple Means of **Action & Expression**

Provide options of physical action

- Provide teacher's codes as templates.
- Include CS unplugged activities that show physical relationship of abstract computing concepts
- Use assistive technology including larger/smaller mice, tough-screen devices.
- Select coding apps and websites that allow coding with keyboard shortcuts in addition to dragging & dropping with a mouse.

Provide options for expression and communication

- Give options of unplugged activities and computing software and materials (e.g., Pseudocode, Scratch, code.org, Alice).
- Give opportunities to practice computing skills and content through projects that build prior lessons.
- Provide sentences starters or checklists for communicating in order to collaborate, give feedback, and explain work.
- Create physical manipulatives of commands, blocks of lines of code.
- Provide options that include starter code.

Provide options for executive function

- Guide students to set goals for long-term projects.
- Record students' progress (have planned checkpoints during lessons for understanding and progress for computing skills and content).
- Provide exemplars of completed products.
- Embed prompts to stop and plan, test, or debug throughout a lesson or project.
- Provide graphic organizers to facilitate planning, goal-setting, and debugging.
- Provide explicit instruction on skills such asking for help, providing feedback, and using problem solving techniques.
- Demonstrate debugging with think-alouds.

Multiple Means of **Engagement**

Provide options for recruiting interests

- Give students choices (Choose project, software, topics).
- Allow students to make projects relevant to culture and age.
- Minimize possible common "pitfalls" for both computing and content.
- Allow for differences in pacing and length of work sessions.
- Provide options to increase or decrease sensory stimulation (for example, listening to music with headphones or using noise cancelling headphones).
- Allow for differences in pacing and length of work sessions.

Provide options for sustaining effort and persistence.

- Remind students of both computing and content goals.
- Provide supports or extensions for students to keep engaged.
- Teach and encourage peer collaboration by sharing products.
- Utilize pair programming and group work with clearly defined roles.
- Discuss the integral role of perseverance and problem solving in computer science.
- Recognize students for demonstrating perseverance and problem solving in the classroom.

Provide options for self-regulation

- Communicate clear expectations for computing tasks, collaboration, and help seeking.
- Develop ways for students to self-assess and reflect on own projects and those of others.
- Use assessment rubrics that evaluate both content and process.
- Break-up coding activities with opportunities for reflection such as turn and talks or written questions.
- Acknowledge difficulty and frustration. Model different strategies for dealing with frustration appropriately.

Israel, M., Lash, T., Ray, M. (2017). Universal Design for Learning within Computer Science Education. Creative Technology Research Lab. University of Illinois. http://goo.gl/1nP6sx

Strategies

1. Start small, utilizing UDL principles in one lesson or unit at a time.

2. Begin planning by thinking about what is most important in the unit/lesson and then what would make that content difficult for your students. By focusing first on barriers to learning, you can begin to isolate which checkpoints in the UDL framework to begin with.

3. Don't attempt to do all the checkpoints in the entire UDL framework. Start with one or two UDL checkpoints and build up to a realistic number. More isn't always better!

4. Reflect on how UDL works in other content areas. For example, if multiple means of representation in mathematics means that you provide students with options for manipulatives and the use of video to reinforce learning, these same strategies can be used in CS education by using Unplugged activities and worked example videos.

5. Consider Goals, Environment, Materials, and Assessment (see example lesson plan).

6. Use the table (UDL for Learning within computer Science Education) and lesson plan template we provided for examples to launch this work. *(Note: It's not an exhaustive table).*

UDL Instructional Planning Process: UDL IRN

As a framework, UDL requires educators to think proactively about the needs of all learners. In consideration of the UDL Critical Elements, educators implementing UDL should use a backwards design instructional process that incorporates the following five steps.

1. Establish Clear Outcomes.
    - Establish a clear understanding of the goal(s) of the lesson (or unit) and specific learner outcomes.
2. Anticipate learners needs
    - Prior to planning the instructional experience teachers should have a clear understanding of the learner needs within their environment.
3. Measurable outcomes and assessment plan
    - Prior to planning the instructional experience, establish how learning is going to be measured.
4. Instructional Experience
    - Establish the instructional sequence of events.
5. Reflection and New understandings
    - Establish checkpoints for teacher reflection and new understandings.

Summary

Mr. Gibson is excited about utilizing a UDL approach when planning for his computer science lessons for his students. With Ms. Gomez's help, him saw that starting small can make integrating a UDL approach feasible and that planning for learner differences ahead of time can provides benefits for all of the students in his class including those with disabilities.

Citations

Israel, M., Lash, T. A., & Jeong, G. (2017). Utilizing the Universal Design for Learning Framework in K-12 Computer Science Education. Project TACTIC: Teaching All Computational Thinking through Inclusion and Collaboration. Retrieved from University of Illinois, Creative Technology Research Lab website: CTRL.education.illinois.edu/TACTICal/udl

Useful Resources

- CAST (2017). About Universal Design for learning. Retrieved from http://www.cast.org/our-work/about-udl.html#.WbwEQa3MxE6
- Creative Technology Research Lab. (2017). Illustrative example of a UDL instructional planning process for a fourth grade integrated CS and Math Project. Retrieved from ctrl.education.illinois.edu/TACTICal/udl/planning-process-example
- National Center on Universal Design for Learning. (September, 2014). The Three Principles of UDL. Retrieved from http://www.udlcenter.org/aboutudl/whatisudl/3principles.
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