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Acknowledgements

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Journal Editors

Editorial Board

Journal of Technology-Integrated Lessons and Teaching Contents

Volume 3 Issue 2 December 2024

Front Matter

Learning Representations

Competition Award Winners

Call for Manuscripts: Computational Thinking & Computer Science

Description

The Journal of Technology-Integrated Lessons and Teaching will publish a special issue about computational thinking and computer science in June 2025. Manuscripts are due by January 31, 2025!

Topics

Potential unit, lesson, activity, or micro-credential topics include (but are not limited to):

- High and low-technology approaches to teaching computational thinking and/or computer science.
- Teaching students how to define the problem space.
- Teaching logical or sequential thinking, approaches to break down problems into component parts, developing procedures or sequential steps to solve problems, and so forth.
- Troubleshooting problems and learning from failure
- Developing coding skills (e.g., block, text, or markup languages)
- Leveraging artificial intelligence (AI) to help solve ill-structured problems
- Leveraging AI to facilitate coding and/or troubleshooting
- Ethics associated with computational thinking, computer science, and AI
- Other computational thinking and computer science topics

Manuscripts should be original and unpublished elsewhere (personal blogs and websites do not count as publications). Lessons, activities, and other learning representations should be described in detail so that others can implement them. Submissions should follow the JTILT Author Guidelines and use the Manuscript Template. Supplemental files needed for lesson implementation (e.g., presentations, videos, rubrics) should be included with the manuscript as separate attachments.

Submit manuscripts at https://journals.uwyo.edu/index.php/jtilt/index

Important Dates

January 31, 2025: Initial Manuscripts due
February 22, 2025: Reviewer feedback provided
March 8, 2025: Manuscript revisions due; second review begins
March 29, 2025: Reviewer feedback provided on revised manuscript
April 12, 2025: Revisions due; copyright editing begins
May 3, 2025: Copyright feedback provided
May 17, 2025: Final revisions due; copy and layout editing begins
June 2025: Special issue published

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Introduction

Craig E. Shepherd, Editor-in-Chief

Welcome

As the third year of JTILT ends, I find myself reflecting on what the journal provides, how it was established, and where it is heading. Past issues and articles capture various teaching styles, strategies, delivery approaches, and purposes. Readers may enter elementary classrooms, middle school media centers, high school science courses, informal learning organizations, teacher preparation programs, and beyond. We even have an article from medical school! Each article presents candid details regarding their use of technology and how that influenced learning.

As I peruse these articles, I am struck by the diversity of their approaches. Some capture the first attempts of instruction. Others document refined processes that emerged over multiple implementations. Article approaches are unique and provide glimpses into potential practice. I am constantly reminded that teaching is a science and an art. I relish detailed procedures and steps that authors articulate in their work. I enjoy mapping these processes to planning frameworks and instructional theory. Yet, I also marvel at the art of teaching and the broad possibilities that exist in developing instruction. JTILT has helped me broaden my perspectives and consider new facets of the field.

The journal has humble origins. A group of designers with a passion for teaching wanted to know how others used and taught about technology. Many had spent years teaching in the public school system or instructing others how to use technology effectively. However, they had limited access into each other's classrooms, spaces, and labs (and limited opportunity to provide that access). Eventually, the group settled on a simple website to capture and disseminate lessons, most of which related to one or more technology integration courses for preservice teachers.

From those origins, a better, more inclusive vision for the journal emerged. I am grateful for the Association for Educational Communications and Technology (AECT) to allow us to implement that vision. I am also grateful for the many volunteers who submit their work, review others' manuscripts, provide detailed feedback and guidance, and promote the journal so the vision can become a reality. I am grateful that we can publish lessons and materials free of charge with a Creative Commons license and know that this opportunity would not be possible without countless volunteer hours.

This Issue

This issue includes six peer-reviewed articles and four design-competition award winners. Peer-reviewed articles include lessons regarding the use of Makey Makey kits to create interactive posters, robotics and coding with girl scouts, teaching experiential learning with origami, and promoting computational thinking among elementary students and preservice teachers.

Annually, the Teacher Education Division of AECT holds a three-day lesson plan competition around a specific tool. This year's tool was the Bloxels EDU Bundle. The winning entries included a lesson by Elisa Shaffer where students explore the setting around the Boston Tea Party and a lesson by Brittany Rivera, wherein students explore and develop their author's purpose for a writing assignment.

Additionally, JTILT holds an annual technology-rich lesson competition. The two winning entries of this competition included a chemistry lesson by Katheryn Ure, wherein students visualize 3D covalent bonds, and a lesson by Robin Dazzeo, wherein students use artificial intelligence to self-assess their writing. Congratulations to these award winners.

Moving Forward

I am proud of JTILT. However, we have a long way to go before we meet the vision established by its

founders and AECT. The journal strives to bring higher education, PK-12, and related professionals together to consider technology-integrated instruction. The journal desires practitioner and international voices. We have made strides in these areas, but more work is needed. Practicing teachers know how to plan lessons but they may be less comfortable navigating the publication process, style guidelines, peer-review, and copyright. Higher education scholars may be familiar with the publication process but may not be familiar with how it applies to the journal.

The JTILT editors and editorial board continue to examine how they can simplify processes, make them more relevant to practitioners, and disseminate materials that are immediately useful. As JTILT enters its fourth year, you may see alternative article formats, greater emphasis on international and underrepresented voices, and broader perspectives for technology integration in teaching. We welcome your voice. Reach out to the editorial team to get involved. Share your ideas and suggestions. JTILT is still growing! We openly invite you to become part of that journey.

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Immersing Students in Classics: Turning Scenes from a Short Story into Interactive Posters Using Makey Makey Kits

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Overview

This lesson engages 7th grade students in a creative reading/writing project where they extend their knowledge of a text by utilizing block coding, sound recording, and Makey Makey kits which are "a digital toolkit that creates a closed-loop circuit by connecting alligator clips to conductive materials" (Turcotte, 2024, p. 1)—to create an interactive poster. This lesson requires students to move beyond comprehension to analysis and interpretation. This lesson could be adapted for any subject and grade level with the proper scaffolding and supports.

Topics: Block Coding, Close Reading, Design-Thinking, Problem-solving, Project-Based Learning

Time: Two to four 50-minute class periods.

Materials

- Makey Makey Classic Kits
- Makey Makey Educator's Guide (Deck & Moyer, 2018)
- Bag of Wonder Activity
- Interactive Poster Story Board
- Makey Makey Project Checklist
- Teacher Modeling Outline
- Projector and display screen/flat panel
- Internet-enabled computers with a USB port
- Recording device
- Snap! (n.d.-b)
- Construction paper and markers
- Conductive materials (e.g., brass tacks, paperclips)
- Insulating materials (e.g., plastic straws, tape)
- 5mm LED bulbs in multiple colors
- Short stories

Context-at-a-Glance

Setting
Private middle school in a major metropolitan city in the United States.

Modality
Face-to-Face

Class Structure
Class of 15-20 middle school students which met 3-4 times a week.

Organizational Norms
The school prioritizes engaging students in critical thinking and problem solving through project-based learning. Professional learning communities facilitate cross-curricular, multi-grade level collaboration.

Learner Characteristics
Students had prior experience with conductive material, block coding, and collaboration through previous curriculum. They were new to Makey Makey kits.

Instructor Characteristics
Two instructors collaborated for this lesson. The English teacher was a digital literacy specialist. The Middle School Innovation Coordinator brought STEM and technology expertise to the lesson.

Development Rationale
This lesson was created to engage students in a fun, creative manner while promoting creative writing merged with skill building and logical coding processes.

Design Framework
Design Thinking, Project-Based Learning (PBL)

Standards

This lesson supports the following Common Core State Standards Initiative (CCSS, n.d.), International Society of Technology in Education (2016), and International Technology and Engineering Educators Association (ITEEA, 2020) standards:

> ELA-LITERACY.RL.7.1 - Cite several pieces of textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text (CCSS, n.d.)
>
> ELA-LITERACY.RL.7.3 - Analyze how particular elements of a story or drama interact (e.g., how setting shapes the characters or plot; CCSS, n.d.)
>
> 1.4a - Students know and use a deliberate design process for generating ideas and creating innovative artifacts (International Society of Technology in Education, 2016)
>
> 1M - Apply creative problem-solving strategies to the improvement of existing devices or processes or the development of new approaches (ITEEA, 2020)
>
> 2M - Differentiate between inputs, processes, outputs, and feedback in technological systems (ITEEA, 2020)

Prerequisite

To support students through this project, teachers should take time to familiarize themselves with Makey Makey boards and block-coding. The *Makey Makey Educator's Guide* supports educators at any entry point in using Makey Makey kits in the classroom. There are also several YouTube videos with clear instructions such as the *Makey Makey First Time Plug-In and Troubleshooting Guide* video (Makey Makey, 2021).

Setup

We spent one-to-two hours organizing materials into kits that would be checked out by the student partners. This involved unboxing the Makey Makey board, USB cable, alligator clips, and wires and adding them to a larger bag which included a variety of conductive and insulator materials that could be used on their posters.

Before the main lesson, the instructors spent one 50-minute class period reviewing conductive and insulator materials. They also used this time to pre-teach block coding and the Makey Makey boards since most students were unfamiliar with these resources. Please see the "Optional Step A" and "Optional Step B" sections for more details. If students are familiar with Makey Makey boards and Snap!, the "Optional Step A" and "Optional Step B" can be skipped.

For the main lesson, students were paired up and the desks were arranged in pairs so the student partners had plenty of workspace and the instructors could easily monitor. For some groups, students opted to work on the floor or recruit additional desks to comfortably spread out their laptop, Makey Makey kit materials, books, and poster.

Students were well versed in the practice of close reading, having worked on this skill throughout the school year. With the practice of close reading, two different annotation practices were utilized. The second practice was more effective, so it is the one discussed in this lesson plan.

Context and Setting

The lesson described takes place in a middle school English Language Arts classroom. The school has a history of cross-curricular collaboration, utilizing Professional Learning Communities (PLC) and academic coordinators to promote innovative instructional practices in the classroom. This approach is rooted in the belief that students take responsibility for learning when they are actively engaged. For this, teachers are asked to embrace new approaches and technologies to give students the knowledge and skills to be successful in their adult lives. Bill Ferriter states, "Empowering students means giving kids the knowledge and skills to pursue their passions, interests, and future" (Spencer & Juliani, 2017, p. 21).

The lesson occurred in the spring semester during a unit on Edgar Allan Poe's short stories and poetry. Students engaged in a variety of adaptations of Poe's works, including a reading of Gareth Hinds' (2017) *Poe* and viewing several film adaptations. For this project, students were tasked with bringing the short story to life by creating an interactive poster of a scene from "The Raven."

Harvey and Goudvis (2017) propose that close reading in the 21st century is tied to close listening and viewing. This entails focusing on an excerpt of a text and asking students to read between and beyond the lines to determine what is said and not said. When describing close reading, Harvey and Goudvis's approach that "close reading is strategic reading" geared towards helping students "learn about interesting content, immerse themselves in great literature, engage in rich talk about text, and read extensively" (p. 31) was used.

At this school, students are assigned their own Chromebook laptop. However, the limited number of Makey Makey kits made partner work a more feasible option. Students were introduced to the Makey Makey board and its possibilities through the Bag of Wonder activity.

Learning Representation

This lesson was founded on the following premises:

- Coding teaches us to identify, break down, and solve problems, supporting the development of analytical thinking (Bers, 2022).
- Coding is a means of communication with sentence structure (Hack Upstate, 2015).
- Reading instruction needs to be authentic, creative, and aesthetic (Young et al. 2022).
- Educators need to empower students by giving them "the knowledge and skills to pursue their passions, interests, and futures" (Spencer & Juliani, 2017, p. 21).

With these premises in mind, we sought to help students see parallels between reading, writing, and coding. Each is a valuable literacy skill our learners need. The newer generation of learners are heavily influenced by technology and its uses, seeing it as fun. Unfortunately, these entertaining and educational applications of technology too often occur outside of their core classes. Meeting learners at their interest is key to ensure they obtain important instruction and enjoy learning. Coding can be a bridge to literacy, allowing students to enhance their literary skills while integrating a creative S.T.E.M. element into their learning.

Snap! is a block programming site that is similar to the Scratch project and allows more customization and advanced coding for young adult learners (Snap!, n.d.-a). In Snap!, the command and response is similar to the subject and predicate of a sentence. When the command and response are correct and compatible, the students hear their sound. This is similar to having proper grammatical structures in the subject and predicate of the sentence, only the block coding provides a reward, or helps the students realize there is a problem if it does not run (Koeser, 2019).

Learning through play is an effective way for students to gain the knowledge and skills they need. Maria Montessori was once quoted saying, "play is the work of the child," emphasizing children naturally learn through play (Mansio Montessori of Geneva, 2023, para. 5). Inevitably, students will grow their traditional literacy skills and gain a worthy 21st century skill of computational thinking. As close reading requires a student to focus on words, ideas, flow, structure, and purpose, so does coding. Cognitively, both advance problem-solving, structural understanding, analytical thinking, and communication skills for students.

Activity Overview

Step 1: Read the Text

For this lesson, students need a strong foundation of the original text. In addition to reading the original text of Edgar Allan Poe's "The Raven," before, during, and after reading, students independently answered questions to help focus their attention on key details that might bring their scene to life. This was especially important in helping them understand the allusions of the piece.

In addition to reading the text, the English teacher wanted students to think of the different ways the text could be interpreted. Thus, students read Hinds' (2017) adaptation of "The Raven" and watched a popular cartoon adaptation. Seeing familiar characters embody the narrator, Lenore, and the raven helped students dive deeper into the characterization and dynamic relationships of the original text.

Teacher Checkpoints

Any time the class compared the original text to the graphic novel or animated adaptation, text evidence was used to support observations and hypothesize

what the artist intended with the changes. This was a great way for students to feel like they had

permission to interpret a classic work when creating their interactive poster.

Step 2: Close Reading Activity

Students were then assigned partners to complete a close reading of one stanza (see Figure 1). In close reading activities, students are asked to summarize the text they read into their own words to show their understanding. Students do this through steps of reading, analyzing the text for tone, and observing patterns in the writing. By this point in the year, students were already familiar with the process of annotating a text, so instruction was limited on how and what to do. Students were specifically asked to identify sense details to help make the posters immersive, thus considering sounds and textures to add to their drawing. Students utilized Hinds' (2017) illustrations to both guide and compare their interpretations. Students then articulated how these details would be reflected in their scene.

Figure 1. Students analyzing a stanza and pulling support from Hinds' (2017) illustrations.

Teacher Checkpoints

For students unfamiliar with annotations, Harvey and Goudvis (2017) provided several great prompts for close reading, listening, and viewing that could direct students to dive more fully into the text.

Optional Step A: Introducing Makey Makey Kits

To introduce students to the technology component of the project, each partner group was assigned a Makey Makey kit consisting of the Makey Makey board, USB cable, and alligator clips. As a class, the group reviewed the Becoming Familiar with Makey Makey (Deck & Moyer, 2018, p. 11-13), identifying all parts of the kit and how to connect the pieces.

The Middle School Innovation Coordinator modeled for the students how to utilize the Makey Makey kits. The step by step actions are outlined in the Teacher Modeling Outline. Modeling made the process clear for students to use the Makey Makey board while also reinforcing the knowledge that they themselves are conductive material and are essential to complete a circuit.

The students were assigned to repeat the steps modeled for them. After practicing, the students furthered their understanding of conductivity with the Makey Makey board through the Bag of Wonder activity. Students were given a bag of conductive and insulator materials along with a worksheet (see Bag of Wonder). On this worksheet, students had to label material as conductor or insulator and provide a brief explanation of why that item fell into the category. This was also a great way for them to practice closing circuits with the Makey Makey boards as often students forget to ground the board, completing the circuit.

The worksheet was reviewed with students as a class to reinforce the difference between conductors and insulators and what type of materials are necessary for their project to be a success.

Optional Step B: Teaching SNAP! with Makey Makey Kits

To integrate sounds with the Makey Makey board, SNAP! was used to produce commands. The students had background knowledge of block coding

from their 3rd and 4th grade maker space enrichments, which made this section of the unit

easy to teach. Many of them were still tinkerers at heart and continued block coding exploration on their own when they moved into middle school. However, some students needed a refresher.

With the Makey Makey board connected to the instructor's flat panel board, the Middle School Innovation Coordinator reviewed how to use SNAP! They browsed a royalty free website for a sound effect (e.g., BBC Sound Effects), downloaded it, and loaded it into the SNAP! library for their demo project. The teacher block coded, "When space key is pressed", "Play sound howl" (see Figure 2).

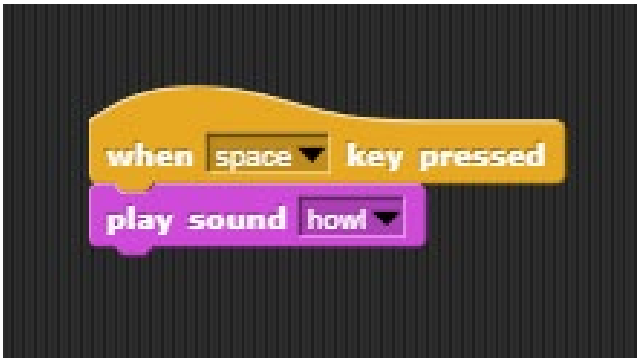

Figure 2. Example of block code from Snap! platform.

In block coding, the connecting words are missing (Figure 2 illustrates the block code structure). A normal sentence written out would read as:

> When the space key is pressed, play the howl sound.

In block coding, you need to pseudo insert words and typically connection words (i.e., the, and) are removed. The above normal sentence written for code would read as:

> When space key pressed, play sound howl.

Students were asked to write their needed code out in standard sentence form first, then remove connection words to develop their block code.

Students were then asked to repeat the exact steps as the Middle School Innovation Coordinator in the Snap! platform. The Middle School Innovation Coordinator and English teacher walked to each group asking students to demonstrate their understanding and read their code as a sentence.

Teacher Checkpoints

It was necessary to point out to students the connection between sentence structure and writing code. While writing code may look incomplete at times, it reinforces the nature of writing sentences and how individual words and their order are necessary to convey a point, or in the SNAP! example complete a command.

Step 3: Plan the Scene

Once students are familiar with conductive materials, Makey Makey boards, and block coding, students plan their scene. To do this, they must brainstorm what their interactive poster will actually look like, which parts of the poster will be interactive, and what effects the commands on the Makey Makey board will trigger when activated. This encouraged collaboration and set the stage for design thinking to emerge. Using the Interactive Poster Story Board, students visually outlined their thoughts. Some students utilized clip art and others used online images, found through search engines, to inspire their project vision. Usually, while one student was drawing the scene the other student began constructing the scene (Step 5).

Teacher Checkpoints

We found it appropriate for Steps 4 and 5 to happen in tandem with one another as the partners inevitably divided-and-conquered the work. Through this, they were communicating their visions. As one student drew the vision in a storyboard, the other student would find clipart, sound effects, and other audio/visual elements that would work well with their project. Sometimes the student storyboarding would hear a sound that would inspire the drawing to take a new form. This also provided an authentic moment for students to discuss their interpretations of the original text.

Step 4: Construct the Scene

Once the plan was complete, students used their drawings or printed clip art to stage the scene on construction paper. Conductive elements such as copper tape, brass fasteners, paper clips, pencil lead shaded areas, and modeling clay were used to provide conductive touch points for the project.

These conductive touch points created the interactive and immersive experience once coupled with audio and visual items.

Teacher Checkpoints

Since this project is partner focused, while one partner is constructing the scene, the other partner is locating sounds online or recording sounds to incorporate into the coding aspect of the project. This happened organically. Allowing students the freedom to lean into one another's strengths produced more buy-in for the project. If one student knew they were not as visually creative as their partner, they happily supported their partner's vision and produced sounds that would complement. Steps 5 and 6 could happen in tandem as well if the partnership benefitted from dividing the work.

Step 5: Record the Immersive Elements

Students explored online libraries of free sounds to use royalty free sound effects, or they recorded their own. When recording their own sounds, students utilized the school-issued Chromebook laptops with a built-in microphone, or they used their smart phones—with or without microphoned earbuds. Creating their own sounds proved to be more rewarding for students that found it difficult to locate the exact sound they needed.

Teacher Checkpoints

It was great seeing students look around the classroom to determine what materials would make the intended sounds. Student's creativity was boundless as things like metal water bottles were used for crashing sounds. It might speed up the process if the students were asked to practice recording a sound in "Optional Step B" and adding it to the code prior to reaching that step in the project. This would also be a good warm-up activity if students have been away from the project for a couple of days, such as a long weekend.

Step 6: Assign Elements to Codes and Controls

After recording sounds, students decided what areas of the Makey Makey board were assigned to each sound. Students could use the up, down, left, right, space, and click controls on the front of the board.

Teacher Checkpoints

Students were reminded to ground themselves during testing. Advanced students were encouraged to find a way to continuously ground the Makey Makey board without using themselves in the closed circuit.

Step 7: Assemble the Circuits

During the assembly stage, students layered conductive material over their constructed scenes from Step 5. Since the idea was for the project to be interactive or immersive, the material should be layered in a way that allows the wires to be hidden through the back of the construction paper. As seen in Figures 3 and 4, students labeled the conductive material on the back of their posters so they knew which alligator clips to connect with each Makey Makey control.

Teacher Checkpoints

It was suggested to students to use different colored alligator clips to help when troubleshooting. For example, if a sound did not happen or the wrong sound was made when tested having a specific color alligator clip for sound makes the physical connection issues easier to see. Students were also encouraged to layer conductive material on the front and back for easier connections between the conductive material and the alligator clips. Students could use the "cleaner" looking items on the front, like brass fasteners, and modeling clay pushed into the end of those fasteners behind the project. The modeling clay provided more stability for wires.

Step 8: Gallery Walk

When all projects were completed, student groups took turns doing a gallery walk. As seen in Figure 5, students grounded the Makey Makey board and triggered the features of the interactive posters. In doing so, we were able to retell the story one stanza at a time. Additionally, we asked students to provide constructive feedback, such as glows-and-grows (i.e., good components and things to continue updating), for their peers. To encourage meaningful feedback, we provided them with sentence stems.

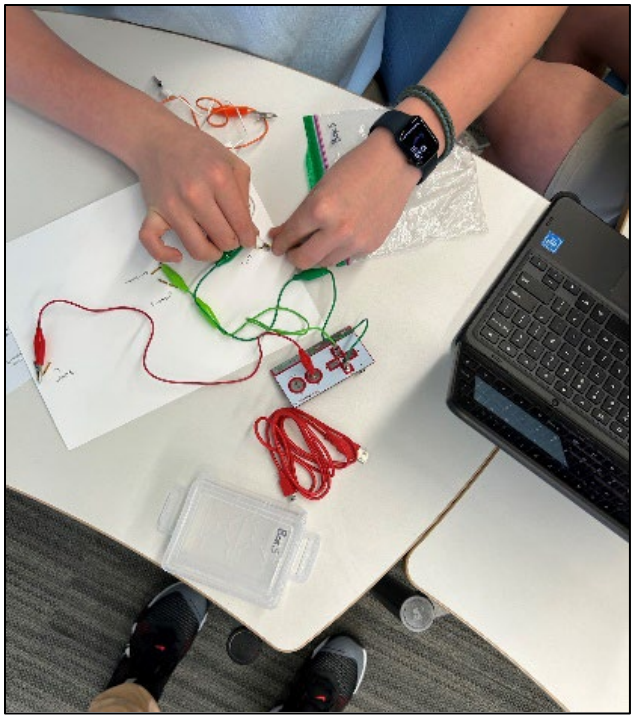

Figure 3. Students connecting alligator clips to the back of their project.

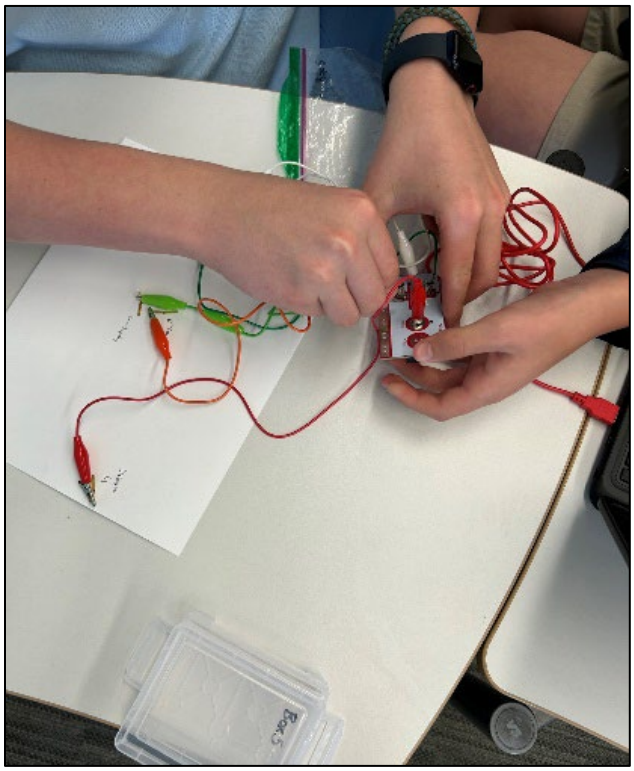

Figure 4. Students connecting opposite side of alligator clips to Makey Makey board.

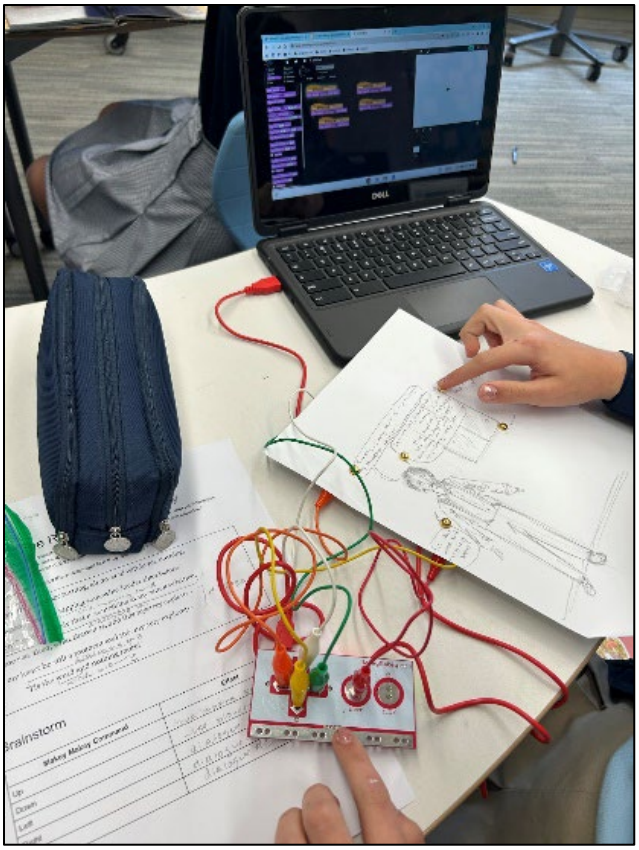

Figure 5. Students showcasing their completely assembled project.

Critical Reflection

We implemented this lesson in two different years. The first year, it was a single implementation of this lesson across four days. Given this was the first time utilizing this technology in an English Language Arts class, we allowed ample time for the students to explore the conductive materials, insulators, and LED bulbs. For the English teacher, this felt out of place as it seemed we were teaching more science and technology standards than English Language Arts standards. To address this concern in the second year, we limited the pre-teaching to conductive materials only. We believed that in limiting the exploration of materials and the LED bulbs in the second year made students less adventurous in making their interactive posters. In the first year, students utilized far more materials—such as brads, foil, paper clips, and copper tape--to make their interactive posters, whereas in the second year, students mainly utilized brads.

During the second year, we did this project across multiple texts. Not only did the student's rate of creating the posters quicken, but they also integrated more complex sounds and circuitry. Part of this is attributed to a change in how passage annotations were done from the first year. Sadly, no group attempted the integration of a lightbulb in the two years of this project. We attribute this to the way the Makey Makey boards are formatted: LED bulbs must be connected to the back of the board using thin wires, while alligator clips are connected more securely through the front of the board. The LED bulb wires would disconnect when the board was moved or adjusted, even when activating the poster controls. One option would be to use two Makey Makey boards for one poster—one dedicated to bulbs and one dedicated to sounds and effects. However, we did not have the resources to allow for this.

In the second year, having the iterative cycles of creating interactive posters back-to-back was less than ideal. For some, this assignment provided an entry point for engaging in a story and making the classic text more contemporary. For others, this assignment was a frustrating mix of steps, especially if their partner was absent or the class ended before a clear stopping point was reached while constructing the poster.

Overall, the requirement to work with a partner was a valuable opportunity for students to dive deeper into the texts and/or coding. There were several instances of students teaching each other. For example, one student was familiar with coding and even practiced in his own time. When paired with someone less familiar with coding, he was eager to share his passion and knowledge with them.

If this assignment were to be done another time, we feel students would benefit from a checklist of reminders, such as:

- Grounding the Makey Makey board to activate the buttons.
- The steps for block-coding.
- Tips for sequencing the sounds and/or effects.

Lastly, we would consider using this project as a whole class formative assessment and then include interactive posters as an option for students to show master on future literary units.

This assignment could be modified for other grade levels and subject areas. For example, a history class might create an interactive poster highlighting the details of a historic event, such as the signing of the Declaration of Independence. The interactive elements could be scaled up to not only include sound, but video, animations, and other graphics through the Snap! platform.

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Computational Thinking in Undergraduate Preservice Special Education Programs

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Overview

In the 21st century, an increased emphasis on integrating computational literacy within classrooms occurred (Bouck & Yadav, 2020). This learning representation aims to equip preservice special education teachers (PSSETs) with tools to deliver inclusive computational thinking (CT) and computer science (CS) instruction, fostering an understanding of CT/CS concepts and promotes integration across content areas. This technology-rich learning representation employs robots, interactive whiteboards, and a blend of unplugged and plugged CT activities to demonstrate how CT can be integrated into a PK-12 classroom. This learning representation concludes with an assessment tasking PSSETs to create an activity integrating CT. This approach prepares PSSETs to provide equitable and accessible CT/CS education, aligning with current educational priorities.

Topics: Computational Thinking, Special Education, Teacher Education

Time: 1.5-2 hours

Materials

- CT in SPED Slides
- Design a CT Activity Rubric
- Interactive whiteboard or projector that connects to a computer (i.e. screen projection capability)
- Speakers
- Robots (preferably Sphero-mini, mTiny, or Dash & Dot, but these types are not required)
- Chart paper and markers OR whiteboard and whiteboard markers
- Virtual whiteboard (e.g., Padlet or FigJam)
- Sticky notes

Context-at-a-Glance

Setting
A university undergraduate special educator preparation program.

Modality
Face-to-Face

Class Structure
Session lasting 1.5 to 2 hours, arranged with tables or desks grouped to encourage group work.

Organizational Norms
The teacher preparation program utilizes the Universal Design for Learning (UDL) framework to prepare preservice special education teachers (PSSETs) and integrate technology effectively.

Learner Characteristics
Learners are third-year undergraduate PSSETs with limited prior exposure to special education and computational thinking (CT).

Instructor Characteristics
The instructor was a special education expert with a novice understanding of CT and computer science (CS). No CS background is necessary for implementation.

Development Rationale
The learning representation addresses the lack of CT exposure for students with disabilities by tasking PSSETs with integrating CT into the curriculum, aligning with current educational priorities, and ensuring equitable and accessible instruction.

Design Framework
Backward Design Approach

Setup

The setup for this lesson takes about 15-20 minutes. Instructors should preview and work through the CT in SPED Slides (PDF) before implementation, review the Design a CT Activity Rubric (PDF), and practice using all technology before expecting preservice special education teachers (PSSETs) to use it effectively. This includes setting up robots and other technology items with the appropriate applications, ensuring they are charged, and placing them in a safe place within the classroom.

The learning environment should promote collaboration and discussion amongst the PSSETs in the classroom. Grouped seating is encouraged. Screen projection or an interactive whiteboard is required to display the technology-embedded slides with speakers and play sound.

Standards

This lesson supports an International Society for Technology in Education (ISTE, 2017) standards for educators and a Council for Exceptional Children's High Leverage Practice (McLeskey et al., 2017). The ISTE (2017) standard this lesson meets is, "Educators continually improve their practice by learning from and with others, and exploring proven and promising practices that leverage technology to boost student learning" (2.1 Learner).

The Council for Exceptional Children's High Leverage Practice this lesson meets is #19:

> Teachers select and implement assistive and instructional technologies to support the needs of students with disabilities. They select and use augmentative and alternative communication devices and assistive and instructional technology products to promote student learning and independence. They evaluate new technology options given student needs; make informed instructional decisions grounded in evidence, professional wisdom, and students' IEP goals; and advocate for administrative support in technology implementation. Teachers use the universal design for learning (UDL) framework to select, design, implement, and evaluate important student outcomes. (McLeskey et al., 2017, p. 24)

Context and Setting

Computational Thinking (CT) is considered a vital "21st-century skill" (Tabesh, 2017) that involves breaking down complex issues into manageable parts and using logical reasoning to devise solutions. CT is an essential skill for understanding computer science (CS) but extends beyond coding, including crucial cognitive skills that can transfer to many fields and academic content areas. As such, it is necessary that PSSETs be made aware of these critical thinking and life skills that pre-Kindergarten through twelfth grade (PK-12) students will be tasked with understanding in our ever-evolving digital landscape. However, students with disabilities in PK-12 settings are often not included in opportunities to learn about CT/CS. With an increasing number of states incorporating CT/CS standards as mandatory graduation requirements (Ofgang, 2022), it is imperative to ensure that students with disabilities have access to CT content in their academic curriculum. PSSETs, therefore, must be prepared to include CT into the curriculum for their learners, not only to increase accessibility and equity in CT content but also to emphasize the importance that CT knowledge can have in a student's future.

To prepare PSSETs for integrating CT into the curriculum, the integration of CT concepts into two key courses was the focus. The courses were a course on Universal Design for Learning (UDL) and a course on curriculum and methods for instruction for students with disabilities. Students take these courses concurrently. Together, these courses support PSSETs' learning of methods for teaching students with disabilities across the content areas in PK-12 settings and the support required to provide students with access to academic content. In the UDL course, PSSETs are provided with opportunities to create lesson plans for different content areas for learners with disabilities. As UDL is a central concept taught in this course, PSSETs must incorporate and align to UDL in their lesson plans and activities. Technology use is heavily emphasized in the UDL course, and a substantial portion of the course also focuses on instructional and assistive technology.

This learning representation was presented to PSSETs in the UDL course during weeks 11 and 12 of the 15-week semester. At this point in the semester, PSSETs were exposed to methods for teaching special education in mathematics, reading, social studies, and science; the UDL framework;

instructional planning; and assistive and instructional technology. Given the aims of the UDL course, the learning representation discussed in this lesson aligns with the following concepts:

- Understanding of content and methods for teaching various content areas to learners with disabilities.
- Supports for teaching learners with disabilities.
- Instructional planning for learners with disabilities.

Our university's UDL course is most frequently taught in a classroom with multiple technology access points, including a computer with screen projection, an interactive whiteboard, multiple brands of robots (Sphero, mTiny, mBot, Dash & Dot), and various crafting supplies. Approximately 12-20 students are in each section of this course, and all are either Special Education majors, dual Early Childhood and Special Education majors, or dual Elementary Education and Special Education majors. The room is arranged with large tables, and students sit in groups of four. The course is taught by faculty in the Department of Special Education. This learning representation is customizable to the unique needs of each of the majors offered within the Department of Special Education, as PSSETs can choose the grade level and content area of interest.

Learning Representation

The following description outlines the details of our learning representation for increasing awareness and understanding of CT for PSSETs. At the end of this learning representation, PSSETs are tasked with creating an accessible activity for learners with disabilities, integrating CT into a content area of the PSSETs' choice. With this result in mind, a backward design was applied to create the following activities to assist PSSETs with identifying the importance of CT in the classroom, exploring CT concepts, learning CT concepts, and exploring ways of integrating CT concepts into their future curricula.

The learning representation begins with an introduction to CT concepts through a group activity, followed by a description and discussion of what CT is. Then, in the content presentation, concepts are elaborated on and PSSETs explore technology and CT/CS concepts in an applied format. The instructor discusses concepts of equity and access for students with disabilities and CT, and statistics for students with disabilities and their inclusion in CS courses are presented. Then, PSSETs are asked to practice making suggestions, based on the UDL framework, for scenarios in which general educators are including CT in their classrooms for learners with disabilities. After PSSETs practice this, they are presented with the limited research that exists around incorporating CT into the curriculum for students with disabilities. Finally, PSSETs are asked to independently create a CT activity integrated into the content area of their choice, including accommodations, modifications, and specific references to CT concepts. *During this lesson, italic text identifies questions or prompts for the learners.*

Introduction (20 minutes)

The learning representation opens with the presentation, or the CT module, visible on the screen projection or interactive whiteboard. PSSETs also have access to the presentation on their personal laptops that they bring to class. The module opens with critical questions that the student will answer (see Slide 2 of CT in SPED Slides PDF):

- *What is computational thinking?*
- *Why is computational thinking important?*
- *How do I teach computational thinking to learners with disabilities?*

After these questions are presented to the class, an engaging activity that serves as a hook for PSSETs is introduced. PSSETs can answer one of three questions with a small group of peers (see Slide 3 of CT in SPED Slides PDF). They are asked to create a set of directions or a diagram to describe the process of one of the following questions, ensuring that no directions are left out:

How would you:

- *Describe the process for alphabetizing graded papers?*
- *Build a structure out of Legos?*
- *Cook a meal (rice, meat, and vegetables) to ensure everything is ready at the same time and nothing gets cold?*

The instructor then provides students approximately 5-10 minutes for PSSETs to work in small groups to discuss and map out their answers. Whiteboards and dry-erase markers are provided to students, as well

as sticky notes. Instructors should encourage PSSETs to write each step on a sticky note to rearrange the order of events easily. After the time is up, the groups share their answers with the class. The instructor should highlight their process, make subtle corrections to their directions (debugging), work together to seek out patterns that they can loop (pattern recognition), or describe a formula to follow (algorithmic thinking). The instructor can use CT/CS terminology to describe this process, or can wait to make that connection, as students will be asked to make explicit connections later in the module.

Next, the instructor formally describes CT using a definition provided by Cuny et al. (2010): "Computational thinking refers to the thought processes involved in expressing solutions as computational steps or algorithms that can be carried out by a computer" (see Slide 4 of CT in SPED Slides PDF). The instructor should ask the class, "*why is it important that we are able to articulate information to be carried out by a computer?*" PSSETs should describe reasons why and a conversation should ensue.

The instructor should also state that CT is a "*way of thinking,*" "*a critical and logical thinking process,*" and "*can be applied to computer sciences or any content area*" (see Slide 5 of CT in SPED Slides PDF). These aspects of CT are important to highlight, as they emphasize that CT is not necessarily computer science, but a way of thinking that helps us understand how computers think, given the human inputs that create them.

The instructor then provides an introductory video to students that explains the concept of computational thinking by solving a complex mathematics problem (College & Career Ready Labs, 2018; see Slide 6 of CT in SPED Slides PDF)). Closed captioning should be enabled to increase accessibility for this fast-paced video.

This video introduces the PSSETs to CT vocabulary and the problem-solving process using a familiar method that they have worked with in the past in a mathematics course during their high school careers.

Content Presentation and Exploration (25-35 minutes)

The PSSETs are then provided with definitions of key CT vocabulary, including decomposition, pattern recognition, abstraction, and algorithms. Slide 8 of CT in SPED Slides (PDF) lead PSSETs through the actions required to engage in that part of the CT process.

After introducing the vocabulary, PSSETs are asked to connect it back to their introductory activity (see Figure 1). The instructor will ask the students to reflect on their chosen challenge, and identify when they engaged in decomposition, pattern recognition, abstraction, and algorithmic thinking. PSSETs will be directed/asked to talk about this in their groups and will share after five minutes. The instructor should encourage as many groups to share their ideas as possible.

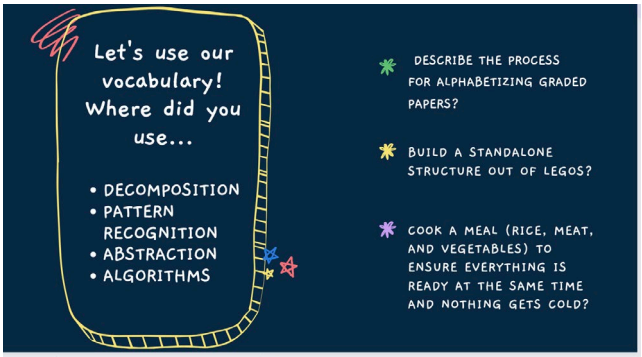

Figure 1. Connect the vocabulary back to the hook (see Slide 9 of CT in SPED Slides PDF).

The instructor will then share a slide that discusses CT concepts (logic, evaluation, abstraction, patterns, decomposition) and the approaches for engaging with those concepts (tinkering, creating, debugging, persevering, collaborating). These approaches are presented in a way that emphasizes the importance of providing these opportunities for engaging in CT concepts to promote inclusivity and equity in the classroom. The instructor should underscore the idea that "we're all computational thinkers here" (Barefoot Computing, n.d.)

The instructor should then transition into a discussion about why CT is important for all learners (see Slide 10 of CT in SPED Slides PDF). The slides include that future career paths may increasingly rely on CT/CS and an understanding of how computers work, along with the importance of STEM concepts and coding in PK-12 curricula (see Figure 2). The information included in the presentation slides are hyperlinked to current data and articles around these concepts.

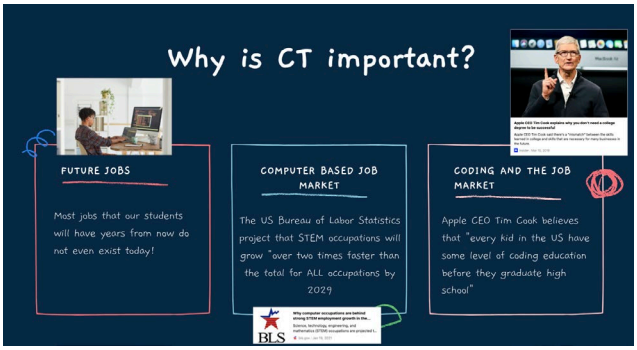

Figure 2. Why is CT Important?

An exploration activity is provided to engage the PSSETs further. They are instructed to do a series of tasks with a partner/small group using the Sphero robots, or other robots that instructors may own. Please note that the following activities should be adjusted if working with another brand of robot. We chose Sphero-mini robots due to their low cost, easy-to-use format, and smaller size than most robots. However, the following activity can be adjusted using any robot that instructors can access. The following activity emphasizes open-ended exploration for PSSETs, limited instruction in using the robots, and reflection on engagement and the steps needed to adequately program or use the robots.

First, PSSETs will be asked to take the Sphero-mini bowling. No instructions will be given to the PSSETs, other than how to connect them to a device to navigate them. Second, PSSETs will be asked to build and navigate a Sphero through an obstacle course Once PSSETs have attempted these tasks for about 10 minutes, they will be asked the following questions to reflect on with a partner/small group (see Figure 3 and Slide 12 of CT in SPED Slides PDF):

1. *Were these tasks challenging for you/your partners? Why or why not?*
2. *What CT skills/steps did you use? Reference your resources!*

Figure 3. Sphero reflection activities

PSSETs will share their answers with the class after discussing with their partner/small group for about five minutes.

The instructor will then discuss current state initiatives around incorporating CT/CS into the curriculum for all learners, and for learners with disabilities. This discussion should take about five minutes and involves the instructor clicking through relevant links to show PSSETs where to find this information independently (see Slides 13-15 of CT in SPED Slides PDF). The state CS standards will briefly be examined. The instructor will go into depth on the current ISTE standards, so that PSSETs can see what is expected of different age groups regarding their knowledge of CT/CS information.

Additional internet resources are provided to PSSETs, including Scratch (https://scratch.mit.edu/), resources from the ISTE website (https://iste.org/), and resources from https://code.org/ (see Slide 19 of CT in SPED Slides PDF).The instructor clicks through these websites to show vetted lesson plans, and activities to incorporate into the classroom for learners in PK-12 grades. PSSETs are given about five to 10 minutes to explore these websites and acclimate to their features.

A discussion about equity and access in CT/CS content is the most critical component of this lesson. After all the resources above are explained and the importance of CT/CS is highlighted, the instructor will discuss applications of CT/CS specifically for students with disabilities (see Slide 20 of CT in SPED Slides PDF). The instructor begins this conversation with the quote:

> The purpose of equity in computer science is not to prepare all students to major in computer science and go on to careers in software engineering or technology. Instead, it is about ensuring that all students have the foundational knowledge that will allow them to productively participate in today's world and make informed decisions about their lives. Equity is not just about whether classes are available, but also about how those classes are taught, how students are recruited, and how the classroom culture supports diverse learners and promotes retention. The result of equity is a diverse classroom of students, based on factors such as race, gender, disability, socioeconomic status, and English language proficiency, all of whom have high expectations and feel empowered to

> learn. (K–12 Computer Science Framework, 2016, p. 23)

After the quotation is displayed on the screen and PSSETs are given sufficient time to read and reflect, the instructor will ask the students what parts of this quote resonate most with them. Given that we have framed the importance of CT as an equity and accessibility issue that must be resolved to equip students with disabilities with the needed skills to participate in our society, it is assumed that PSSETs will most likely drive the conversation toward equity and access. If not, then the instructor can ask PSSETs about what their role is or should be regarding CT in their future teaching practice.

A graph that depicts the trends in education regarding specific disability categories is shown next (see Slide 21 of CT in SPED Slides PDF). These slides show that students with various disabilities experience CT/CS content in their classrooms at very low rates, and these rates decline over time in school (Fancsali & Israel, 2021).

Practice (25-30 minutes)

A slide that describes multiple elements of CT in special education is presented next (see Slide 22 of CT in SPED Slides PDF). This slide highlights multiple articles on CT/CS for learners with disabilities. First, a teaching brief on using UDL to increase accessibility for all learners in computer science is presented to students (Project TACTIC, n.d.) The instructor reads the scenarios and makes connections to the UDL content currently being discussed in their coursework. The instructor asks the PSSETs to think/pair/share on the question, "*What UDL elements should the teacher consider for each student in this scenario?*" The PSSETs should take five to ten minutes to discuss their ideas with a partner, and the instructor should have the PSSETs verbally share this information or write their ideas on a whiteboard or virtual whiteboard application (e.g., Padlet or FigJam) in the classroom. It is suggested that the physical/virtual whiteboard be laid out in a similar format to that of the UDL framework, with "Multiple Means of Representation," "Multiple Means of Engagement," and "Multiple Means of Action and Expression" written across the top of a table. After all ideas are presented, the instructor should review the ending of the teaching brief where multiple ideas are presented, and these answers should be compared to those the PSSETs generated.

Now that PSSETs have begun to generate ideas around increasing accessibility for students with disabilities in CT/CS content, the instructor should also describe additional research that accompanies this concept. An article by Bouck and Yadav (2020) provides additional ideas for supporting students with disabilities in CT/CS content. They suggest that teachers should:

- Use explicit instruction and immediate feedback.
- Include CT vocabulary in instruction.
- Explore ways that CT can be integrating into the mathematics curriculum, answering the question, how can it support instruction of the content?
- Use the resources in their classroom such as mobile devices, computers, robots, etc.
- Use vetted lesson plans from code.org, ISTE, etc.

Assessment (30 minutes; in the classroom or as homework)

PSSETs have now learned what CT is, why it is important for students, how to integrate it into the curriculum, and how to specifically design CT content for students in a way that is accessible to increase equity in education. The final component of this lesson is to have PSSETs design an activity for students in a hypothetical classroom of their choosing (see Figure 4 and Slide 23 of CT in SPED Slides PDF). PSSETs are asked to do the following:

Brainstorm HOW you would incorporate computational thinking skills into a lesson you have taught or planned for. Consider some of the following:

- *Could you use some of the suggested resources to enhance an assessment in your lesson?*
- *Do you require computers or devices to incorporate CT into your lesson plan, or can it be an "unplugged" activity?*
- *Can you teach/reteach a concept using CT skills?*

After brainstorming the above, describe your activity. Include the grade level, classroom setting, and academic standard you are addressing and explain the activity. Describe the activity or activities and your plan for how students will engage in this activity. Be sure to include CT terminology!

Figure 4. Design an activity.

PSSETs will require 30 minutes to one hour to complete this activity. The instructor should consider providing time outside of class to have students work on this independently. Students could generate ideas in class, discuss with an instructor or a peer, and then work independently outside of class. In the next class session, the instructor should review the previous class meeting and should ask PSSETs to describe some of their activities and ways they include both CT terminology/concepts and accessibility into their plan. A suggested rubric for this activity is included (see Design a CT Activity Rubric PDF).

Critical Reflection

This learning representation was implemented in five consecutive semesters (Fall 2021-Fall 2023) with at least 225 undergraduate students. The goals for this learning representation are to increase awareness and understanding of CT amongst PSSETs and to increase understanding of ways to incorporate CT into existing curricula for students with disabilities. PSSETs were asked to participate in pre/post surveys in all semesters of this project. The surveys were not required, and participation in the surveys did not impact PSSETs' grades in the courses. When asked to respond to the statement, *Please specify your level of agreement to the following statement: I am confident in my ability to teach computational thinking to students with disabilities,* through a Likert scale (1=strongly disagree, 2=disagree, 3=neither disagree or agree, 4=agree, 5=strongly agree), PSSETs showed a significant difference from pre- to post-survey ($t(191)=5.30$, $p<0.0001$), with post-survey scores higher than pre-survey scores on this item.

Reflections on the lesson revealed both strengths and weaknesses. For many PSSETs, this lesson likely marks their first exposure to CT terminology and concepts in their higher education careers. Ideally, there should be many other "touchpoints" across their academic careers where they are exposed to CT content, but we must consider that they have little to no exposure to CT up until this point. We believe that this lesson, while limited, provides PSSETs with the rationale, purpose, and impetus for including and integrating CT in their future curricula.

PSSETs indicated that they have increased their understanding of CT and appear to place importance on teaching CT concepts to all learners through our pre-/post-surveys. However, per the grades and anecdotal reports from instructors on the *"Design a CT Activity"*, PSSETs seemed to struggle with creating meaningful opportunities for future learners to learn CT concepts, indicating a limited understanding of how they could integrate CT concepts, or limited understanding of lesson planning for future students. Due to time constraints, one to two class meetings (totaling one and a half to two hours) dedicated to discussing CT is all that is currently available in the UDL course. In the future, we are hopeful other special education faculty will begin to discuss CT and integration of CT teaching methods in their coursework, where applicable, to provide more opportunities for exposure and practice with this content.

Many PSSETs struggled to create meaningful and challenging CT activities for their future learners. More specifically, many PSSETs created activities that asked students with disabilities to engage in lower-order thinking skills such as defining terms, knowledge retrieval, or literal comprehension, as per Bloom's Taxonomy (Adams, 2015). As this is their first time being asked to do such an assignment, we consider this a learning opportunity for PSSETs. We believe that this should not be the only time that PSSETs consider integrating CT skills in their lesson plans or activities they design throughout their preservice teacher programs and that with reinforcement in other coursework, PSSETs can refine these skills over time. We encourage instructors implementing this lesson to conference with PSSETs, using the Design a CT Activity Rubric (PDF) as a guide, to see where improvements can be made to the activities that PSSETs developed. Specifically, we encourage instructors to give examples of possible activities that encourage

students to engage in higher-order thinking skills. We also encourage other special education faculty to discuss CT in any special education coursework that they teach, as this content is as important as mathematics, reading, and writing.

PSSETs expressed to instructors the challenges they experienced with the limited instructions provided to them in the Sphero-mini robot activity. The instructor should continually reinforce the concept that limiting instructions is an *intentional* practice to engage our PSSETs in productive struggle and utilize their social-emotional skills. Experiencing this challenge simulates what their PK-12 students with disabilities may experience their first time working through the CT problem-solving process. More explicitly linking CT to social-emotional learning (SEL) skills (e.g. collaboration, emotional regulation, perseverance, etc.) in future lessons could also broaden the application and integration of CT concepts in future PSSET classrooms. Connecting CT to SEL equips PSSETs to analyze situations, communicate effectively, and gain insight into future student interactions in their classrooms. In the future, we may consider connecting and highlighting SEL skills to CT in a more purposeful and intentional way, recognizing that SEL is a critical component of effectively supporting and instructing learners with and without disabilities.

It is critical that instructors spend time reading about CT and exploring the resources before implementing this learning representation with PSSETs. While this is always true for educators, for this lesson it was essential due to the instructor's role as a novice/learner of CT/CS. Additionally, instructors should model expectations for working with high-tech items such as robots (e.g., ways to share the robots and ways to keep the robots from breaking) before allowing PSSETs to explore these resources. This, in turn, will encourage PSSETs to do the same with their future students.

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Building Math Skills with Computational Thinking: CT-Enhanced Addition Strategies

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Overview

This elementary math intervention lesson plan integrates computational thinking (CT) and generative AI tools, focusing on addition strategies. It combines tech-enhanced experiences with hands-on activities to develop CT skills and content knowledge. This three-part lesson includes reviewing addition facts, engaging in interactive games, and creating digital content. Students practice pattern recognition, abstraction, problem decomposition, and step-by-step solution development. The plan emphasizes CT connections, engagement, and deepening understanding of addition strategies. This adaptable, multimedia approach offers a comprehensive learning experience blending traditional math instruction with modern tech tools across various grade levels and content areas.

Topics: Addition within 20, AI Tools, Computational Thinking, Content Creation, Digital Learning, Technology Integration

Time: Minimum of eight 20-minute intervention sessions (2 hours, 40 minutes)

Materials

- Whiteboard and markers
- Magnetic ten-frames and counters
- Opening Sentences
- Recording device
- Chart paper and markers
- Chat GPT Generated Openers and Script Text
- Steve Wyborney's (2023) - Mystery Number
- Desmos Classroom (n.d.) - What Sum Do You See

Context-at-a-Glance

Setting
Fifth grade Tier-3 math intervention at a suburban, public, Title 1 elementary school in the Southeastern United States.

Modality
Face-to-face

Class Structure
Students worked in pairs, facilitated by math interventionist.

Organizational Norms
Classes met 4 days/week for 25 minutes each. This was the school's first year with full-time Interventionist.

Learner Characteristics
The learners were 5th graders with math scores two or more grades below level. The students were unfamiliar with CT, video creation, social media content, or generative AI for learning.

Instructor Characteristics
The lesson was designed by the math interventionist pursuing EdTech doctorate, focusing on CT in elementary math. Instructors should be tech-proficient, familiar with sensemaking routines and evidence-based resources for developing foundational math skills.

Development Rationale
Created as math intervention resource to engage upper elementary students in primary concepts while introducing CT and AI learning tools.

Setup

Six 5th grade math intervention students worked in pairs to complete activities culminating in the

creation of videos demonstrating addition within 20 using ten-frames and counters. Students were permitted to choose partners, resulting in the formation of three pairs. The classroom environment was spacious, allowing each pair to work at separate tables and converse at a voice level that did not disturb others. Each session began with a sense-making or number sense routine to review CT and addition strategies and encourage student discourse. Prior to the students' arrival, materials were prepared and accessible to maximize time on task during brief intervention sessions. During each session, the facilitator circulated the room addressing questions and guiding students through productive struggles by highlighting their use of CT elements and skills. Before implementing this activity, instructors should create necessary accounts, access all sites for number sense and sense-making routines, and review the latest developments in integrating CT concepts (see We Are Teachers Staff, 2023, for concepts).

Standards

Multiple standards were met in this three-part lesson.

International Society for Technology in Education (2016) Student Standards:

> 1.3.b Evaluate Information - Students evaluate the accuracy, perspective, credibility and relevance of information, media, data or other resources.
>
> 1.5.c Decompose Problems - Students break problems into component parts, extract key information and develop descriptive models to understand complex systems or facilitate problem-solving.
>
> 1.6.b Original and Remixed Works - Students create original works or responsibly repurpose or remix digital resources into new creations.
>
> Common Core State Standards Initiative ([CCSS], n.d.) Math Content Grade 1:
>
> CCSS.MATH.CONTENT.1.OA.C.6 - Add and subtract within 20, demonstrating fluency for addition and subtraction within 10. Use strategies such as counting on; making ten (e.g., 8 + 6 = 8 + 2 + 4 = 10 + 4 = 14); decomposing a number leading to a ten (e.g., 13 - 4 = 13 - 3 - 1 = 10 - 1 = 9); using the relationship between addition and subtraction (e.g., knowing that 8 + 4 = 12, one knows 12 - 8 = 4); and creating equivalent but easier or known sums (e.g., adding 6 + 7 by creating the known equivalent 6 + 6 + 1 = 12 + 1 = 13) (CCSS, n.d., p. 15).
>
> CCSS.MATH.CONTENT.1.NBT.B.2.B - The numbers from 11 to 19 are composed of a ten and one, two, three, four, five, six, seven, eight, or nine ones (CCSS, n.d., p. 15).

Alabama State Department of Education (2019) Standards:

> MA19.1.6c - Demonstrate fluency with addition and subtraction facts with sums or differences to 10 by decomposing a number leading to a ten.

Alabama Learning Exchange (2018) Grade 5

> DLCS18.5.R6 - Produce, review, and revise authentic artifacts that include multimedia using appropriate digital tools.
>
> DLCS18.5.17 - Publish organized information in different ways to make it more useful or relevant.

Context and Setting

This lesson was implemented in a math intervention classroom at a public, Title 1 elementary school in a rapidly-growing suburban school district in the Southeastern United States. The district serves over 20,000 students.

The Tier 3 intervention classroom is designed to fill gaps in foundational math concepts using individual and collaborative hands-on learning experiences. Students selected to receive Tier 3 intervention are those whose scores on diagnostic assessments fall at least two years below their current grade level. The classroom space is large enough to allow flexible seating configurations that are ideal for individual or partner work, whole group discussions, direct instruction, and inquiry-based learning activities.

Older students often resist foundational concepts and strategies from elementary computation progressions once they've been exposed to traditional algorithms. This resistance leads to an

over-reliance of count-by-one strategies that become inefficient with larger magnitudes. By introducing elements of computational thinking, we can enhance students' abilities to understand and apply multiple addition strategies and strengthen their foundational understanding for future mathematics coursework. This lesson was designed to develop students' ability to use decomposition to apply a non-count-by-one strategy to add within 20 while fostering collaboration, creativity, and a deeper understanding of CT concepts and their application in computation strategies.

Students are challenged to create a video demonstrating addition using the "make ten" strategy, enhancing their comprehension of how pattern recognition and decomposition aid in calculating sums within 20. Students also explore the use of AI-generated text to craft scripts for their videos. Additionally, this lesson offers students the opportunity to synthesize and present their learning through a creative presentation. This exercise not only reinforces mathematical and CT concepts but also integrates modern technology and public speaking skills, providing a holistic educational experience.

Learning Representation

During this lesson, italic text identifies questions or prompts provided to the learners.

Activity Learning Objectives

Upon completion of this lesson, students were able to:

- Describe CT concepts.
- Model adding within 20 using a ten-frame.
- Justify breaking apart an addend to create a ten.
- Identify two addition sentences for sums within 20 based on representation in ten-frame.
- Analyze addition sentences to identify and describe patterns.
- Work effectively with a partner to brainstorm and develop a script for a video that details a set of steps to add within 20 using a ten-frame.
- Prepare a 2-minute presentation that communicates how to use a ten-frame to model addition.
- Understand the process of creating and uploading a video on the YouTube platform.
- Understand the real-world applications of the CT, mathematical, generative AI and technology principles used in the lesson.
- Analyze and evaluate text generated by AI.
- Understand how AI text can spark creativity for original ideas and innovation.

Lesson Structure

The lesson consists of three parts. Part 1 draws from the EngageNY (n.d.) curriculum (Grade 1, Module 1, Lesson 7) focusing on counting from embedded numbers. Students use concrete and pictorial methods to decompose numbers 6-10 (1.OA.5; CCSS, n.d.), emphasizing CT concepts such as recognizing patterns and decomposing numbers. Part 2 is based on the Do the Math curriculum - Number Core (Burns, 2008), which encourages flexible thinking in addition. Students engage in interactive, game-based activities and use manipulatives to model addition within 20. In Part 3, students become content creators, developing materials for a fictitious YouTube channel to demonstrate addition within 20 using ten-frames. The sessions in any part of the lesson may span multiple days. Suggested timing is provided for each session.

Part 1: Sums of 6-10

Part 1 includes one, 20-minute session.

Session 1

Introduction. At the beginning of the session, invite students to analyze an image projected on the screen as they enter the classroom (Figure 1). Ask for volunteers to share information about what they notice or wonder about in the displayed image. During the discussion, record the number sentences that students identify (e.g., "there are seven children, two are at the board, three are on the couch, and two are at the table", 2 + 3 + 2 = 7) and facilitate the

sharing of ideas about numeric patterns in the images. These conversations present numerous opportunities to connect to CT concepts. It's important to acknowledge when students use patterns or decomposition to solve problems, as this reinforces their CT skills.

Figure 1. "Picture Cards" by Eureka Math. Creative Commons Attribution-NonCommercial-ShareAlike 3.0 Unported License.

As students examine the image and share their observations, highlight examples of composing and decomposing. For example, "I see 10 people on the playground, 3 are playing jump rope and 7 people are not playing jump rope." This statement describes decomposing 10 into 3 and 7, one of many possible decompositions.

If needed, prompt students with questions about different attributes that decompose the images:

- How many people are seated?
- How many people have gym shoes?
- How many people are wearing blue?
- How many people have black hair?

This approach reinforces decomposition by helping students examine a complex scene (in this case, a playground), and naturally leads students to break down the whole (total number of people) into smaller parts based on various attributes. Prompting students to consider different attributes reinforces that decomposition can occur along various dimensions which broadens students' understanding of the concept. This introduction is approximately five minutes.

Ten-Frames. Ten-frames with red/yellow counters can be used to reconstruct the decompositions of the images (Figure 2). In approximately 10 minutes, record new number sentences, or review the number sentences created in the introduction, to facilitate students recognizing patterns:

3 + 7 = 10
4 + 6 = 10
5 + 5 = 10
6 + 4 = 10
8 + 2 = 10

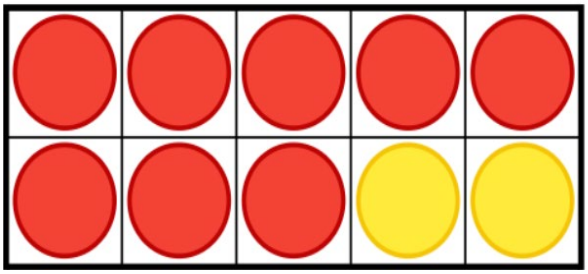

Figure 2. "Ten-frames and counters" (Burns, 2008).

Reinforce pattern recognition by asking students questions to identify patterns in the equations. Students should recognize all equations equal the same number (e.g., 10) and notice increasing/decreasing patterns in addends (Figure 3). If needed, pose questions like:

- What do you notice about the sum in each equation?
- What number sentence would come before 3 + 7 = 10?
- What's happening to the first number as we move down the list? What about the second number?

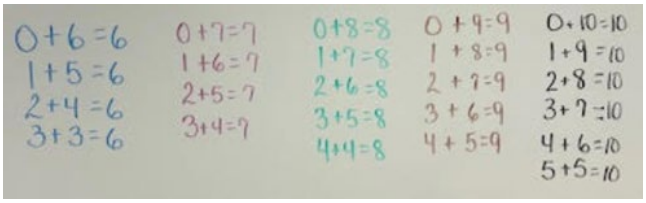

Figure 3. "Patterns in addition" by Rosalind Ali. CC BY 4.0.

Closure. To close the lesson:

- Look at the ways a number (e.g., 10) is made. Ask students, *What patterns do you see?*
- Direct students to the other sums previously discussed (e.g., 7, 8, 9; see Figure 3), and ask them, *What do you see is the same and different about showing ways to make 9 and showing ways to make 10?*
- Give students time to talk with a partner about each question.

To help students become aware of using CT skills, use explicit language like "we used decomposition to break apart 10 into 4 and 6 or 3 and 7" or "we used pattern recognition when we identified the number sentence that would come before 3 + 7 = 10." Use phrases like these to emphasize instances of CT to increase student awareness of their use of CT skills and help them understand its practical application in everyday problem-solving contexts. Closure is approximately five minutes.

Part 2: Modeling Addition Within 20 Using Ten-Frames

Part 2 includes one, session that may take multiple days.

Session 2

The Session 2 activity was adapted from a lesson in Marilyn Burns' (2008) *Do the Math Number Core* book and emphasizes patterns in addends and decomposition.

Introduction. Use a ten-frame to model 8 + 7. Show 8 red counters and then use 2 yellow counters to fill in the ten-frame. Place 5 more yellow counters under the ten-frame (Figure 4). Prompt students to write two number sentences representing the counters. Use questioning to help students generate number sentences and record several student responses.

Sample student response:

8 red and 2 yellow makes 10 plus 5 more yellows make 15.

So, 8 + 2 = 10 and 10 + 5 = 15

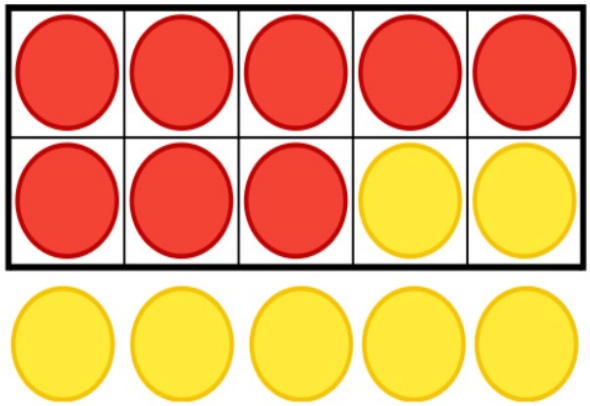

Figure 4. "Ten-frames and counters" with eight red counters and seven yellow counters. (Burns, 2008).

Other number sentences that students might notice are 8 + 7 = 15 and 8 + 2 + 5 (Figure 5). Discuss how decomposing 7 into 2 + 5 helped to make 10 which they can easily then add 10 + 5 to make 15. Compare this strategy to other strategies that students use to help them begin to see the benefits of decomposing numbers including efficiency and accuracy.

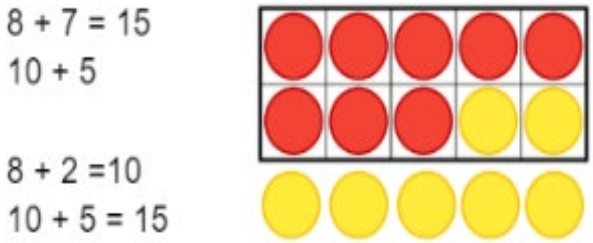

Figure 5. Other number sentences that students might notice.

Model for students the decisions that must be made when considering the addends in a problem. How can addends be decomposed to make the quantities easier to work with? Encouraging students to think about and articulate the steps they take to solve problems fosters the development of algorithmic thinking, a key component of CT.

Guide students to see that 8 + 7 = 15 and 10 + 5 equals 15. One number sentence is based on the colors of the counters (8 + 7 = 15) and the other represents counters inside and outside of the ten-frame (10 + 5 = 15). The latter lays the foundation for

understanding patterns in teen numbers composed of a ten and some ones.

Dice Game. Following this introduction, provide students with custom dice designed to more frequently yield sums up to 20. Students will take turns rolling the dice and represent the resulting quantities using red and yellow counters on ten-frames using decomposition to make ten. They will then write two corresponding number sentences that match their representations. To support language development and reinforce key concepts, provide sentence frames, to allow students to practice articulating their representations using both computational thinking and mathematical vocabulary (Figure 6). This hands-on activity aims to enhance students' understanding of CT skills, number relationships, and promote active engagement in learning.

Sample Sentence Frames

My ten frame represents 8 + 7

To show 8 + 7 on my ten frame I used ____ red counters and need ____ more to complete the ten frame.

I can decompose or break apart ____ to fill my ten frame and put the remaining ____ counters under the ten frame.

Now I see that ____ + ____ = ____ and ____ + ____ = ____.

Figure 6. "Sample Sentence Frames" by Rosalind Ali is licensed under CC BY 4.0.

Part 3 - Video Content Creation

Part 3 includes Sessions 3 through 8. Each session will take a minimum of 20 minutes.

Session 3

The purpose of Session 3 is to tap into students' prior knowledge about YouTube videos. Start by asking them to share their experiences of learning something from a video. Spend about 10 minutes letting students talk about how they've used videos, which platforms they prefer, and a time when a video helped them learn something new. Select a video to demonstrate the typical format of video content. Highlight how its style and format relate to writing: start with an attention grabber, use clear and concise language for the target audience, and conclude with a call to action.

Explain to students that their task is to create a video for a hypothetical YouTube channel aimed at teaching other students how to use ten-frames for addition within 20. Allow students time to brainstorm considerations for creating video content and to select an addition problem for their instructional video. To wrap up this session, summarize progress and set goals for the next session.

Session 4

During Session 4, introduce Chat GPT (or some other generative AI platform) and discuss how it can be used as a tool for learning and boosting creativity. Students will begin developing their script for the video. In developing the script, students will utilize the Chat GPT Generated Openers and Script Text to create opening and closing lines for their script and develop additional script content. Print the opening and closing statements on different colored paper and cut into strips. This helps students manipulate the sentences as they consider remixing text from the AI generated sentences, merged with their own ideas, to begin creating their video scripts. Students recorded their work in a google doc which facilitated collaboration, editing, and timely feedback. By the end of this session, each pair should have created text for the beginning of their video. Facilitate this session as many times as needed until the script for the beginning of the video is created.

Session 5

Before Session 5, the teacher should review students' scripts to provide timely feedback before they continue creating their scripts and practicing with ten-frames and counters to model their chosen addition problem. Encourage students to create concise step-by-step directions for their video. Support the use of CT language and content-specific vocabulary by providing a list of essential terms to be incorporated into their video scripts. Include words

such as decompose, pattern, or sum. At the end of this session, students will turn in a completed draft script. If scripts are hand-written, it is suggested that they are typed before Session 6 to prepare for a read-through and editing.

Session 6

Session 6 focuses on ensuring the scripts include appropriate, correct math and computational thinking vocabulary, as well as clear, concise, and age-appropriate language.

The read-through and editing process can be conducted either with the entire group or with pairs of students, depending on what works best for the class dynamic. To minimize distractions, consider working with each pair individually in pull-out form, instead of gathering the entire group at once. If needed, this session can be spread over multiple days to ensure quality review and engagement.

Session 7

In Session 7, students practice recording their videos. Before they arrive, set up an area for recording in the classroom. Use self-adhesive chart paper to create cue cards to help students remember the lines from their scripts. Use stacks of plastic containers on tables or whatever is available in your space to hang the chart paper at eye-level for students to read, if needed. These practice sessions help students get comfortable being recorded, reading from cue cards (chart paper), timing, speaking clearly, and using the whiteboard and manipulatives to model addition with ten-frames. Students record, watch their recording, discuss adjustments, and then record again, repeating this cycle several times.

Session 8

In Session 8, students recorded their videos (Figure 7). Rather than meet with the entire group, meet with student pairs individually to record their videos and eliminate possible distractions from others in the room. Afterwards, upload the videos and share the links with other teachers to use with their students.

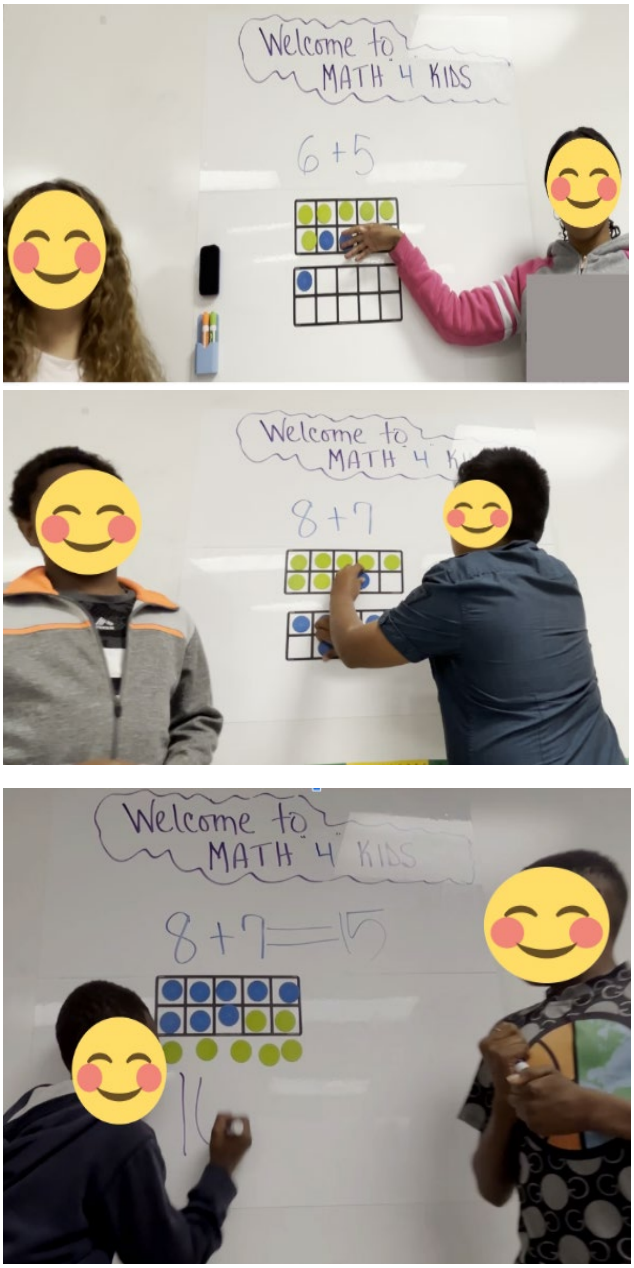

Figure 7. Students recording their videos. Photos by Rosalind Ali. CC BY 4.0.

Assessment

Various tools and strategies can be used for students to demonstrate their understanding. Facilitating reflective conversations with each student pair allows students to analyze and critique their work while reflecting on the learning process. These discussions give students the opportunity to demonstrate their grasp of the learning objectives

and explore how CT concepts connect to problem-solving. Number sense routines, such as Desmos Classroom (n.d.) *What Sum Do You See?* (Figure 8) or Steve Wyborney's (2023) *Mystery Number*, encourage rich mathematical discourse and provide valuable data for assessing progress toward proficiency in standards.

Throughout the project, taking anecdotal notes, observing, and listening to students as they use decomposition, identify patterns, and apply CT concepts can offer important insights into their learning. Additionally, documenting students' progress in using strategies (e.g., "make ten" to solve addition problems within 20) during subsequent Tier 3 intervention activities can provide further opportunities for them to demonstrate proficiency in standards related to this project.

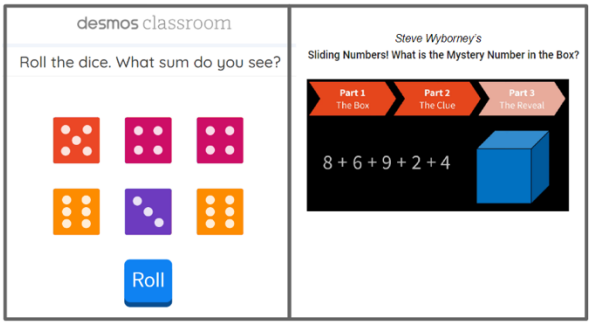

Figure 8. Image of Desmos Classroom (n.d.).

Critical Reflection

This was my first time implementing this lesson with a 5th grade math intervention group. It has been a few years since I led intervention groups, so I was excited to take on this role. Since starting as an interventionist this year, I've seen many discussions on social media highlighting the struggles of addressing unprecedented gaps in foundational math skills, largely due to disruptions caused by the pandemic. The abrupt shift to virtual learning and the gradual return to in-person classes created significant inconsistencies in students' learning experiences.

For my 5th graders, the data revealed they were missing foundational concepts typically mastered in first grade. To engage them effectively, I knew I couldn't simply present the curriculum as-is; it would likely lead to resistance from these pre-teens. Over the years, I've learned strategies that capture students' interest without making them feel embarrassed. Many students feel self-conscious about their skills, particularly if they've been labeled as "low." At this age, peer relationships and social-emotional development are critical, so I wanted to create lessons that respected their dignity while showing them the relevance of concepts they consider "stuff for little kids".

Despite knowing traditional algorithms, many students lacked a strong understanding of place value and the ability to analyze numbers for more efficient strategies. This math intervention lesson focused on helping them develop skills in decomposing numbers and using non-count-by-one strategies to find sums within 20. My goal was to guide them toward flexibility and proficiency in these strategies while preserving their self-esteem and building their confidence as mathematicians.

Recently, the leadership in my school district issued new guidance on promoting four key areas of CT in elementary math. They emphasized the importance of blending CT with mathematical discussions to enhance number sense and problem-solving skills. This math objective in this lesson, grounded in foundational number sense, was a perfect fit to introduce and develop CT concepts. After exploring different creative ideas for integrating computational thinking and mathematics, I decided students would become content creators.

The number progression curriculum in my district includes the use of ten-frames, number tracks, and number lines to build number sense and model addition and subtraction. I told the intervention students that our first graders are learning to use ten-frames and number lines to add within 20, and their help is needed to create instructional videos because sometimes we learn better from each other. They all recalled instances where a classmate helped them solve a problem or learn something, both inside and

outside of school. One student shared a memory of learning something new on the playground from another student.

Every student could recall a time when they watched a video to learn something new, whether it was about a video game, a hairstyle, dribbling a basketball, or putting together an outfit. One student mentioned her sister making hairstyling videos to advertise her cosmetology services and another talked about a cousin who was inspired by social media videos to create her own instructional videos on her favorite hobby. I could tell the students were getting excited about becoming content creators and creating videos to model addition problems for first graders. Initially, I planned for intervention students to create videos using ten-frames, number tracks, and open number lines, but we could not finish before the school year ended. Instead, they chose a representation and kept each video under 2 minutes. Our initial conversation sparked many questions from the students, and I assured them that in the following sessions, they'd have time to create scripts, rehearse, and record their videos.

I used ChatGPT to generate phrases and sentences to spark ideas for opening and closing sentences for their scripts (see Chat GPT Generated Openers and Script Text). I printed them on different colored paper—green for openings and blue for closings—and cut them into strips so students could easily piece together their presentations with their partners. They quickly began remixing some of the text and adding their own ideas to hook viewers and consider important details needed to best communicate their message. Once students created opening sentences, they were asked to talk through steps they were taking to find the sum using ten-frames. Vocabulary related to CT to reinforce ideas of pattern recognition and decomposition was included in AI-generated sentence stems available to students to help them articulate their processes.

To rehearse and record the videos, I worked with student pairs individually for 15-20 minutes. This multi-day process created many opportunities to highlight CT concepts. Students wanted to memorize their scripts, and when someone forgot a line or spoke out of turn, they had to analyze the order of their presentation and debug the sequence of statements to ensure their steps were logical. Multiple recording attempts were needed before the final video, giving students ample opportunity for meaningful practice applying their strategies to find sums within 20.

Occasionally, I asked students to use different addends to observe their ability to transfer and generalize their process using different numbers. This approach was effective, as students were often reluctant to speak in front of the entire group but more willing to articulate their thoughts individually. Considering social dynamics like personalities, maturity, and the ability to give and receive constructive criticism is crucial to fostering an environment where risk-taking and mistakes are encouraged without judgment.

My initial plan was to record ten-frame videos before spring break and then create videos modeling the use of number tracks and number lines after spring break. However, I underestimated the time students needed to prepare their videos and didn't account for interruptions in intervention sessions due to preparations for state-mandated standardized tests. Next time, I'll make sure we have enough time to create more videos with options to use number tracks or number lines for addition and subtraction. I will be sure intervention students have an opportunity to review the work of their peers and offer constructive feedback.

Due to the students' age, the videos were only posted on our school's internal Google Drive. However, I demonstrated how to post videos on YouTube and create a channel. While too young for social media accounts, the students were familiar with platforms and had many questions. I aimed to give them a complete view of the content creation process with connections to CT concepts. I hope they continue this work in middle school, at home, and be able to transfer and apply these skills CT concepts in real-world situations.

Progress monitoring focused on observing students' use of CT concepts and their ability to accurately model addition. Instead of traditional assessments, I kept anecdotal notes documenting their mathematical thinking, behaviors, and mastery of decomposition strategies, particularly the "make ten" method. Evidence of achieving our goals included active participation in number sense routines and comments like, "I can decompose 6 to make a ten" or "I can break apart the second addend to get to 10 and then add the rest." Other evidence of understanding was displayed as students noticed patterns in relationships between number sentences. The Desmos Classroom (n.d.) and Wyborney (2023) digital activities were engaging for students and ideal for facilitating rich, student-to-student discourse to demonstrate learning.

Looking ahead, I plan to introduce this lesson earlier in the school year and utilize CT lesson planning resources from CT4edu (n.d.) to better identify moments where computational thinking can be naturally incorporated into the lesson.

I recognize the critical value of student reflection time. Moving forward, I will allocate sufficient time at the end of each lesson for students to reflect on their learning. This will enhance their understanding of computational thinking skills and their application to everyday problem-solving scenarios.

In conclusion, here are a few key considerations for future implementations of this lesson:

1. **Age-Appropriate Introduction to AI**: Tailor discussions on AI to the students' level and in accordance with district AI policies. Decide if students will directly engage with AI (e.g., crafting prompts) or if AI will remain a behind-the-scenes tool used solely for lesson preparation.
2. **Creative Use of AI-Generated Content**: Explain to students advancing to middle school how AI-generated text can serve as inspiration for their own creative work, particularly in script design.
3. **Manipulatives and Concept Progression**: Engage students with manipulatives to connect AI-supported activities to math concepts.
4. **Incorporation of CT Language**: Emphasize CT concepts like pattern recognition and number decomposition, helping students to connect CT vocabulary to lesson activities.
5. **Consideration of Social and Emotional Factors**: Assess students' comfort with partner work, video recording, presentations, and other collaborative activities to foster a supportive learning environment.

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About the Author

Rosalind Ali, a veteran mathematics educator, recently completed her doctoral studies in Educational Technology at Central Michigan University. Her professional background encompasses roles as a computer scientist, classroom teacher, mathematics resource specialist, math coach, and math interventionist. Dr. Ali's research focuses on enhancing pre-service teacher preparation for the integration of computational thinking into pedagogical practices. Her scholarly work investigates computational thinking attitudes and their practical applications in classroom and small group settings, with an emphasis on improving student engagement and parental involvement.

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Robotic Badges for Girl Scouts: Coding Exploration Integrated with Multimodal Literacy

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Overview

This three-day computer science (CS) robotics coding exploration targets three Girl Scouts (n.d.) Brownie (2nd/3rd grades) badges. For each badge, a 60-minute session follows the 5E instructional model, which incorporates various robots to provide learners with diverse coding experiences. Throughout the coding exploration, learners engaged with real-life robot applications and used different robots to complete coding challenges. This learning exploration concluded by having learners complete at least one robot coding challenge per session, tailored to their capability, and utilize their expressive language skills to describe and explain their designed artifacts, algorithms, and block-based codes. This coding exploration can be extended to support broader elementary-level CS instruction.

Topics: Coding, Girl Scouts, K12 CS, Multimodal Literacy, Robots

Time: One hour per session, three sessions total

Materials

- LCD projector
- Masking tape in multiple colors
- Plastic cups
- Educational robots: Cubelets, BeeBots, Dash Robots (or other robots with similar functionality)
- Ipads with Internet access
- Paper and pencils
- Girl Scouts robotic badges slides: Day 1, Day 2, and Day 3 (Guo, n.d.-b, n.d.-c, n.d.-d)
- Learning Website: Think Like a Programmer (Guo, n.d.-f)

Context-at-a-Glance

Setting
An informal learning experience for Girl Scouts Brownies in a rural area of the northwestern U.S., supporting three robotics badges.

Modality
In person

Class Structure
10-12 girls were divided into small groups (3-4 girls)

Organizational Norms
Providing more computer science (CS) access, raising awareness of CS significance, and developing knowledge of CS and computational thinking through diverse coding experiences for girls.

Learner Characteristics
Girl Scouts Brownies (2nd/3rd graders)

Instructor Characteristics
The instructors were the CS education and literacy faculty; the teaching assistants were Ph.D. students and preservice teachers.

Development Rationale
This coding exploration aimed to develop students' language literacy, technology literacy, CS knowledge, and coding skills through hands-on robotic activities. The collaboration with local Girl Scouts broadened CS access in a larger community, particularly by increasing girls' participation. The goal is to attract more students' interest in CS and open a discussion about involving local communities in CS education.

Design Framework
5E Model of Instruction

Setup

The instructors need to pre-charge the robots and iPads, install and test the robot-related apps on the iPads, and set the pre-designed maps on the floor with masking tape before each session. The learning environment should include a projector for information presentation, tables and chairs for Cubelets activity, an indoor flat field/space for students' unplugged activities, and a flat field/space for educational robot (e.g., BeeBots and Dash Robots) movements. The Learning Website (Guo, n.d.-f) should be reviewed prior to each session. The instructors should estimate 30 minutes for this preparation, other than charging the robots and devices.

Standards

Idaho K12 Content Standards for Computer Science (n.d.):

- 3-5.D.02 Identify, using accurate terminology, simple hardware and software problems, and apply strategies for solving these problems (Grades K-5).
- 3-5.AP.02 Construct and test problem solutions using a block-based visual programming language, both independently and collaboratively (Grades K-5).
- 3-5.AP.05 Understand, explain, and debug the sequencing in an algorithm (Grades 3-5).

Idaho K12 Content Standards for English Language Arts/Literacy (Idaho State Department of Education, 2022):

- 2. ODC-2. Recount or describe key ideas or details from a text read aloud or information presented orally or through other media.
- 3. ODC-4. Report orally on a topic, tell a story, or recount an experience with appropriate facts and relevant, descriptive details, speaking clearly at an understandable pace.

Context and Setting

This three-day coding exploration aimed to provide young girls in a rural area in the northwestern U.S. with early exposure to Computer Science (CS). These sessions supported young girls in exploring their interests in the CS field, developing their technology literacy, and experiencing various robots via hands-on coding activities. Primary CS knowledge was optional for participation in the lesson.

This lesson was developed for Girl Scouts Brownies (2nd/3rd graders) as a three-day informal learning experience. This lesson included three sessions that matched with three Girl Scouts (n.d.) Robotics badges:

1. Designing Robots
2. Showcasing Robots
3. Programming Robots

Each session was 60 minutes long and hosted a maximum of 10-12 girls in one troop. This three-day coding exploration was delivered to two Girl Scouts Troops face-to-face at the university technology integration center, which housed various robots and plenty of CS teaching materials. This lesson employed three types of robots: Cubelets, BeeBots, and Dash Robots.

Since this three-day coding exploration was designed for these specific Girl Scouts Robotics badges, emphasizing robots and programming, the lesson designer purposely chose three standards from the state K12 content standards for CS (Algorithms and Programming). In addition to the CS standards, we adopted the English Language Arts/Literacy standards because New Literacy Studies (Gee, 2023; Sang, 2017) describe literacies as a multiplicity of practices that include engagement with multimodal texts. Taking this perspective allowed us to consider multimodal literacies in the CS coding context that invoked girls' awareness of literacy practices while coding robots. Girls were provided with opportunities to be consumers and inventors of these digital textual interactions during CS coding. Hence, in this lesson design, designers included three standards from the state K12 content standards for English Language Arts/Literacy (Oral and Digital Communications Strand) to encourage students' exploration of multimodal literacies and open up spaces for digital text reading and interpretation, self-expression, and oral presentation.

The three-day coding exploration was designed to follow the 5E Model of Instruction (Bybee, 2014), and each session included five phases: Engage, Explore,

Explain, Elaborate, and Evaluate, with each session emphasizing one of the five phases. For example, the Day 1 - Designing Robots session emphasized the Explain phase, encouraging the girls to describe their robots' design. The Day 2 - Showcasing Robots session emphasized the Explore phase, which provided the girls with opportunities to program the robots. The Day 3 - Think Like a Programmer session emphasized the Explore and Elaborate phases, which connected robot coding to real-life examples.

This three-day coding exploration involved lead instructors and teaching assistants to support content delivery. Before the sessions, all teaching assistants received a 30-minute workshop to familiarize themselves with the device usage, instructional activities, debugging strategies, and the possible errors students could make. The role of the lead instructors was to introduce the CS concepts and demonstrate the usage of robots, as well as to facilitate class discussion, hands-on practice, and learning debriefing. During each session, teaching assistants actively interacted with students to help with device usage, clear up concerns, debug the algorithm and programs, create inquiry plans, and answer the "in the moment" questions. After each session, all instructors and teaching assistants gathered to share critical reflections regarding the teaching processes. The instructors adjusted the instructional strategies based on the reflections for the following session and future teaching practices.

We employed various robots, such as modular robots (Cubelets), pre-built robots (BeeBots), and programmable robots (Dashes), that were available in our lab, to enrich and expand the students' coding experience. Since this lesson was specially designed for the Girl Scouts, we included female computer scientists and females in CS development on the learning website (Guo, n.d.-e, n.d.-f). The goal was to introduce CS to girls and encourage them to explore the CS field. Instructors had the flexibility to modify the content, session length, and room setup based on the size of the class, the space of the room, and the number of technical devices. The robots could be replaced by similar robots available to instructors.

Day 1 - Designing Robots

The Day 1 - Designing Robots session was a 60-minute lesson featuring Cubelets. Each of the 5E phases is provided with estimated timing for each phase. The Girl Scouts Robotic Badges - Day 1 slides (Guo, n.d.-b) will be needed for this lesson.

Engage (15 minutes)

First, lead a discussion on what computers, computer science, and computer scientists are using the prompts from the Learning Website, Intro to CS/CT page (Guo, n.d.-e). Then, let the girls imagine what a computer scientist looks like and have them draw a computer scientist avatar using the Avatar Maker (n.d.), sharing their art with each other once completed. Discuss the similarities and differences in their avatars. Next, the instructor introduces the famous female computer scientists in history (e.g., Ada Lovelace and Grace Hopper; see details in Girl Scouts Robotic Badges - Day 1 slides).

Ask the girls about their robots' experiences and allow them to describe their experiences with various robots and multiple contexts. Brainstorm with the girls about what they want the robots to do. Use the following questions as a guide to this discussion:

- Have you experienced any robots?
- What can these robots do?
- How do the robots function?
- What do robots mean to you?
- If you can design/create a robot, what do you want it to do?

Introduce the Cubelets (Modular Robotics, n.d.-a) to the girls and clarify that each functional robot needs to include at least one input module, one processing module, and one output module (review the Introduction to Cubelets guide; Modular Robotics, n.d.-c). Separate the girls into smaller groups, let them explore the different Cubelets modules, and challenge them to build robots.

Explore (25 minutes)

After playing around with and testing out the function of each Cubelets module, the girls should be able to combine Cubelets modules to build their functional robots with a free design. At this point, the teaching assistants challenge the girls to build three items: (a) a lighthouse, (b) a vehicle, and (c) an ambulance car, according to the girls' working pace (see Figure 1). These three challenge examples are selected because the design difficulty of these three prototypes gradually increases.

Figure 1. Girls are creating a Cubelets lighthouse.

During the process, the teaching assistants provide continuous guidance and feedback to support the girls in completing the challenges asking questions such as:

- What makes a lighthouse a lighthouse?
- What are the distinctive features of an ambulance?

In addition, the teaching assistants could ask constructive questions to encourage the girls to explain their robot design such as:

- Which cubes are necessary for the design?
- Which cube can be removed from the design but not impact the functions?
- What can this cube do?
- Why do you put this cube in here?

Beyond that, the teaching assistants should support the girls' debugging. For example, the Cubelets vehicle may not be going forward because the wheels are turning in different directions.

Explain (10 minutes)

Once the girls finalize their robots, the instructor invites each team to introduce their robots to the whole class, showcase their design and function, and explain how the robots work, how they were designed, and how they were debugged during the robot-building process (Idaho K-12 Content Standards for Computer Science, n.d.).

In this informal oral presentation, the girls demonstrate their understanding of the robots' design based on the knowledge from previous engagement and exploration and their creative interpretation of the robot building. Through this practice, the overall oral expression skills, including applying technology vocabularies, conversational skills, contextual clues, rationale clarification, and academic presentation language, are addressed using the context of robot building presentation (Idaho State Department of Education, 2022).

Elaborate (5 minutes)

While the girls showcase and introduce their robots, the instructor reinforces the terms they use, such as input, processing, output, sensor, etc. Additionally, these CS terms can be used in various contexts, such as input and output for a computer. Due to the girls' backgrounds, the context in which the CS terms are used can be generative. For example, the processing cube could be the CPU in a computer.

The instructor can also link the girls' artifacts to real-life products around them and reinforce the language in a real-world context. For example, self-driving cars use distance sensors to sense objects around them.

Evaluate (5 Minutes)

Since this is an informal learning context, the instructors and teaching assistants evaluate the girls' learning by facilitating class discussions, asking open-ended questions, and getting direct responses from the girls.

Day 2 Showcasing Robots

The Day 2 - Showcasing Robots session was a 60-minute lesson featuring BeeBots. Each of the 5E

phases is provided with estimated timing for each phase. The Girl Scouts Robotic Badges - Day 2 slides (Guo, n.d.-c) will be needed for this lesson. A BeeBots map taped on the floor needs to be completed prior to the lesson (see Figure 2). According to the number of students, the size of the map could be flexible. In this curriculum, the map was a 16 by 16 squared grid with a center hive (four-by-four grid), and the length of each squared grid's side was 15 centimeters.

Engage (10 minutes)

Building upon what the girls learned on Day 1, this session goes beyond fundamental Cubelets design and focuses on programming and coding BeeBots. To begin the Day 2 lesson, several questions were prepared that used child-friendly terms to activate the girls' prior knowledge of programming and coding:

- When I say programming/coding, what are the top three words in your mind? Why?
- What does a typical programmer/coder look like to you?
- What do you think programmers/coders can do?

After the girls' responses to the questions, start with an unplugged activity, "Code Friends to get the BeeBots," to engage them in preparing for the demonstration. In this game, pair the students up with one girl playing the robot and another playing the coder. Have the coder give step-by-step instructions to the robot to pick up an object off the floor. Remind the girls to give one step of instructions at a time. If there is time, have the girls switch roles.

Explore (25 minutes)

Introduce to the girls that an "algorithm" is a set of step-by-step instructions, and an algorithm describes how to perform a task (see Guo, n.d.-a). These steps are used to solve a problem or reach a result. Directly introducing the "algorithm" concept will facilitate the girls' holistic understanding of basic programming logic and prepare them for the exploration activities. After a brief safety demonstration for the BeeBots including not putting hands close to the wheels of the BeeBots, treating the BeeBots as friends, and watching the BeeBots move but not moving with

them (see Girl Scouts Robotic Badges – Day 2 slides), the instructor codes the BeeBots with the girls step-by-step using the BeeBots code cards.

Have the whole group observe and participate in the BeeBots operation collaboratively before they try it independently. For this lesson, there were enough BeeBots for each girl to use one. If you do not have a one-to-one match of BeeBots to learners, you can match students in pairs or small groups. The instructor should pass out or place the BeeBots in different places of the room for the independent use and introduce the guidelines for independent exploration:

1. Think about the goal: What do you need to do?
2. Step-by-step instructions: Write down all the steps.
3. Test the codes: Run the BeeBots.

Using the guidelines, the girls practice identifying the moving distance, programming with cards, writing codes on paper, and testing the codes. The practice is conducted on a big BeeBots map on the floor (Figure 2), previously set up by the instructor(s). After a few minutes of free exploration, as the girls feel comfortable using the BeeBots, the instructor starts to challenge the groups by putting barriers on the map and encouraging the girls to code the robots to reach the center area by moving around the barriers. For this session, plastic cups were used as barriers (Figure 2). The girls are encouraged to write down their codes for the challenges and test them individually.

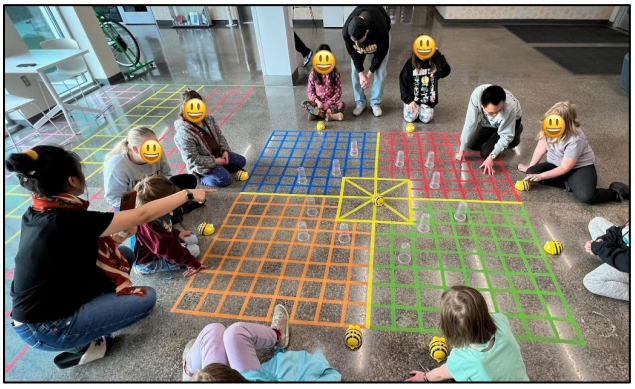

Figure 2. Girls are coding BeeBots and playing the "Hive Challenge" on the map.

Instructors and assistants give ongoing guidance and advice to the girls who struggle with coding. As soon as the individual exploration is completed, the instructor expands the challenge and endeavors a "Hive Challenge." Every girl selects their starting point on the map and codes their BeeBots to reach the Hive Mark at the center of the map with the shortest

algorithm. They can play the "Hive Challenge" multiple times if time allows.

Explain (15 minutes)

During the BeeBots challenge, the girls frequently use coding language to articulate their BeeBots exploration. The coding terms include algorithm, debugging, and turning right and left. When the girls explain, instructors and assistants employ questioning strategies to encourage their detailed expression. For instance, invite learners to describe the design processes of their routes with differentiated selections of starting points and levels of challenges. Girls' descriptive reasoning of the approaches and sequences of operating BeeBots demonstrate their ability to explicitly indicate selections, solutions, and rationales of BeeBots programming, which are aligned with the state content standards.

Elaborate (5 minutes)

The elaboration of BeeBots exploration manifests itself in three significant aspects. First, ask the girls to repeatedly elaborate on the BeeBots' operations using coding terms during the process (see Guo, n.d.-f). Second, encourage them to demonstrate their flexibility in problem-solving. As observed in the BeeBots challenge, the girls used multiple approaches to problem-solving and did not necessarily follow the pre-planned paths throughout. For example, one girl separated the whole moving path into several segments and coded these segments one by one. Third, train the girls' higher-order thinking skills by asking them to elaborate on the advantages and disadvantages of using BeeBots compared to Cubelets.

Evaluate (5 Minutes)

We recommend using a variety of informal ways, including norm-referenced and criterion-referenced evaluations, to assess the girls' BeeBot learning outcomes. The informal assessments help instructors pinpoint the girls' progress and locate areas where they may need more support for upcoming sessions. The following are examples of assessments we propose using in this Day 2 session.

- Observations of the girls' engagements
- Oral presentations and explanations of coding processes
- Results of completed BeeBots challenges
- Interaction and discussion during activities
- Girls' self-evaluation of BeeBots route designs and challenge completion

Day 3 Programming Robots

The Day 3 - Programming Robots session was a 60-minute lesson featuring Dash Robots. Each of the 5E phases is provided with estimated timing for each phase. The Girl Scouts Robotic Badges – Day 3 slides (Guo, n.d.-d) will be needed for this lesson. A coding map taped on the floor needs to be completed prior to the lesson (see Figure 4). Depending on the teaching space, the size of the coding map could be flexible. In this curriculum, each Dash robot ran on a two-by-ten squared grid map, and the length of each squared grid's side was 30 centimeters.

Engage (10 minutes)

In order to build the connection between robots and real-life examples, we use a local food delivery robot system (Starship, n.d.) to show the girls how robots are used in their daily lives. The instructor orders bottles of water on the app with the girls together as the first thing in this session and uses the delivery waiting time to introduce the Dash Robots.

While waiting for the delivery in the classroom, the instructor introduces the Dash Robots, explains how to drive them for movement in the Go App (Wonder Workshop, n.d.), and provides safety guidance (see the Girl Scouts Robotic Badges – Day 3 slides). The Go App is an application that requires no coding and supports the movement of a Dash Robot through a joystick and buttons. At this moment, the girls experience driving the Dash Robots using the Go App.

When the delivery is getting close, the instructor and teaching assistants pause the Dash Robot introduction and take all the girls outside to watch how the robot is arriving at the delivery spot. The instructors and teaching assistants ask the girls constructive questions and discuss with the girls, such as:

- Why does the robot stop when a person is in front of it?

- How does the robot cross the intersection?
- How does the robot read the traffic lights?
- How do we ensure that only the buyer can open the robots to get the order?

Once the delivery robot arrives, allow the girls to explore the robot and observe how it delivers the water (Figure 3).

Figure 3. Girls are experiencing the Starship food delivery robots.

After getting the delivery from the Starship (n.d.) Robots, the instructor brings the girls back to the classroom and discusses using robots to deliver food based on what they observed earlier:

- We can use iPads to drive the Dash Robots, but who drives the Starship delivery robots?
- Who controls the Starship delivery robots?
- How to control multiple Starship delivery robots at the same time?
- Who else is involved in this progress, from ordering to receiving the products?
- What is the programmers' role in this progress?

EXPLORE (30 MINUTES)

Let the girls compare the driving experiences of Robots with the Starship (n.d.) delivery experiences and emphasize that moving the robots is not good enough; moving the robots accurately and safely is more important in the real-life world. Then, introduce the Blocky App (Wonder Workshop, n.d.) and use block-based coding to move the robots controllably and accurately.

The instructor allows the girls to explore and become familiar with the robots and also control the robots via the Blocky App (Wonder Workshop, n.d.). Then, the instructor clarifies the numbers and distance settings in the Blocky App and explains the inch-to-centimeter conversion to the girls if necessary. The instructor and teaching assistants take the girls to the coding map, which was pre-designed and taped to the floor, and challenge the girls to deliver Lego pieces with Dash Robots in multiple ways: (a) deliver Legos to the endpoint, (b) deliver Legos to a selected location, and (c) deliver the Legos to a selected location and back to the start point. Teaching assistants can put obstacles, such as cups or cones, on the map to challenge the girls based on their capabilities (Figure 4).

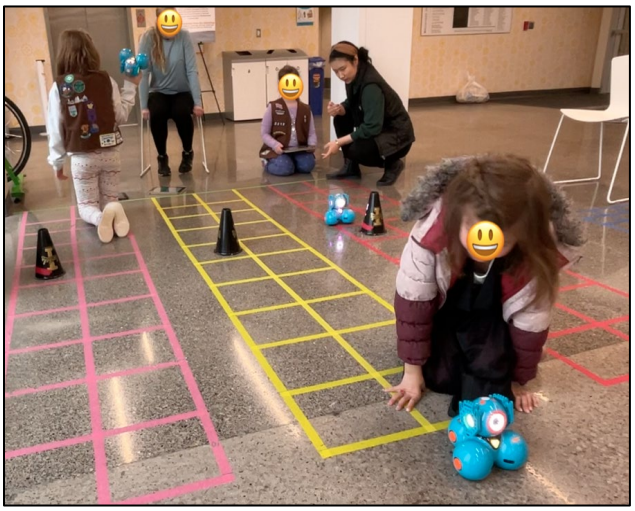

Figure 4. Girls are coding Dash Robots to avoid obstacles.

The teaching assistants should continuously guide and support the girls in completing the challenges during the process. For example, the teaching assistants could conduct a shared reading with the girls to read aloud the textual blocks on the app to consolidate the terms to code a Dash Robot. This quick reading activity also examines girls' responses, interactions, and creations of digital texts before they use the digital texts as a tool to code their Dash Robots. Also, the teaching assistants should help the girls debug during their coding exploration.

Meanwhile, we encourage the teaching assistants to have constructive conversations with the girls about how to make the codes more efficient and effective. For example, if multiple "move-forward" blocks are used, consider using a "repeat" block with numbers and one "move-forward" block together.

It is also valuable to inspire the girls to try out the other coding options in Dash Robots, such as the lights, the colors of the light, and the sounds. In addition, Dash Robots have a function that allows users to record their voices to customize the robots. Considering the possibilities of exploring the multiple coding options using the abundant vocabulary on the app, it is essential to discuss the girls' multimodal literacy engagement and creation. In that context, the girls verbally, textually, and auditorily author their multimodal literacy interactions in Dash Robots play and see themselves as influential programmers. Implementing multimodal literacies would also provide girls opportunities to use multiple sources, such as the information on the Blocky App, guidelines, and other supportive materials to navigate solutions or find answers to the challenges and inquiries they encounter.

Explain (5 minutes)

During the exploration, the girls are encouraged to showcase how the Dash Robots completed the challenges, describe what blocks they used in the codes, and explain the function of their codes to the teaching assistants and instructors while completing the challenges. In the showcase, the girls expand their robot sponsorship to incorporate detailed illustrations of code planning and path designs that are used, expressed, and embodied in the Dash Robots coding exploration. Besides, encouraging the girls to articulate their coding experiences also increases opportunities for them to be owners and creators of technological material.

Elaborate (10 minutes)

The instructor brings all the girls back for a discussion, focusing on real-life robots, such as sweeping and food delivery robots in restaurants. What can robots do, and what can they not do? What are the advantages and disadvantages of using robots in our lives? When designing a robot, what do you want it to do?

If the girls have new questions, the instructors can contextually explain them. For instance, during the discussion, the girls asked about differentiating robots, artificial intelligence (AI), search engines (SE), and virtual assistants (VA), and the instructor also explained how programming matters in these implementations.

Evaluate (5 Minutes)

In this informal learning context, the instructors and teaching assistants evaluate the girls' learning by facilitating class discussions, asking open-ended questions, getting direct responses from the girls, and assisting them in completing the coding challenges.

Critical Reflection

This CS robotic coding exploration was implemented with 20 students from two Girl Scouts Brownies in the aforementioned classroom setting. Both implementations incorporated minor changes due to the girls' various knowledge backgrounds. We aligned the activities of each session with the state's content standards (Idaho K-12 Content Standards for Computer Science, n.d.; Idaho State Department of Education, 2022). For instance, the Cubelets Building activity on Day 1 (Designing Robots) focused on the CS standards 3-5.CS.02 and 3-5.AP.05, as well as the Language standards 2. ODC-2 and 3. ODC-4. The BeeBots Moving activity on Day 2 (Showcasing Robots) focused on CS standard 3-5.AP.05 and Language standards 2. ODC-2 and 3. ODC-4. The Dash Robots Driving activity on Day 3 (Programming Robots) focused on the CS standards 3-5.AP.02 and 3-5.AP.05 and the Language standards 2. ODC-2 and 3. ODC-4.

To expand CS access, we utilized a variety of robots (modular, pre-built, and programmable robots) in this exploration. We also provided multiple teaching assistants for timely feedback and sufficient support. The girls in both troops enjoyed exploring the different robots over the three days. We received exceptionally positive feedback from the Girl Scouts troop leaders, who noted that the level of engagement exceeded their expectations. This dynamic exploration, coupled with the design of creative artifacts, directly bridged real-life robot examples with CS concepts and coding. When

parents and guardians picked up their children each day, we received many comments and inquiries about the different robots, coding language, and CS learning resources. The girls and the families in our community were more aware of the significance of learning CS, robotics, and coding since they observed the girls talking about their experiences and showcasing their artifacts.

In terms of developing students' CS knowledge and language skills, we observed that the girls demonstrated increased interest in applying CS concepts. For example, on Day 3, the girls challenged each other by moving the obstacles and coding Dash Robots for their designed paths instead of simply completing the given challenges. Regarding enhancing their language skills, the girls viewed multimodal literacies as tools to author their CS coding practice. For instance, they read and interpreted guidelines/questions on the daily slides, sought digital information on the Dash app to solve challenging coding problems, and adopted writing strategies to plan paths for the BeeBots movements. In addition, the girls began using more expressive language and coding terms while responding to the instructors' questions and describing their coding designs. Particularly on the final day, the instructors and teaching assistants noted that the girls used more coding terms as expressive information and eloquent knowledge for articulations.

The activities of each session required the girls to continuously participate over the three-day exploration, following a specific sequence that gradually increased in difficulty. Although the girls had fun with the robots and grasped the basic CS concepts during the exploration, we had one emotional breakdown on Day 2. A girl cried because the challenge was too hard for her to complete. It was an unforeseen circumstance for one of the teaching assistants, who was a junior undergraduate student in a teacher education program. The Girl Scouts troop leaders and instructors intervened immediately, and that girl showed persistence in finishing the rest of the coding challenges. For future practice, we would ensure the teaching assistants receive training about emotional support in coding persistence. Also, to ensure full participation in all activities and to improve classroom management, we would use timers to secure equitable robot access for each student during group collaborations in the Cubelet activity. We also recommend that instructors include teaching assistants or practicum interns to help with robotic debugging, coding, and problem-solving.

The overall design of this exploration manifested an interplay of students' CS coding and multimodal literacy practices. For further adoptions and implementations, however, based on the content/topic of coding projects, instructors could integrate extended multimodal literacy practices (e.g., reading, interpreting, responding to, interacting with, and creating technological and digital texts) before, during, and after the coding activities (Walsh, 2010, as cited in Hines, 2014). As such, this exploration created a cross-disciplinary engagement between computer science learning and multimodal literacy practices, highlighting the role of expression, innovation, and analytical skills in both content areas.

This three-day dynamic robotic exploration, including artifact creation and coding development, was purposely designed for the Girl Scouts Brownies (2nd/3rd graders). However, we selected the state CS standards that can be integrated into K-5 grade bands. In terms of integrating multimodal literacies into CS, instructors could customize the English language arts/literacy standards related to the oral and digital communication (ODC) strand to match the students' grade level. Regarding the unisex content, although the exploration was initially created for young girls, the instructor could modify the gender-related content and introduce the content more inclusively, such as "CS is for everyone" in regular classrooms.

The limitation of this exploration is the heavy reliance on specific robots (e.g., Cubelets) and services (e.g., Starship Delivery), which may not be accessible to all instructors. We suggest the instructors utilize their available modular, pre-built, and programmable robots and play robotic delivery videos as examples if there is no access to robot delivery. Each day's activities and challenges could be used separately in any informal CS learning scenarios (e.g., STEM night, Robots Day) or supplements for CS events (e.g., summer camp activities) at the elementary level based on students' prior CS knowledge and skills.

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Using Discussion Boards to Teach CSS and Improve Canvas Course Layouts

Craig E. Shepherd, Andrea F. Hall, and Maxine D. Evans, University of Memphis

Overview

In this three-week lesson, situated in a five-week, shortened summer course, instructional design graduate students learn basic cascading stylesheet (CSS) skills to facilitate page layouts within learning management systems. During Week 1, basic HTML tags (e.g., heading levels, lists, paragraphs, images, divider, span, link tags) and tag attributes, including style (used for inline CSS in Canvas), are introduced. In Week 2, learners are introduced to CSS attributes: background color, font color, borders, margins, and padding. During Week 3, they learn about block position, float, clear, and z-index. Throughout the three weeks, learners leverage low-stakes discussion boards to share ideas and refine skills.

Topics: Coding, CSS, Higher Education, HTML, Learning Management System, Online Learning, Page Layout, Web Design

Time: Approximately one hour a week for three-weeks of content

Materials

- Internet-enabled computer for each student
- Access to Canvas or another learning management system (LMS)
- Learning materials in an exported course shell (A Canvas imscc file that is compatible with many other LMSs)
- HTML Intro video (erschelshep, 2022a)
- HTML Attributes video (erschelshep, 2022c)
- CSS Intro video (erschelshep, 2022b)
- CSS positioning video (erschelsheph, 2022d)
- Canvas HTML Editor Allowlist (Instructure, 2021)

Context-at-a-Glance

Setting
This course is for instructional design graduate students in an urban, Southeastern, public university in the United States.

Modality
Asynchronous online

Class Structure
The five-week seminar course focuses on course structure and community development. It is delivered through Canvas, and students use free Canvas accounts to develop and share projects. Students are expected to login to the course daily.

Organizational Norms
The degree program is entirely online. This course is an elective for most learners, focusing on application of theory through curriculum development.

Learner Characteristics
All students were enrolled in an instructional design master's or doctoral program and came from business, PK-12, and higher education sectors. Some students had prior experience designing online courses. Few had prior HTML or CSS experience.

Instructor Characteristics
The instructor had moderate experience with web development and regularly used CSS to design course layouts in D2L Brightspace and Canvas LMSs.

Development Rationale
Many LMSs provide *What You See Is What You Get* (WYSIWYG) editors for basic design layouts. However, advanced layouts require basic knowledge of HTML and CSS. This training sought to introduce the basic knowledge of HTML and CSS to expand student abilities with webpage design.

Setup

Instruction took place in an LMS. The imscc file is an exported Canvas course that includes two modules: One regarding basic HTML and another regarding CSS (see Figure 1). Each module contains content videos, web resources, and discussion boards to complete instruction. Educators can use a free Canvas account (Instructure, n.d.-a) if they desire. Instructure (n.d.-b) provides guidance to import content into Canvas. However, this article also describes the resources used, if importing content into an LMS is not possible.

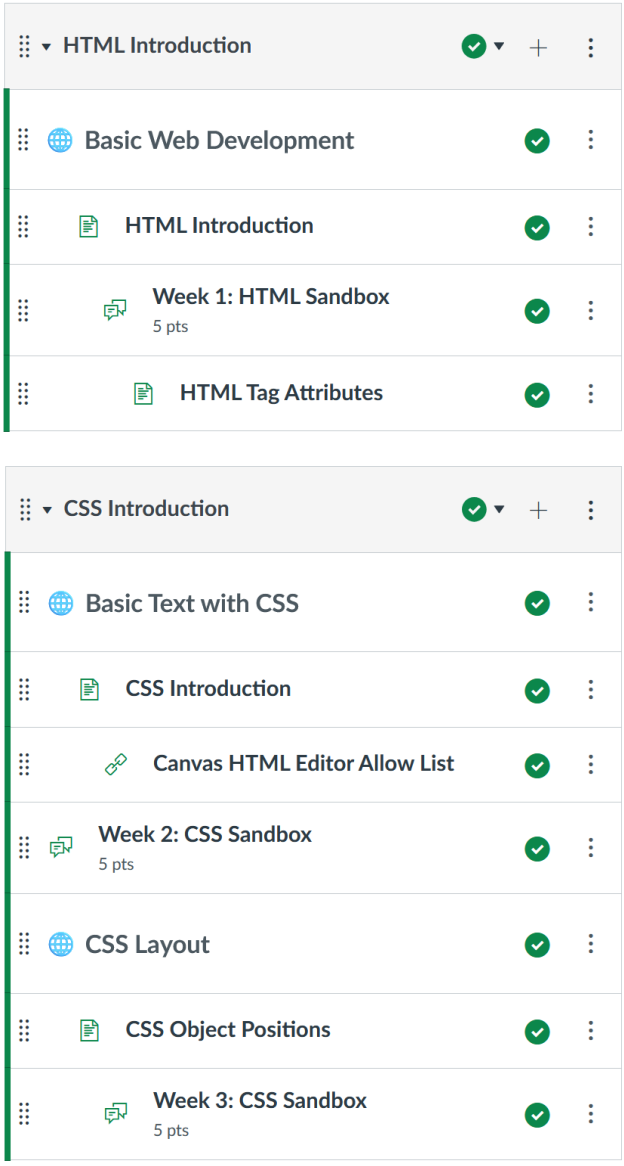

Figure 1. Module structure in Canvas

Learning Objectives

By the end of this three-week lesson, learners will be able to:

- Recognize how HTML tags function within a document.
- Add and remove block and inline HTML tags in Canvas discussion boards.
- Add and alter attributes of those tags in a Canvas discussion board.
- Recognize three ways that CSS elements can be added to a web document.
- Recognize the CSS elements allowed in Canvas.
- Use the style attribute to add CSS elements that influence text properties to discussion threads.
- Use the style attribute to add object placement CSS to HTML tags in Canvas discussion boards.

Context and Setting

In the early 2000s, the lead author taught basic HTML to preservice teachers as part of an introductory technology integration course. However, user-friendly online content creation tools have diminished this need (e.g., Google Sites, WordPress, Wix). Educators can publish basic websites using *What You See Is What You Get* (WYSIWYG) editors.

Learning management systems like Schoology and Canvas also use WYSIWYG editors for content creation. However, these editors have limited page layout functionality. Additionally, WYSIWYG editors sometimes scrambled HTML codes when users copy and paste text from word processing documents or make several color, font, and size adjustments. These scrambled HTML codes create awkward and unwanted formatting that can lead to frustration when users lack the HTML skills to correct the formatting problems.

Some LMSs like D2L Brightspace allow designers to quickly update page layouts with external style sheets. Changing course styles is as simple as updating the external style sheet. Others, like Canvas do not allow this access. CSS styles can be used but must be added to HTML tags within each page. CSS styles allow greater page layout customization but are more time consuming and a skill many people do not have.

Learner Characteristics

Alumni from an instructional design and technology master's degree program at a medium, urban, southeastern university in the United States indicated they wanted more design and development opportunities in the program. Based on this feedback, faculty members selected several courses to include additional design opportunities. The seminar in online learning, the course where this three-week lesson is housed, was one of these selected courses.

Results from a skills assessment survey completed at the beginning of the course indicated that most students were comfortable developing content in an LMS, though few students had used the Canvas platform. Additionally, fewer students expressed comfort navigating HTML or using CSS to format web documents. Based on course sequencing, most students completed this course after they took the introduction to instructional design, message design, and multimedia development courses. Thus, students had some background in design and development when taking this course.

Course Structure

Based on the skills assessment survey results, the lead author developed content to help students consider structure and community in online course development (Shepherd, 2022). Assignments tasked learners to modify or create online modules to better organize and communicate course expectations, align with established rubrics for quality online learning experiences, and reduce perceptions of transactional distance. Students also developed online content to promote community and foster a sense of belonging. Development activities occurred within free Canvas accounts. Students built course content and shared them with peers and their instructor for feedback.

The lead author also wanted to include HTML and CSS attributes, but the asynchronous seminar course was scheduled in a five-week, shortened summer semester. To learn HTML and CSS attributes, the lead author believed that learners would need practice over time to troubleshoot problems, better conceptualize principles, and gain confidence in their abilities. Yet, the author did not want to devote the entire course to CSS instruction. Rather, he focused on mini lessons, consisting of about one hour each week over three-weeks, to be included within modules devoted to broader course topics.

Development Rationale

Because Canvas already provided basic HTML commands to developers through WYSIWYG editors, the lead author speculated that learners only needed to familiarize themselves with those commands to begin learning CSS. The author also did not want to focus on web design principles like file management or HTML page structure (e.g., doctype, title, head, body tags) because Canvas handled these functions.

Web pages developed within Canvas provide an option for anyone to edit them. However, the lead author believed that having several learners examine and modify the same HTML document (even asynchronously) would result in frustration. If anyone maladjusted a tag, it might influence the rendering of others' work. Rather than rely on one page for all learners, the lead author desired a space where learners could explore page design principles in their own area and demonstrate ideas to the larger group for feedback. Discussion boards fit this desire.

Discussion boards leverage the WYSIWYG editor of other content pages. They also provide an HTML editor, allowing learners to examine and modify the underlying HTML and CSS tags. Posts in a discussion board are assigned (and labeled) to the content creator. They also provide editing rights to that creator and their instructor (providing opportunities for troubleshooting). Additionally, posts are viewable by other class members and threaded by topic. These features allow other learners to examine tag experimentations, reply to posts with feedback and ideas, and maintain the original post—capturing the evolution of the experience.

With these ideas, the lead author developed mini lessons regarding HTML and CSS during the first 3 weeks of the course. Four short videos (between six and 15 minutes) introduced concepts. Students practiced those concepts in discussion board sandboxes where they were graded solely on participation. This participatory activity allowed learners to primarily focus on other aspects of the course but still gain experience designing content with HTML and CSS. A final assignment leveraged CSS for page layout purposes.

Learning Representation

The five-week course was organized into five modules, one for each week. The first page of each module introduced module purposes, expected learning outcomes, readings and resources, and activities. Because these broader topics are not the focus of this article, they are not included. The HTML and CSS mini lessons were introduced within these larger modules. *During this lesson, italic text identifies the content or prompts provided to the learners.*

Week 1: Basic HTML Recognition

In the mini lesson during Week 1, learners were introduced to basic HTML coding using block and inline tags. They were encouraged to explore the presented content and ideas through participation-graded discussion boards. To situate the activity within the broader topic of online learning, learners were told that a basic understanding of HTML would help them grasp CSS, which would help them customize LMS page layouts. At the beginning of the Week 1 module, the following learning objectives were provided:

> *By the end of Week 1, you will be able to:*
>
> - *Recognize how HTML tags function within a document.*
> - *Add and remove block and inline HTML tags as well as attributes of those tags.*
> - *Add and alter attributes of those tags in a Canvas discussion board.*

Introduction to HTML Video

Learners then navigated to an introduction to HTML video (erschelsheph, 2022a) that included the following prompt:

> *This 9:20 minute video (feel free to speed-up playback) introduces the structure of an HTML document and introduces block and inline tags. It then shows you how to add tags to an HTML document (like a discussion post in Canvas). The content in this presentation is pretty basic. It distinguishes between block and inline tags. It also introduces heading, paragraph, division, unordered list, strong, line break, image, and span tags. All tags mentioned in this presentation (with the exception of division and span) are available in the WYSIWYG Canvas discussion thread editor. However, knowing how to read HTML tags is integral to understanding CSS attributes and how to use them.*
>
> *Take some time to play with HTML tags in the HTML Discussion thread this week. Feel free to begin by using the WYSIWYG editor to add headings, bold and italic text, and ordered and unordered lists.*
>
> *Afterwards, review the tags using the HTML editor </> button at the bottom-right of the discussion post. Look for the beginning and ending tags. Add additional content between those tags. Remove a tag and see what happens to your text.*

Week 1: HTML Sandbox Discussion

After learners reviewed the video, they were taken to a discussion board with the following prompt:

> *Use this space to practice writing HTML code. I realize the WYSIWYG editor will do a lot of this code for you. Begin there! Once you've added a few headings, paragraphs, lists, and bolded or italicized words, enter code view </> at the bottom-right of the editor and examine the tags. Then try to add additional content and tags manually in code-view. Becoming more familiar with HTML tags and how they appear will prepare you for CSS attributes that will be introduced later.*
>
> *As you play with the codes, reflect on the process in your discussion thread. What makes sense? What do you struggle with in terms of grasping HTML tags and attributes? Mess around with the HTML tags as you write your reflections. Next, try adding a few link and image tags. Begin using the WYSIWYG editor. Then try to alter the size of the image or change the URL by modifying the attributes in the tag.*
>
> ***Remember: You can embed inline tags within block tags, but you cannot embed block tags within inline tags!***

In addition to the prompt, the discussion board contained example block and inline tags (provided

below) with links to additional information from the W3schools (n.d.-a) website (see Support Materials; W3schools, n.d.-b to n.d.-l).

Block Tag Examples

- * paragraphs*
- * generic block container*
- *<h1> </h1> through <h6> </h6> headings*
- * ordered (numbered) lists*
- * unordered (bulleted) lists*
- * list items*

Inline Tag Examples

- * generic inline container*
- *<a> link*
- *<img /> image*
- * emphasis*
- *
 line break*

Learners spent a couple days adding HTML tags to discussion posts (either within the WYSIWYG editor or in the HTML editor) and then viewed the code to examine it. They also asked questions in the discussion board. The instructor posted ideas, provided feedback and suggestions, and encouraged learners to try new tags. Learners also supported each other by answering questions and troubleshooting problems.

HTML Attributes Video

After learners gained basic familiarity with block and inline tag appearances in the HTML editor, they watched an HTML Attributes video on modifying attributes within HTML tags (erschelsheph, 2022c). The video included the following text introduction:

> *Watch the HTML Intro Presentation and mess around with the Week 1: HTML Sandbox discussion thread before you watch this video.*
>
> *This 6:04 minute video continues the HTML introduction by discussing attributes that can be placed within HTML tags. Attributes describe particular features of a tag. They may be used to indicate the size of an image or the web address of a link. They are important for CSS because a special attribute called "style" can be used to create inline CSS formatting in Canvas. After watching this presentation, try to add and modify a few link and image tags in the HTML Sandbox discussion thread. Reflect on your experience. You do not need to experiment with the style attribute yet. We will begin covering that attribute next week.*

Experimentation with these attributes occurred within the Week 1: Html Sandbox Discussion (previously described). The goal was to familiarize learners with HTML tags and attributes and help learners recognize those tags and attributes in the HTML viewer. Gaining this awareness helped learners add CSS attributes to those tags during the second and third weeks of the course.

Week 2: CSS Introduction

During the second week, learners were informed about three ways that CSS elements could be added to web documents: inline, internal, and external. They were then informed that the course would focus on inline CSS because that was the only option allowed in Canvas. Next, learners were introduced to CSS elements that influence text properties and were provided with a resource that documented what CSS elements were allowed in Canvas. Finally, students practiced adding CSS elements to WYSIWYG generated HTML through another participation-graded discussion thread. At the beginning of the Week 2 module, the learning objectives were provided.

> *By the end of Week 2, you will be able to:*
>
> - *Recognize three ways that CSS elements can be added to a web document.*
> - *Recognize the CSS elements allowed in Canvas.*
> - *Use the style attribute to add CSS elements that influence text properties to discussion threads.*

Introduction to CSS Video

Learners navigated to the CSS Introduction video (erschelsheph, 2022b) that included the following prompt:

> *Cascading Style Sheets (CSS) are used to format the layout of a webpage. They leverage HTML tags but provide additional structure to manage the look and feel of those tags. This 9:40 minute*

video introduces CSS styles. It begins by reviewing the main sections of an HTML document (remember, Canvas only allows course developers to access tags within the body of the HTML page). The presentation then indicates three ways that CSS can be added to a webpage: inline, internal, and external. It focuses predominantly on inline styles because that is what Canvas allows. To add inline styles, you add the style attribute within HTML tags. You can then include various specifications for those styles. The presentation describes background-color, color, font-size, margin, padding, border, border-radius, and a few more.

Once you have watched this presentation, try your hand at basic CSS styles. Navigate to the Week 2: CSS Sandbox Discussion Board and modify the text color, background color, padding and other specifications for headings, regular text, and so forth. Learning how to complete these simple modifications will help prepare you for more difficult layouts in subsequent weeks.

Additionally, learners received a list of the HTML and CSS tags allowed in Canvas (Instructure, 2021). Afterwards, they experimented in a new discussion board.

Week 2: CSS Sandbox Discussion

Use this space to practice writing CSS.

Reflect on your experience learning HTML and CSS and modify those paragraphs and headings with the style attribute and various specifications.

Remember: each element is placed within the style attribute and uses a colon and semi-colon.

For example:

* Content *

In addition to the prompt, the discussion board also contained example elements (provided below) with links to additional information from the W3schools (n.d.-a) website (see Support Materials; W3schools, n.d.-m to n.d.-t).

CSS Examples

- *background-color*
- *color*
- *font-size*
- *margin*
  - *margin-top, margin-bottom, margin-left, margin-right*
- *padding*
  - *padding-top, padding-bottom, padding-left, padding-right*
- *border-width*
- *border-style*
- *border-radius Links to an external site.*
  - *border-radius 0px 10px 0px 10px; (where the first number represents the top-left corner, second is top-right, third is bottom-right, and fourth is bottom-left)*

Learners spent their time altering HTML tags with inline CSS elements using the style attribute. During this time, students and the instructor posted examples and shared their HTML and CSS in discussion threads. Learners also used the space to ask questions, post ideas, and provide feedback (see Figure 2). Learners were encouraged to experiment with their ideas. As with the previous activity, five points of participation credit were awarded at the end of the week (based on the number of posts made and learner attempts to comprehend CSS formatting).

Week 3: Object Positioning

During Week 3, learners were told that they would continue to examine CSS for layout design and object positioning. At the beginning of the Week 3 module, the learning objectives were provided.

- *Learners will work towards using the style attribute to add object placement CSS to HTML tags in Canvas discussion boards.*

As with the previous weeks, learners were provided content through a video and a sandbox-like discussion board.

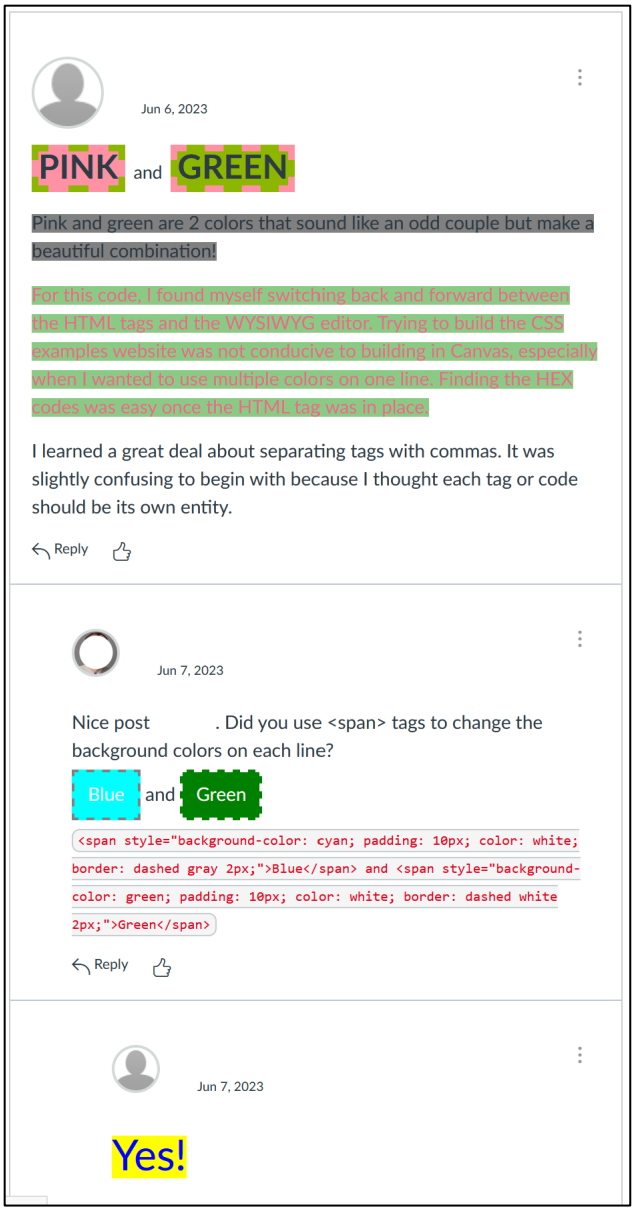

Figure 2. Example of student post with instructor feedback.

CSS Object Positioning Video

Learners began CSS instruction this week by navigating to the CSS Postition video (erschelsheph, 2022d), which showcased object positioning with CSS. It included the following prompt in Canvas:

> *This 14:53 minute video describes how to use float, clear, min-height, position, and z-index styles to manipulate the layout of an HTML document.*

Learners were reminded of allowable tags in the Canvas LMS (Instructure, 2021) and practiced their skills in a discussion board.

Week 3: CSS Sandbox Discussion

> *Now that you have some basic experience modifying HTML tags with CSS, use this space to practice modifying tag position on the page.*
>
> *Reflect on your experience learning and modifying those paragraphs and headings with the style attribute and various specifications.*
>
> ***Remember: Each specification is placed within the style attribute and uses a colon and semi-colon.***
>
> *For example:*
>
> * Content would show the word Content on the screen. It would be blue and have a gray background.*

Additionally, learners were provided with the following lists of tags, some repeated from the previous week, with accompanying links to the W3schools (n.d.-a) website (see Support Materials; W3schools, n.d.-m to n.d.-z).

Previous CSS Examples

- *background-color*
- *color*
- *font-size*
- *margin*
  - *Margin-top, margin-bottom, margin-left, margin-right*
- *padding*
  - *Padding-top, padding-bottom, padding-left, padding-right*
- *border-width*
- *border-style*
- *border-radius*
  - *Border-bottom-left-radius, border-top-right-radius*

Object Placement CSS Examples

- *Width*
- *Float*

- *Position*
  - *Static*
  - *Relative*
  - *Fixed*
  - *Absolute*
  - *Sticky*
- *z-Index*
- *Clear*
- *Min-height*

Again, learners modified HTML tags with CSS, particularly focusing on float, clear, and min-height, and positioning elements (see Figures 3 and 4).

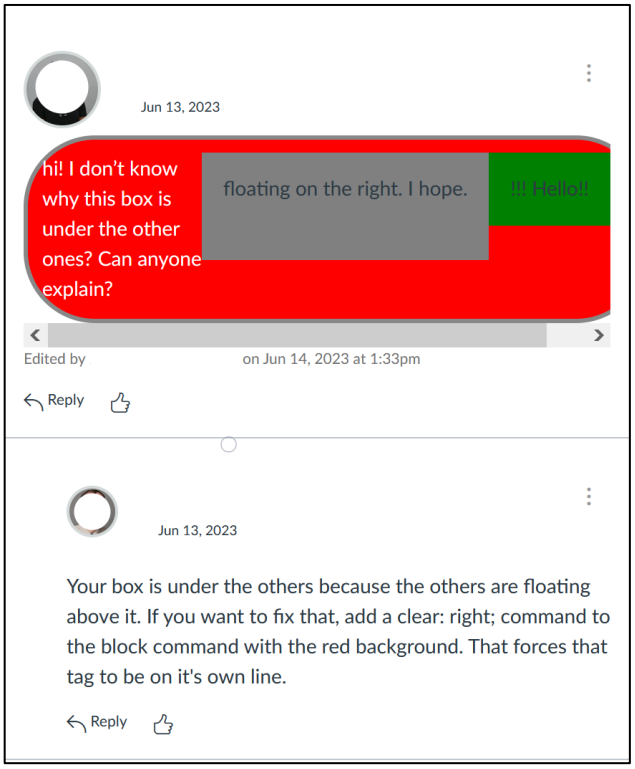

Figure 3. Learner example and question using float.

The instructor also posted examples in discussion threads. Learners used the space to ask questions, post ideas, and provide feedback. They were awarded five points for participation.

Optional Assessment

During the fourth week of the course, learners were tasked to develop two activities within a Canvas course shell that promoted community development. These activities were graded based on adherence to web accessibility guidelines and the use of CSS principles. Learners were told that their activities would be evaluated on the look and feel of the module (through CSS styles and relevant images), including the following:

- Change the background color of at least one HTML block tag of your choice.
- Use at least two different levels of heading and include different text colors, text sizes, padding, margins, border options or other components to distinguish them from normal text.
- Include at least one object that floats to the right of your window but does not overlap with other page elements.
- Include an image that takes up between 33-50% of the screen and includes a border of your choice.

Because the focus of this assignment was community development (as opposed to CSS), only three of 20 points were allotted to these tasks.

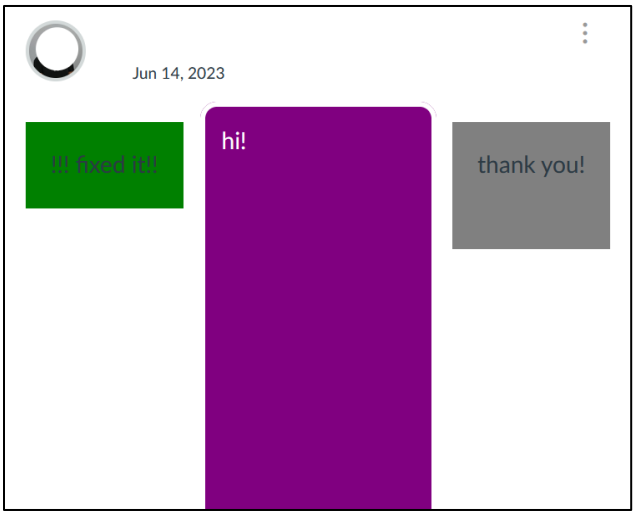

Figure 4. Resolution after instructor feedback.

Critical Reflection

This lesson has been implemented three times, once per year during a shortened summer semester. Overall, most learners in the course appear to enjoy the activities. Most learners also gained basic skills with inline CSS. They successfully used these concepts to help stylize Canvas course shells as described in the assessment activity. However, a few struggled to use inline CSS concepts during weeks two and three. Some attempted to leverage ChatGPT and artificial intelligence for help, which often

resulted in CSS styles suitable for external style sheets or within page headings but unsuitable for inline CSS. This section describes these issues in greater detail and provides ideas for future implementation.

Learner Perceptions and Uses

As mentioned, most learners appeared to enjoy CSS sandbox activities. Since these mini lessons were only one part of the content for the whole course, other graded, course-level discussion boards prompted learners to synthesize instructional content, relate content to current practice, post and respond to guiding questions, and other formal practices. The HTML/CSS Sandbox Discussion Boards differed from these formal discussions.

First, sandbox discussion board points were awarded solely on participation. Learners could earn full points whether or not they successfully used inline CSS elements. If learners posted multiple attempts, they obtained participation points. Second, content did not matter; learners did not have to provide insightful comments or well-developed summaries. Rather, they could post whatever came to their mind, including nonsense. Posts focused on aesthetics rather than content. Many students wrote about extracurricular interests or TV/streaming shows they regularly viewed. Some posted Lorum Ipsum and other dummy text. This shift in focus away from posting specific content seemed to provide a light-hearted space to pursue colorful, vibrant, and bombastic posts.

Although the discussion boards continued to emphasize thoughtful participation with original posts related to module activities, the sandbox-like structure and grading of the HTML/CSS discussion forums seemed to lessen feelings of anxiety among many participants. Because discussion threads captured learner attempts over time, they depicted successive approximations that were mined by other learners. Individuals posted their attempts and often wrote whether it appeared as they desired. The posts that deviated from desires typically included learners' code (sometimes code was requested by the instructor or other learners). This allowed the instructor and other learners to provide feedback and trouble-shoot collectively. Suggestions often resulted in additional posts and further attempts. Although these tinkering methods and participatory, troubleshooting culture went well in the discussion forums, there were some unique challenges in these mini lessons.

Learner Anxiety

Introducing any type of coding can be intimidating. Bringing this content to a fast-paced, asynchronous shortened summer course can add to the anxiety of learning HTML/CSS. Some students were intimidated by the topic and the sandbox. They wondered why coding was being introduced in a seminar course regarding online learning. During the second week, a student posted the following message (see Figure 5):

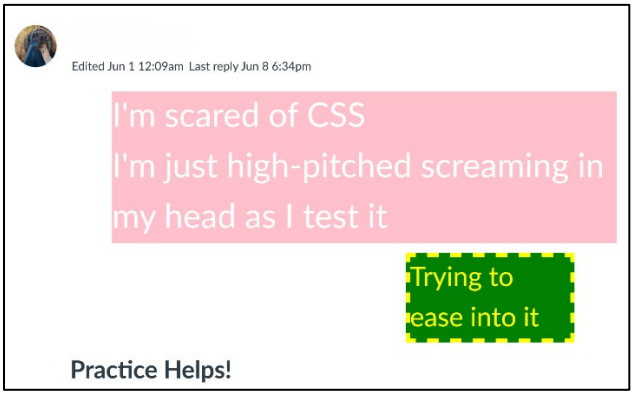

Figure 5. I'm scared of CSS message.

A few days later, another learner wrote a response:

> I genuinely appreciate your honesty about being uncomfortable and struggling. I was seriously not thrilled when I saw this on the course outline…. This is still something I am struggling with, as I keep putting off playing around in the sandbox, pun intended, because I just know that I am not *good* at it.

The original poster then stated:

> You're not alone with the discomfort. It's all new to me, too. To me, the sandbox feels like a safe place to practice. We are all learning, and it's OK to make mistakes. I believe that's the purpose of the sandbox. I know it's easier said than done to feel comfort in the discomfort.

She then concluded the thread two days later with the following post (see Figure 6).

Figure 6. Borrowed/modified content from the sandbox.

Canvas Updates

Additionally, during the Summer 2024 iteration of this course, the university updated Canvas discussion boards to provide greater functionality. This functionality update introduced display challenges for these mini lessons. Previously, a new or edited post would automatically appear in discussion threads. The update removed this functionality for the duration of the course. New posts sometimes required page refreshes to appear. This problem caused confusion and anxiety among some learners who spent considerable time formatting content only to see it disappear when posted. Several reminders to refresh the page reduced anxiety. Yet, prior to the reminders, some students created two or three versions of the same post—believing their previous work had been lost. When implementing this activity, instructors may want to check with their information technology department to determine if any LMS changes may require adjustments.

Artificial Intelligence Assistance?

Each sandbox area includes sample tags or elements with links to additional information on the W3schools (n.d.-a) website. Learners appreciated these links. However, they often used other sources to continue their exploration, including artificial intelligence (AI). Results varied. Those with prior experience using CSS were able to query AI tools for new elements, tips, and code snippets. They often shared their findings in the discussion thread and indicated that they used AI tools to help them. However, AI assistance caused frustration for some learners. Often AI tools would generate CSS code that was formatted for an external style sheet or for the head section of an HTML document. These styles, while more sophisticated than what we did in class, often could not function as inline styles. Learners would post the code and wonder why it did not work. Fortunately, other learners and the instructor frequently pointed out challenges with their code and potential modifications to remedy the situation. When implementing this activity, instructors may provide information on the benefits and drawbacks of using AI and reiterate the three ways CSS elements can be added to web documents.

Future Plans

This lesson attempted to introduce basic HTML and CSS to graduate students in an instructional design and technology program. The instructors knew that a four-to-five-week introduction was insufficient to have learners master the concepts but attempted to have some inclusion as a starting point for learners. The authors have been using CSS styling for several years and continue to gain new insights and ideas as they leverage different elements. The experience seemed to reduce anxiety among learners in leveraging HTML views in LMSs, attempting to modify code in that view, and personalizing page layouts.

However, as mentioned in the AI section of this reflection, the lesson does not cover external style sheets and some of the more powerful cascading features of cascading style sheets. In this sense, this lesson is a very narrow introduction to HTML and CSS. In future semesters, we plan on adding another video that introduces external style sheets and linking those sheets in the head section of an HTML document. The cascading nature of CSS will be further introduced, showcasing how it can simplify and fine tune page layouts for websites and learning management systems (like D2L Brightspace).

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Supplemental Materials

The HTML supplemental materials are presented in order of appearance in the article.

Block Tag Examples

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Experiential Learning in Higher Education

Charlotte Jones-Roberts and Crystle Bechtold, University of Central Florida

Overview

Kolb's (1984) experiential learning theory explains how to turn a four-stage cycle that relies on concrete experience, reflective observation, abstract conceptualization, and active experimentation into effective learning. This unit, intended for university students, is designed to teach this theory through implementation. The learners progress through the four stages in Kolb's theory while learning to fold an origami paper crane. Each stage requires the learner to reflect and share their discoveries in an online video discussion forum. The lesson concludes with a reflection on the process of learning to fold a paper crane and on learner's understanding of experiential learning in practice.

Topics: Experiential Learning, Learning by Doing, Online Learning

Time: Approximately 4 hours

Materials

- Computer and internet connection
- Canvas Web course (see Support Materials)
- Padlet (n.d.) discussion board (or similar tool)
- Web camera
- Microphone
- Scrap paper
- Scissors

Setup

This is a fully online, asynchronous unit within a larger course. To prepare the online course and assessments, instructors will need to ensure that all instructional materials are accessible through Canvas learning management system (LMS; see Support Materials). Additionally, Padlet (n.d.) video discussions must be published and enabled for each of the five discussions.

Context-at-a-Glance

The design of this unit is self-referential, in that the students learn Kolb's (1984) Experiential Learning Theory by *doing* Experiential Learning Theory.

Setting
An online graduate education course required before enrolling in internships at a university in the United States.

Modality
Fully online, asynchronous

Class Structure
A group-paced, asynchronous online course divided into modules.

Organizational Norms
All students have access to Canvas Learning Management System. The university prioritizes experiential learning to create inclusive opportunities that promote collaboration between students, faculty, and community partners.

Learner Characteristics
Graduate students (N=19) with limited experience in experiential learning or Padlet video discussions.

Instructor Characteristics
The educator holds an M.A. in Instructional Design and Technologies.

Development Rationale
The course emphasizes the importance of experiential learning as a pedagogical approach that bridges theory and practice, preparing students for real-world challenges in their internships and future professional endeavors. By engaging in hands-on activities and interactive learning experiences, participants gain a deeper understanding of concepts and develop practical skills that are transferable to their respective fields.

Design Framework
ADDIE Framework; Kolb's (1984) Experiential Learning Theory

Context and Setting

This project introduces graduate level students to the principles and practices of experiential learning before they embark on their requisite internships.

The course was offered at a public, metropolitan, research university with a quality graduate-level professional education program. The Instructional Design and Technologies program that the course is a part of includes a practicum that is completed towards the end of the program. The university prioritizes experiential learning and internships as a leading "partnership university" and strives to develop and sustain quality experiential learning opportunities that promote collaboration between students, faculty community, and employer partners. The students are guided by faculty as they apply theory to practice in ways that enhance their academic learning and development of skills and abilities to contribute to their field of choice.

Learner Characteristics

The students who participated in this activity were diverse in backgrounds and understanding. Some of the students were professional educators in PK-12 classrooms, others were practicing instructional designers, and some were pursuing career-changes either into or out of education. Their experience and understanding of the learning theories were equally diverse.

From a technical standpoint, all students completed at least some professional education graduate-level coursework, had a working knowledge of Canvas, were comfortable operating a webcam or phone for the purpose of recording a video and submitting it, and successfully engaged in a group-paced, asynchronous online course prior to this course. This experiential learning activity, however, has the potential to be used across class standings and disciplines as a precursor for experiential learning. It could be easily modified to meet the needs of other learners or varying settings.

Experiential Learning Activity

This activity was introduced following assigned readings and videos related to experiential learning theory. The course is completed prior to the learner beginning a practicum as a part of their program requirements. By engaging in this activity, and the course, the students may better understand the theory behind practical internships as well as develop an understanding of Kolb's (1984) experiential learning theory and its implementation. The unit also provides additional resources and applications for experiential learning in higher education.

Incorporating asynchronous video discussions with Padlet (originally Flip before it was discontinued) in an online course on experiential learning for busy university students serves a dual purpose:

1. Video discussions facilitate the integration of hands-on, experiential activities into the curriculum while accommodating the diverse schedules and commitments of students. By utilizing Padlet, or alternative video discussion tools, students can engage in reflective activities and share their experiential learning experiences through video recordings at their convenience, allowing for flexible participation without the constraints of fixed class times. This approach not only promotes active engagement with course content but also encourages students to apply theoretical concepts to real-world situations, fostering deeper understanding and integration of experiential learning principles.
2. The visual and auditory nature of video discussions on Padlet also enhances social presence and collaboration among students, creating a sense of community despite physical distance and time constraints.

The instructional unit is grounded in experiential learning theory. It instructs the learner about Kolb's (1984) experiential learning theory by having students actively complete the steps of the theory and reflect on each of them.

The activity, creating a paper crane, was chosen to contextualize this theory because it requires very few materials (a piece of paper and scissors), does not take as much time as other forms of genuine experiential learning (such as service learning, internships, or study abroad), and is something that requires the learner to be hands-on.

Reflective observation is a pivotal part of the experiential learning process (Kolb, 1984). Kolb's (1984) emphasis on a "here-and-now concrete experience" echoes the importance of hands-on learning in testing and validating abstract concepts.

For instance, the creation of a paper crane with the learner's own hands provides a genuine opportunity to learn by doing. Through each step of creating the paper crane, students are actively engaging in Kolb's experiential learning process:

1. **Concrete Experience:** Making a paper crane involves physically folding and manipulating paper, providing a hands-on, tangible experience for the learner that is representative of the concrete experience phase in Kolb's model.
2. **Reflective Observation:** As students fold the paper crane, they can observe their actions, notice patterns, and reflect on their progress. They may consider what techniques are working well and what adjustments need to be made. This reflective observation encourages introspection and insight, characteristics of this phase.
3. **Abstract Conceptualization:** Through the process of reflection, students can begin to abstract general principles or concepts from their concrete experience. They might identify underlying principles of origami, such as symmetry, precision, and technique. This abstraction allows them to conceptualize broader ideas beyond the specific task at hand.
4. **Active Experimentation:** After reflecting on their experience and conceptualizing key principles, students can apply this newfound understanding by actively experimenting with different folding techniques or variations of the paper crane. They might try different approaches to improve their technique or personalize their creation. This experimentation fosters continued learning and skill development.

By engaging in the process of creating a paper crane, students can actively participate in all stages of Kolb's experiential learning model, making it a powerful and effective way to illustrate the principles of learning by doing.

Learning Representation Overview

This learning experience is a self-led, online lesson. Students will engage with the material presented on the Canvas Web course in sequential order (as described below; see Figure 1). This organization follows the best practices highlighted in Malone and Minor (2014) for experiential learning in online settings.

After students review the objective of the lesson, they read the introduction and watch the embedded YouTube video introducing Experiential Learning (Sprouts, 2015). The text following the video focuses on Experiential Learning Principles and includes an example of baking bread and a supporting diagram image.

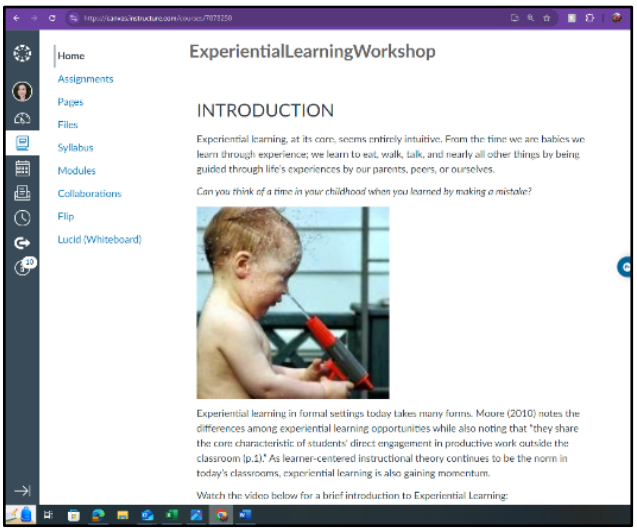

Figure 1: Screenshot of introduction page in canvas.

Following the reading portion of the lesson, students are asked to share their preconceptions of the assignment through the Padlet discussion tool. Three questions related to their currently held perceptions of paper cranes are provided for them to answer (see #1 Abstract Conceptualization section)

In the active experimentation portion of the lesson, students must use a scrap piece of paper to fold a paper crane without using additional supports or reference materials. They then post a picture of the attempt on Padlet.

The students then record a reflective observation of the activity using Padlet and share these insights with their peers. They are provided with three guiding questions to help facilitate their responses (see #3 Reflective Observation section).

After viewing the reflections of their peers, the students develop improved strategies to fold a paper crane. They may now consult outside resources such as friends, family, or online tutorials. In another Padlet video, students discuss how their strategy changed based on new knowledge and display their latest paper crane.

In a final Padlet video, students reflect on the active experimental portion of the assignment (try, learn, try again). They are provided with five leading questions that tie the active experimental portion to the steps in Kolb's (1984) experiential learning theory. As with the reflective observation videos done during step 3, students will review the Padlet of their peers to develop a deeper understanding.

Detailed Learning Representation

The following sections outline the content in the Canvas Web course. *Italic text identifies directions, questions, or prompts provided to the learners.*

Objectives

The objectives course page presents a comprehensive overview of the terminal and enabling objectives. The terminal objective is the goal students aim to achieve. In this unit, the terminal objective is:

- *Learners will actively practice and reflect upon the basic principles of Experiential Learning Theory.*

Enabling objectives serve as intermediate milestones facilitating the attainment of the terminal objective. In this unit, the enabling objectives are:

- *Learners will understand an introduction to Kolb's Experiential Learning Theory.*
- *Learners will abstractly conceptualize the process of making a paper crane.*
- *Learners will actively experiment to create a paper crane.*
- *Learners will reflectively observe their crane creation process.*
- *Learners will produce concrete experience on how to effectively create a paper crane.*
- *Learners will reflect upon the Experiential Learning Model and its potential classroom applications.*

Introduction

The introduction course page serves as an instructional guide for Kolb's (1984) experiential learning theory, providing insight into the concept of experiential learning and highlighting its increasing popularity. It serves as a foundational understanding for students, setting the stage for a more in-depth exploration of the content. The page incorporates a video component titled "Experiential Learning: How We All Learn Naturally" (Sprouts, 2015), offering an alternative mode of information delivery.

This video, shown in figure 2, serves as an additional resource to familiarize students with the key concepts and principles of Kolb's (1984) experiential learning theory. By combining textual information with visual content, the instructional approach aims to enhance the learning experience and cater to different learning styles. Together, these elements contribute to a holistic learning environment, supporting participants in their engagement with the content.

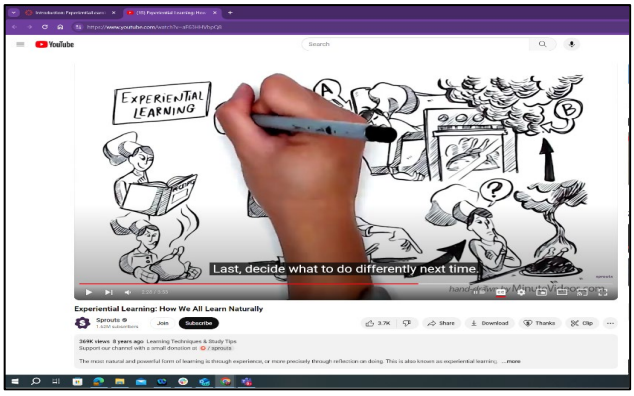

Figure 2: Screenshot of Video on "Experiential Learning: How We All Learn Naturally" (Sprouts, 2015).

Beyond the video, there are introductory text and visuals. The following is the content found on the introduction course page:

> *INTRODUCTION*
>
> *Experiential learning, at its core, seems entirely intuitive. From the time we are babies we learn through experience; we learn to eat, walk, talk, and nearly all other things by being guided through life's experiences by our parents, peers, or ourselves.*
>
> *Can you think of a time in your childhood when you learned by making a mistake?*
>
> *Experiential learning in formal settings today takes many forms. Moore (2010) notes the differences among experiential learning opportunities while also noting that "they share the core characteristic*

of students' direct engagement in productive work outside the classroom" (p. 1). As learner-centered instructional theory continues to be the norm in today's classrooms, experiential learning is also gaining momentum.

Watch the video below for a brief introduction to Experiential Learning:

- *Experiential Learning: How We All Learn Naturally (Sprouts, 2015)*

EXPERIENTIAL LEARNING PRINCIPLES

In the 1980s, MIT professor Michael Kolb was seeking a better way to challenge and instruct students, and experiential learning was his answer. Inspired heavily by Lewin's model, Kolb (1984) published the Experiential Learning Model (ELM), shown in the figure below, and the Elements of Experiential Learning. Kolb is now the most recognizable name associated with Experiential Learning. There are four stages of learning within Kolb's ELM and each one provides grounding for the next. These stages are more cyclical than concrete, ordinal steps.

Through Kolb's theory, a person learns through experience. Take for example, a person who wants to learn to bake bread, but they do not have a recipe. So, they create an abstract conceptualization of what amounts of wheat, water, and yeast they will need. They use active experimentation to bake the bread. Unfortunately, it does not rise properly, so they reflectively observe what went wrong. They try again, and this time observe their grandma baking bread to abstractly conceptualize and realize that the bread needed to sit for at least overnight before baking. Then, there is success, creating concrete experience they can use for baking bread in the future.

Assignments

After the introduction, students begin the assignments which include the creation of the origami paper crane and the five Padlet video discussions. The assignments were designed based on the experiential learning principles. All assignments and prompts can be found on the assignments course page (Figure 3).

Experiential Learning Principles

The focus of this unit is to elaborate on Kolb's (1984) experiential learning theory by offering a detailed exploration of its key components and principles. This instructional approach involves using a practical example to enhance understanding. Specifically, the lesson incorporates a hands-on activity, centered around the process of folding a paper crane.

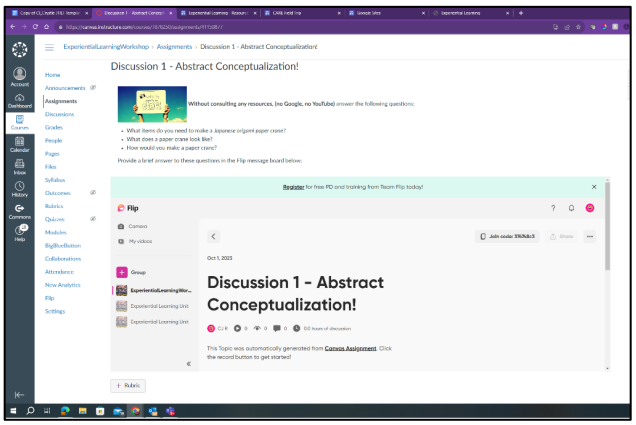

Figure 3: Screenshot of Padlet discussion page.

By engaging in the act of folding a paper crane, learners can directly experience and apply the concepts as illustrated by Kolb's Experiential Learning Cycle in Figure 4. This experiential learning activity not only serves as a practical illustration of the theoretical framework but also provides a tangible and memorable context for grasping the underlying principles. Through the combination of theory and real-world application, this lesson aims to foster a deeper comprehension of Kolb's (1984) experiential learning theory while promoting an interactive and engaging educational experience.

Figure 4: Image of Kolb's Experiential Learning Cycle, created by Charlotte Jones-Roberts.

#1 Abstract Conceptualization

Abstract conceptualization represents the stage where individuals reflect on their concrete experiences and create generalized principles or theories. It involves thinking critically about their experiences, drawing connections, and extracting broader concepts.

The first Padlet video discussion involves only the cognitive understanding of origami techniques and is completed prior to creating an origami paper crane. The following is the #1 Abstract Conceptualization content found on the assignments course page:

> *Now, let's deepen your engagement with the origami process through a self-reflection video. Without resorting to external resources such as Google or YouTube, share your insights on the following questions within a concise 30-60 second video. If you need additional help using Padlet, please visit Record and Post a Video on Padlet (Wilds, 2024).*

- *What items do you need to make a Japanese origami paper crane?*
- *Discuss the materials you utilized in your origami endeavor. Highlight the essential items required to craft a Japanese origami paper crane. This could include the type and size of paper, any additional tools, or any improvised alternatives you might have explored.*

- *What does a paper crane look like?*
- *Offer your personal description of a paper crane. Share your perceptions of its characteristic features, such as wings, beak, and body. This is an opportunity to articulate your understanding of the quintessential appearance of a traditional Japanese origami crane.*

- *How would you make a paper crane?*
- *Provide a brief overview of your approach to creating a paper crane. Describe the sequence of folds and maneuvers you employed, emphasizing any unique techniques or interpretations you incorporated. This part of the video allows you to showcase your individual style in approaching the origami process.*

> *Remember, the objective is to rely solely on your intuition and prior knowledge. This exercise encourages a genuine exploration of your understanding of origami, setting the stage for future comparisons and insights as you delve deeper into the art. After recording your video, consider revisiting it later to observe your progression and newfound understanding as you continue your origami journey.*

#2 Active Experimentation

Active experimentation involves the process of applying new knowledge and skills in real-life situations to test their practicality and effectiveness. It emphasizes hands-on experiences, allowing individuals to actively engage with the material, reflect on their actions, and refine their understanding through direct application.

The second activity and Padlet video discussion involves the physical execution of folding paper to bring the concept to life. As students navigate the folds and creases, they are actively experimenting with their knowledge, refining their skills through trial and error, and gaining a deeper understanding of the principles behind origami. This tactile experience not only reinforces their learning but also fosters creativity and problem-solving skills as they adapt and refine their approach during the process. The following is the #2 Active Experimentation content found on the assignments course page:

> *Now, let's embark on the hands-on portion of our origami journey. Your task is to create a paper crane without consulting any external resources. This is an opportunity to tap into your creativity and intuition. Remember, perfection is not the goal at this stage—simply aim for your first and best attempt.*
>
> *Craft Your Paper Crane:*

- *Set aside a quiet space, gather your materials, and start folding. Follow your instinct and recall any prior knowledge you have about origami. Allow yourself to experiment with the folds and creases, embracing the unique character that may emerge from your unguided approach.*

> *Capture the Moment:*

- *Once your paper crane is complete, capture the moment by recording a video showcasing your creation. Share insights into your thought process, the challenges you encountered, and any surprising discoveries along the way. This video*

serves as a snapshot of your initial exploration into origami without external guidance.

Post Your Video:

- *Share your video within the designated platform or forum. This not only allows you to contribute to the collective learning experience but also provides an opportunity for mutual support and encouragement within the learning community.*

Reflect on the Process:

- *After posting your video, take a moment to reflect on your experience. What aspects of the folding process felt intuitive, and where did you encounter challenges? Consider the overall aesthetic of your crane and any unique elements that emerged from your unassisted endeavor.*

By creating and sharing your first paper crane without external guidance, you are embracing the essence of experiential learning. This unscripted exploration allows for personal discovery and sets the stage for future improvement and refinement. Embrace the imperfections and celebrate the uniqueness of your origami creation!

#3 Reflective Observation

Reflective observation focuses on the thoughtful examination and analysis of one's own experiences. Students can engage in a reflective session after completing the task of folding a paper crane. This reflective phase prompts students to consider the intricacies of their folding process, the challenges they faced, and the strategies they employed to overcome obstacles. By encouraging students to share their observations with peers, they can gain insights into different approaches and learn from each other's experiences.

This third activity and Padlet video discussion not only enhances self-awareness but also promotes a deeper understanding of the learning process. It encourages students to recognize patterns, assess the effectiveness of their actions, and identify areas for improvement. Through reflective observation, learners develop a heightened sense of metacognition, allowing them to transfer these insights to future experiences and learning endeavors. The following is the #3 Reflective Observation content found on the assignments course page:

Now, it's time to delve deeper into your learning experience and provide thoughtful responses to the following questions in a concise 30-60 second video:

- *Did your experiment look like a crane?*
- *Reflect on the outcome of your experiment. Did your origami creation resemble a crane, or did it take on a different form? Be specific in your observations and consider the key features that make a crane distinct in the realm of origami.*

- *What do you think went wrong?*
- *Analyze the factors that may have contributed to any deviations from the intended crane design. Was it a particular step in the folding process, a misunderstanding of instructions, or perhaps a material-related issue? Offer a brief but insightful assessment of what you believe may have gone awry.*

- *What is your improvement strategy?*
- *Outline your plan for improvement. Share the steps you intend to take to enhance your origami skills and achieve a crane-like outcome. Possible strategies could include seeking guidance from your instructor, consulting friends or family members experienced in origami, exploring relevant websites, or watching instructional YouTube videos. Clearly articulate how you aim to address the identified challenges.*

Now, to put your strategy into action by creating a second crane:

- *Execute your improvement strategy by folding a second origami crane. Apply the insights gained from your reflections and take deliberate steps to enhance your technique. Pay close attention to the details and nuances that will contribute to a more accurate representation of a crane. Capture the process in a time-lapse or showcase key moments in your video response.*

By engaging with these questions and actively pursuing improvement, you'll not only refine your origami skills but also cultivate a mindset of continuous learning and adaptation. Your video response serves as a tangible demonstration of your commitment to growth and mastery in the art of origami.

#4 Concrete Experience

Concrete experience emphasizes direct engagement with a particular task or activity. In a lesson designed to facilitate concrete experience, students can focus on gaining mastery in folding a paper crane.

This hands-on, fourth activity and Padlet video discussion provides learners with a tangible and practical encounter with the art of origami. Through the physical act of folding, students develop a tactile understanding of the step-by-step process. The following is the #4 Concrete Experience content found on the assignments course page:

> *Now that you've reflected on the Experiential Learning Unit and identified areas for improvement, let's take proactive steps to enhance your paper crane-folding skills. The process of improvement is an integral aspect of experiential learning, and there are various strategies you can employ to refine your technique. Consider the following steps:*
>
> *Consulting Resources:*
>
> - *Reach out to your instructor: Seek guidance from your instructor by asking for specific tips or additional resources related to paper crane folding. They may provide insights, correct common mistakes, or recommend alternative approaches.*
> - *Engage with friends or family: Collaborate with peers or family members who may have experience in origami. Their practical tips and shared experiences can offer valuable insights into refining your technique.*
> - *Explore online resources: Utilize reputable websites that provide detailed instructions, images, or videos on paper crane folding. Websites dedicated to origami often offer step-by-step guides and troubleshooting tips for common challenges.*
> - *Watch video tutorials: YouTube and other video platforms host a plethora of origami tutorials. Observing experienced folders in action can provide a visual understanding of the folding process and help clarify any ambiguities.*
>
> *Changing Your Folding Process:*
>
> - *Experiment with alternative techniques: Take the opportunity to explore different folding approaches. Adjust your grip, try folding from a different starting point, or experiment with varying levels of precision. Embrace a trial-and-error mindset to discover what works best for you.*
> - *Break down the steps: If you found certain steps challenging, break them down into smaller, more manageable components. Focus on mastering each sub-step before attempting the entire process, allowing for a more gradual and controlled learning experience.*
>
> *Stating Your Strategy for Improvement:*
>
> - *Clearly articulate your plan: Outline your specific strategy for improvement. Whether it involves seeking advice from your instructor, watching online tutorials, or experimenting with alternative folding techniques, having a defined plan will guide your learning process.*
> - *Set measurable goals: Establish specific, measurable goals to track your progress. For example, aim to complete a paper crane with fewer errors or achieve a smoother folding process. Regularly assess your performance against these goals to gauge improvement.*
>
> *Creating a Third Crane:*
>
> - *Apply your improvement strategy: Implement the lessons learned from your reflection and improvement strategy to create a second paper crane. Pay attention to the details and adjustments recommended through your chosen approach.*
> - *Compare the results: Compare your second crane to the initial one, noting any visible enhancements or changes in your folding technique. Reflect on the effectiveness of your chosen improvement strategy and identify areas for further refinement.*
>
> *By actively engaging in the improvement process and incorporating various learning resources, you'll not only enhance your paper crane-folding skills but also deepen your understanding of experiential learning in action. Remember, the journey of improvement is a continuous and iterative process.*
>
> *Post a Padlet Video sharing what strategies you used to improve your crane and include your new crane. The video must be a minimum of 30 seconds.*

Final Reflection

Completing the final (fifth) activity and Padlet video discussion, using Kolb's experiential learning theory, provides students with a structured framework to deeply engage with their learning experiences. By following the provided guidelines, students share moments from the unit based on their *Concrete Experiences*, reflect on their thoughts and feelings through *Reflective Observation*, connect their experiences with relevant theories by *Abstract Conceptualization*, and propose applications or changes during *Active Experimentation*.

This approach fosters self-awareness, critical thinking, and synthesis of knowledge, aligning with the grading criteria and enhancing the learning process. In addition, incorporating visuals of a paper crane to represent each stage of Kolb's theory adds a creative element to the reflection, aiding comprehension and retention.

Engaging with peers' reflections further enriches the learning experience, fostering collaboration and diverse perspectives. By integrating Kolb's framework into their final video reflection, students demonstrate their understanding of the unit and their commitment to lifelong learning and personal development. The following is the #5 Final Reflection content found on the assignments course page:

> *Now, let's dive into the guidelines for your final reflection. Your reflection should not only recap your journey through the unit but also explicitly connect your experiences with Kolb's (1984) Experiential Learning Theory. Remember, Kolb's theory consists of four stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation.*
>
> *In your reflection post, consider addressing the following:*
>
> - *Concrete Experience: Describe a specific moment or activity from the unit that stands out to you. What did you do, see, or feel during this experience?*
> - *Reflective Observation: Explore your thoughts and feelings about the chosen experience. How did it impact your understanding of the topic? Did you encounter any challenges or surprises?*
> - *Abstract Conceptualization: Connect your experience with relevant theories, concepts, or previous knowledge. How does what you've learned align with or challenge existing ideas?*
> - *Active Experimentation: Propose potential applications or changes based on your reflections. How might you incorporate your newfound knowledge into real-life situations or future learning experiences?*
>
> *Now, let's tie this back to the grading criteria, emphasizing the connection to Kolb's theory:*
>
> - *Video post substantially addresses the corresponding step of Experiential Learning (3 points): Ensure your video post covers each of the four stages of Kolb's theory. Clearly articulate your concrete experience, reflective observation, abstract conceptualization, and plans for active experimentation. The video should be no longer than 5 minutes.*
> - *Visual of paper crane is available, created by the student (1 point): As an additional creative element, consider representing each stage of Kolb's theory through visuals on your paper crane. This could include symbols or images that capture the essence of each stage.*
> - *Student responds to another post (1 point): Engage with a peer's reflection post. Share* your insights, ask questions, or provide constructive feedback. This interaction fosters a collaborative learning environment, enhancing the overall experiential learning process.
>
> *By integrating Kolb's Experiential Learning Theory into your final reflection, you'll not only showcase your understanding of the unit but also demonstrate the application of a powerful framework for lifelong learning. Happy reflecting!*

Critical Reflection

After implementing the experiential learning unit, students made significant strides in their understanding and application of the fundamental principles of experiential learning theory. Engaging in hands-on activities and reflective exercises, students actively immersed themselves in practical learning experiences designed to deepen their knowledge and skills.

Despite these commendable achievements, a notable challenge emerged regarding the students' ability to articulate detailed reflections in their assigned posts.

Some video posts did not fully substantiate how the learner's thought process related to experiential learning. This highlighted the importance of providing clearer examples and a more comprehensive grading rubric to support and guide students' reflective process effectively. Additionally, the instructor believes that additional time for video responses, up to 5 minutes as opposed to the 30-60 seconds provided, may be more necessary for a full reflection. The Padlet platform, chosen for its interactive features, generally garnered positive feedback from students. However, a subset of learners encountered initial connectivity issues and had difficulties navigating permissions for Learning Tools Interoperability (LTI). Some of these connection issues were related to cookies settings in students' browsers. Addressing these technical challenges through detailed, step-by-step instructions on adjusting camera permissions during Padlet video discussions on computers is essential to ensure a seamless learning experience for all students.

The instructor found this unit to garner exciting insights into students' thoughts and understanding of experiential learning. For an asynchronous unit, the instructor was very impressed with the connection between learners and the student's engagement in the process. Likewise, the students mentioned they enjoyed the unit significantly, especially the video reflection.

Overall, as students completed the unit, they successfully achieved the terminal learning objective of actively practicing and reflecting upon the core principles of experiential learning theory. Through well-structured activities and thought-provoking exercises, students not only deepened their understanding but also gained practical insights into applying these principles in real-world contexts.

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Support Materials

- Instructure Canvas Shell: Open access, you must create an account to view. Long link: https://canvas.instructure.com/courses/7878250

About the Authors

Charlotte Jones-Roberts is an instructional designer at the University of Central Florida with a doctorate in Curriculum and Instruction. Her research centers on enhancing quality in online learning, student facing generative AI, open educational resources, and supporting mental health for student success in virtual environments.

Crystle Bechtold is a graduate of the University of Central Florida, where she earned her master's degree in Instructional Design and Technologies. She also works in the College of Sciences at UCF, promoting inclusive and welcoming learning environments in higher education.

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PK-12 Lesson Design Competition Awards

Jacob A. Hall[1] and Matthew L. Wilson[2],
[1]AECT Teacher Education Division Past President, [2]AECT Teacher Education Division President

PK-12 Lesson Design Competition

Hundreds of tiny, colorful, plastic cubes lay strewn across tables; dozens of ideas are tossed about; and a crowd of people are gathered with a common goal to effectively integrate technology for teaching and learning. This was the PK-12 Lesson Design Competition at the 2024 Association for Educational Communications and Technology (AECT) International Convention. The Teacher Education Division (TED) of AECT sponsored this competition as part of their mission to promote theory, research, and *practice* that supports teachers and teacher educators to design effective learning experiences for diverse learners.

Integrating technology into learning by creating and implementing technology-rich lessons and teaching is a complex process. Research shows effective technology integration involves teachers' values, prior experiences, contextual factors, and awareness of technology's potential (see Kopcha et al., 2020). The PK-12 Design Competition has become a space for colleagues to share experiences, discuss contextual factors, and collectively expand imaginations.

While TED has a strong history of promoting research and theory (c.f., Neumann et al., 2021), the division seeks to further amplify the voices of PK-12 educators and highlight their teaching and design practices. In support of this goal, TED sponsored the first PK-12 Lesson Design Competition in 2023. The competition recognizes educators, researchers, and academics who design original, hands-on, curricular materials (with an identified tool) that amplify or transform student learning in a PK-12 setting. Participants submit a lesson overview, a design prototype (made with the tool), and instructions for how the prototype will be used in the lesson.

2024 Tool: Bloxels

During the 2024 competition, participants interacted with Bloxels (n.d.) EDU Bundle kits and created lessons that incorporated self-designed Bloxels prototypes (see Figure 1). Bloxels allows users to generate original pixel art using eight distinctly colored block types and a construction frame to import into a video game design application with the goal of creating 13-bit games. Although Bloxels launched in 2015, several conference attendees mentioned that it was their first time hearing about this tool. Many people were intrigued by the colorful characters made with tiny blocks and stopped by the table to gain greater awareness of the tool.

Those who stayed longer explored and observed multiple uses that Bloxels might support. Strangers became colleagues as they helped others consider how Bloxels might be integrated effectively or creatively in lessons. For example, a small group formed around how the animation of characters might support a lesson in different ways. One participant animated a comet to serve as a hook for a content-specific lesson in ELA, and another discussed how to scaffold students learning to animate their own characters in a technology-focused lesson. The competition tables each year are a flurry of activity. They have provided experiences with new tools, expanded perceptions of possibilities, and advanced AECT's mission to lead the application of new technologies for learning (AECT, n.d.).

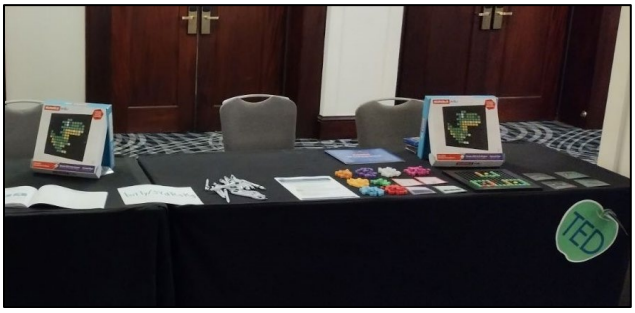

Figure 1 PK-12 lesson design competition table.

2024 Winners

The winners for the 2024 PK-12 Lesson Design Competition were Elisa Shaffer (Figure 2) and Brittany Musgrave Rivera (Figure 3) who both, serendipitously, created lessons for the fifth grade, wonderfully displaying the varying complexities and uses of the selected tool. To further amplify the voices of innovative PK-12 teachers and make their materials easy-to-access for others, these winning PK-12 Lesson Designs Competition lessons are published in this issue.

Elisa Shaffer's lesson, *Join the Sons of Liberty! Exploring 1773 Bloxels Boston*, engages students in a teacher-made simulation of the key events and figures associated with the Boston Tea Party. In this lesson, Bloxels serves to gain learners' attention, teach relevant content knowledge, and assess learners' understanding through the creation of a colonial Bloxels character.

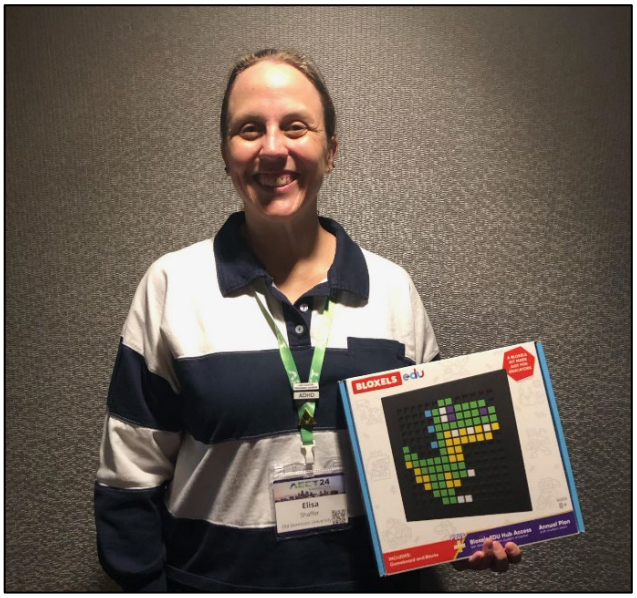

Figure 2. Elisa Shaffer with Bloxels (n.d.) EDU bundle.

In Brittany Musgrave Rivera's lesson, *Understanding Author's Purpose: 5th Grade Becomes the Authors!*, the Bloxels tool supports an English Language Arts lesson. The instructional materials provided (e.g., the infographic and rubric) help to guide and set expectations for students as they write and animate a brief narrative.

Bringing technology-rich learning representations to life during the PK-12 Lesson Design competition is always exciting. While the novelty of the tool hooks people, the interactions between colleagues and the robust discussions of engaged learning through technology are the important outcomes of the annual event. Likewise, the competition's design products have been noteworthy outputs of a grander goal to support a community's professional growth through the design of technology-rich learning activities.

Figure 3. Brittany Musgrave Rivera with Bloxels (n.d.) EDU bundle.

According to Kopcha et al. (2020), "The act of designing technology-rich lessons opens the door to understanding how [technology integration] decisions are made and what impacts those decisions" (p. 743). With support from TED, AECT, and the *Journal for Technology Integrated-Lessons and Teaching (JTILT)*, the PK-12 Lesson Design Competition may be the door the broader community of PK-12 educators need to operationalize technology-integrated teaching and learning in a meaningful way. TED looks forward to welcoming new voices into the competition next year, engaging them in the design process, and continuing to celebrate the many award-worthy practices of PK-12 educators.

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Join the Sons of Liberty! Exploring 1773 Bloxels Boston

TED Design Competition Winner

Elisa L. Shaffer, Old Dominion University

This lesson won the 2024 AECT Teacher Education Division PK-12 Lesson Design Competition. It was not peer-reviewed

Overview

Learners will create a colonial character to explore 1773 Boston and gain insight into the underpinnings of the events that led up to and occurred during the Boston Tea Party on December 16, 1773. Using Bloxels, learners will travel the streets of Boston, interacting with different characters and learning about their concerns and events. They will also interact with British soldiers and tax collectors. Additionally, they will be given an opportunity to join the Sons of Liberty and participate in the Boston Tea Party.

Topics: Boston Tea Party, Social Studies, US Revolutionary War

Time: *Student Preparation*-90 minute class; *Bloxels Exploration*-60 minute class

Materials

- Markers, colored pencils, crayons
- Create Your Colonialist
- Short readings of different individuals and stories involving the Boston Tea Party, the Tea Act, and its impact on the American Revolution
- Bloxels (n.d.-a) Edu sets for every 2-3 students
- iPad/tablet for every 2-3 students or access to the school computer labs
- Bloxels (n.d.-b) app installed on each tablet if using iPads/tablets

Context-at-a-glance

Competition Parameters
The Teacher Education Division of the Association for Educational Communications and Technology provided live explorations of Bloxels Edu during the 2024 annual convention. Attendees accessed Bloxels plastic grids and cubes, iPads, the Bloxels: Build Your Own Games app, sample character and game layout cards, resource workbooks, and blank grids to draw and scan ideas. During a three-day time period, attendees were invited to design original, hands-on, curricular materials based on the tools. Their instructions were to amplify or transform student learning in a PK-12 (or equivalent) educational setting and describe their idea in approximately 750 words.

Setting
Fifth-grade social studies in the United States.

Modality
In-person instruction

Lesson Rationale
Exploring the Boston Tea Party and its events helps learners understand the causes of the American Revolution, develop critical thinking and historical analysis skills, learn about civic engagement and democracy, and explore the significance of symbolic actions.

Technology Rationale
Utilizing Bloxels sets, students will have a unique opportunity to engage in hands-on learning about the events leading up to the Boston Tea Party and decide whether to join the Sons of Liberty and participate in the Boston Tea Party. This allows the students to invest in their character as they experience the same issues that affected the colonists of 1773, therefore creating greater engagement with the topic.

Setup

Prior to implementation, the teacher should ensure Bloxels (n.d.-a) Edu sets have all of the components and/or the Bloxels (n.d.-b) app is installed on all of the iPads/tablets. It is helpful if the teacher creates a Bloxels classroom and student accounts prior to the start of this lesson. It is suggested that learners create their characters off-line with a printed version of the Create Your Colonialist document. Finally, a 1773 Bloxels Boston, including key dates, figures, and events, should be created by the teacher (see 1773 Bloxels Boston section).

Learning Objectives

By the end of the lesson, the learner will be able to:

- Recognize critical historical figures from Boston Tea Party events.
- Identify the date of the Boston Tea Party.
- Summarize events of the Boston Tea Party.
- Summarize reasons behind the Boston Tea Party, (e.g., taxation without representation, the Tea Act).

Learning Representation

Creation of Colonial Characters

Students will use one hour to create their colonial character (e.g., "Jonathan" in Figures 1 and 2) using planning worksheets that include the character's backstory and a gridded template to draw the character (see Create Your Colonialist document. Students should use markers, colored pencils, or crayons to sketch their characters. During this time, as students complete their Create Your Colonialist document worksheets, they should gain access to either Bloxels (n.d.-a) Edu sets or iPads/computers to create their colonialists in the Bloxels (n.d.-b) app or on the Play Bloxels website (Play Bloxels, n.d.). If using the Bloxel (n.d.-a) EDU sets, the teacher should assist students with scanning their characters into the student Bloxel profiles.

The students will use iPads/tablets or desktops for 30 minutes to input their created characters, including their various "states," into the Bloxels software (e.g., idle, walking, jumping, falling). After the characters are completed, learners should read short passages about the Sons of Liberty, the Tea Act, the Boston Tea Party, and their impact on the American Revolution. After readings, students will have one hour to explore a teacher-created 1773 Bloxels Boston. After the lesson, students can be allowed to revisit 1773 Bloxels Boston in any downtime or as an incentive.

Figure 1. Jonathan character in idle position.

Figure 2. Johnathan character in walking position.

1773 Bloxels Boston

The 1773 Bloxels Boston is teacher-created and should include key dates, figures, and events such as:

- The Tea Act of 1773 & Townshend Acts
- Samuel Adams, John Hancock, Paul Revere
- The Sons of Liberty

- Boston Harbor
  - Dartmouth, Elanor, and Beaver-the three ships involved
- The Boston Tea Party - Evening of December 16, 1773
  - 90,000 pounds of tea
  - 90,000 pounds of tea
  - Equal to £10,000 or $1.7 million in today's economy

This 1773 Bloxels Boston should be created with various scenes where students interact with different colonists and see how the Tea Act and the Townshend Acts affected the characters. Students should encounter British soldiers and members of the Sons of Liberty. Following these initial scenes, students will be given an opportunity to join the Sons of Liberty and participate in the Boston Tea Party or abstain from the activities. It is recommended that scenes be created based on both decisions so the student can see the consequences of joining or abstaining. The final scene should show the effects of their decision (see example video - Boston 1773; Shaffer, 2024).

Assessments

By exploring these topics, students should be able to describe how this event led to increased colonial unity and resistance which in turn led to the American Revolution. Following this activity, students should submit a written assignment, discussing the specific individuals they met throughout the game, if they chose to join the Sons of Liberty in the Boston Tea Party events, and what influenced that decision.

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About the Author

Elisa L. Shaffer, Instructional Designer, in conjunction with subject matter experts, develops short (3.5-week) professional development courses for academic advisors for NACADA: The Global Community for Academic Advising since 2016. She is currently a PhD Candidate at Old Dominion University in Instructional Design and Technology. Her research agenda is to enhance learning for neurodivergent learners in online learning environments.

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Unraveling Author's Purpose: 5th Graders Step into the Role of Creator!

TED Design Competition Winner

Brittany Musgrave Rivera, Learning Resource Specialist, Pasadena Independent School District, Pasadena Texas

This lesson won the 2024 AECT Teacher Education Division PK-12 Lesson Design Competition. It was not peer-reviewed.

Overview

In this lesson, students demonstrate an understanding of author's purpose by developing their own narrative and bringing it to life with Bloxels, a platform/app and physical kit for people to build their own video games (Bloxels, n.d.b). This lesson is a progressive activity where students apply what they learned about the authors' purpose, according to TEKs Guide (n.d.) ELA.5.10, and create a narrative. Students are divided into groups and given a base "setting." They can expand and evolve this setting to fit their narrative using the included Bloxels Planning Materials to help them plan it. The student groups plan their narrative, design key scenes using Bloxels, and narrate them using a consistent viewpoint. In groups, students work collaboratively and practice their communication skills. A rubric is used to create clarity for students' expectations. Students are expected to include: text (script, setting description, character descriptions), graphics/images, point of view, anecdote or hyperbole, figurative language.

Topics: Author's Purpose & Craft; Collaboration; Narrative Development

Time: 5-6 days, meeting for 45-minute class periods each day

Materials

- Bloxels Edu Set (one per group; Bloxels, n.d.a)
- Bloxels Lesson & Rubric
- Bloxels Planning Materials
- Bloxels Example Planning Materials
- Laptops (one per group)

Context-at-a-Glance

This lesson was developed conceptually for a PK-12 lesson design competition.

Competition Parameters
The Teacher Education Division of the Association for Educational Communications and Technology provided live explorations of Bloxels Edu during the 2024 annual convention. Attendees accessed Bloxels plastic grids and cubes, iPads, the Bloxels: Build Your Own Games app, sample character and game layout cards, resource workbooks, and blank grids to draw and scan ideas. During a three-day time period, attendees were invited to design original, hands-on, curricular materials based on the tools. Their instructions were to amplify or transform student learning in a PK-12 (or equivalent) educational setting and describe their idea in approximately 750 words.

Setting
A 5th-grade classroom in the United States. Students in this classroom include emerging bilingual, special education, and general education students.

Modality
In-person instruction

Instructor Characteristics
A collaboration between the English Language Arts, Reading (ELAR) teacher, and the campus librarian.

Technology Rationale
Using Bloxels, students will think critically about how different mediums impact graphic design and story development. Bloxels allows for frame-by-frame development to bring students' stories to life, encouraging team communication, critical thinking, and problem-solving skills.

Standards

The following Texas English Language Arts standard aligns with this lesson (TEKS Guide, n.d.):

- TEKS ELA.5.10. Author's Purpose and Craft

This lesson also aligns with the following Common Core State Standards for English (Council or Chief State School Officers & National Governors Association, 2010):

- CCSS.ELA-Literacy.RL.5.5 Craft and Structure
- CCSS.ELA-Literacy.RL.5.7 Integration of Knowledge and Ideas
- CCSS.ELA-Literacy.W.5.3 Narrative Writing

Additionally, this lesson aligns with the following International Society for Technology in Education (ISTE; 2016) Student Standards:

- ISTE 1.1 Empowered Learner
- ISTE 1.6 Creative Communicator
- ISTE 1.7 Global Collaborator

Learning Objectives

By the end of this lesson, the students will be able to:

1. Clearly articulate the author's purpose.
2. State the purpose of the narrative.
3. Organize and draft a narrative.
4. Organize well-reasoned ideas.
5. Apply narrative elements (plot, setting, characters, dialogue).
6. Purposefully use narrative elements to create an engaging story.

Learning Representation

In the weeks leading up to the Bloxels activity, students should receive instruction over Author's Purpose and Craft (TEKS Guide, n.d., ELA.5.10). Instruction should cover figurative language, the use of images within a text, point of view, and hyperbole. After completing classroom instruction, students come to the library for the Bloxels assessment activity, co-taught by the campus librarian and the English Language Arts, Reading (ELAR) teacher. This lesson is separated into six days.

Day 1: Introduction

Students are introduced to the assignment and put into groups of 2-3 students to work collaboratively.

During this time, students are introduced to the Bloxels Edu Set (Bloxels, n.d.a). Students are provided with the rubric and planning materials to help them think through ideas (see Bloxels Planning Materials and Bloxels Lesson & Rubric). They begin brainstorming the author's purpose for their narrative. The narrative development includes plot, character, setting (including time period, landscape, reality or alternate reality) and a short script.

Day 2: Planning and Early Creation

Students will continue planning in Day 2. By the end of the class, they should have their planning materials completed (see Bloxels Planning Materials). This will include character descriptions, a short script, a completed plot diagram, and a description of their author's purpose (see Bloxels Example Planning Materials for an example).

Day 3: Creating with Bloxels

On Day 3, students begin creating their key scenes with Bloxels Art Creator and their characters with Character Builder on the Play Bloxels website (see Figures 1 and 2; Play Bloxels, n.d.). The campus librarian and the ELAR teacher will support use of the Bloxel Edu Set as needed.

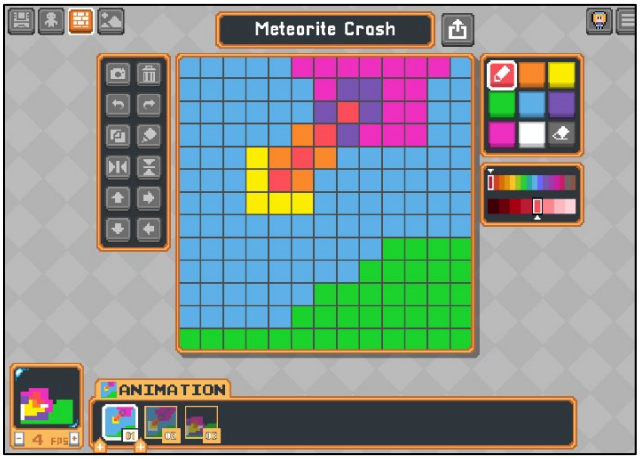

Figure 1. Scene creation example of meteorite crash in Bloxels Art Creator.

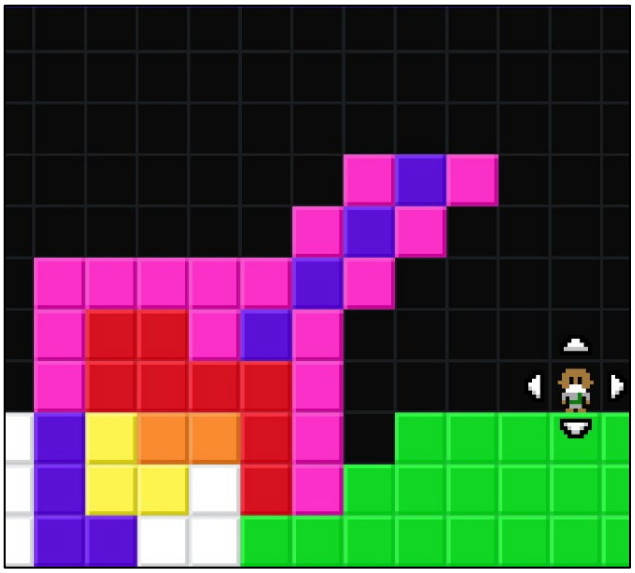

Figure 2. Sample scene with character.

Day 4: Continuing Bloxels Scenes

Students complete their Bloxels scene creation on Day 4. Their final product should include at least three scenes and a minimum of three characters. The completed Bloxels Planning Materials should be used as guide to complete the scenes and characters.

Day 5: Complete and Begin Presenting

At the start of Day 5, students should fine-tune their Bloxels scenes and save them to the Bloxels Edu Class Library.

Students begin presenting their presentations to the class. During the presentations, the campus librarian and the ELAR teacher will use the rubric to provide feedback to each group.

Day 6: Bloxel Presentations

Students continue presentations. At the conclusion of the presentations, rubrics will be returned to groups. Students will have an opportunity to review their rubrics and ask questions to the librarian and ELAR teacher.

Assessment

Students have access to the rubric throughout the assignment as it was presented on Day 1. The rubric was created using Magic School AI (n.d.) and inputting the TEK Guide (n.d.) ELA 5.10 standards, the lesson, and the key components of the narrative (plot, character, setting, and script).

The use of a rubric articulates clear grading expectations for students to self-asses their work, using the rubric as a guide to the project creation (Edutopia, 2008). For teachers, the rubric provides a scale to provide feedback and examine more specifically areas where students need additional instruction (Ferlazzo, 2021).

Formative assessment can be included informally during each class session, and more formally at the end of Day 2 when the students complete the Bloxels Planning Materials. This formative feedback can be provided by the campus librarian and/or ELAR teacher.

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About the Author

Brittany Musgrave Rivera received her master's in library science from the University of North Texas in 2016. Brittany worked as a special education teacher until 2021 when she moved into the role of school librarian. In this role, she seeks out partnerships with classroom teachers and instructional coaches to align library lessons with classroom instruction. Brittany is a doctoral candidate in the Department of Learning Technologies at the University of North Texas. While pursuing her doctoral degree, she is studying technology integration in K-12 learning environments, creating accessibility, and facilitating extended learning opportunities using educational technology.

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Moving Beyond 2D Covalent Bonding: Interactive 3D Experiences with Water and Carbon Dioxide Molecules

JTILT Lesson Competition Winner

Katheryn Ure[1] and Irene A. Bal[2]
[1]St. Paul's Schools, Maryland; [2]Loyola University, Maryland

This article won the 2024 JTILT Technology-Rich Lesson Plan Competition. It was not peer-reviewed.

Overview

This three-lesson sequence is from a Bonding unit in a sophomore High School Chemistry class that focuses on the formation of covalent bonds in simple molecules. The purpose of these lessons is for students to apply their theoretical knowledge of atomic structure and electron arrangements, and understand, at an atomic level, why non-metal atoms share pairs of electrons to achieve electronic stability. Learning objectives are formatively assessed throughout the lessons, focused on addressing student misconceptions. This is done through drawing diagrams and making simple 2D models, through teacher-led question/answer and discussion, and an in-class worksheet. For this three-lesson sequence, eight three-dimensional (3D) experiences were created to support the visualization of the covalent bond formation and minimize students' misconceptions. This paper focuses on two 3D experiences, water and carbon dioxide.

Topics: 3D Experiences, Bonding, Chemistry, Covalent Bonding, Hands on Learning, High School

Time: Three 50-60-minute classes

Materials

- Worksheet showing 11 single bond and multiple bond compounds (see Table 1)
- Counters
- Clear Plastic Sheets or mini (8" x 11") white boards, dry erase markers & erasers
- Paper diagram of the Bohr atomic model
- Student Phones or other QR reading devices

Context-at-a-Glance

Setting
Suburban, all girls, independent high school in the northeastern United States.

Modality
In-person classroom

Organizational Norms
The school has a bring-your-own device policy and has access to a learning management system (LMS) and Microsoft Office 365.

Learner Characteristics
Learners were in 10th grade, all owned iOS devices, and most preferred physical papers and handwriting to complete work. Most students completed physics in 9th grade.

Instructor Characteristics
The lesson was designed by a Chemistry teacher and a Learning Design & Technology faculty member at a local university.

Curriculum Fit
The Chemistry class is divided into seven units over an academic year. This set of lessons falls within Unit 3 which focuses on Bonding.

Setup

For all three lessons, students work in small groups with each group receiving the following materials:

- Eight or more 4" x 4" squares of clear plastic (or mini white board), dry erase markers & erasers

- A large sheet of paper showing a simple Bohr atomic model diagram
- Multiple colored counters

In Lesson 2, students receive a worksheet that includes a partially completed table and information about the bonding and presentation conventions of 11 simple covalent molecules (see Table 1). This worksheet is completed over Lessons 2 and 3. The teacher should check the QR codes and ensure they are working, and students should be prepared to use phones for Lessons 2 and 3.

Context and Setting

This lesson took place at a suburban, all girls, independent high school in the northeastern United States during the 2023-2024 academic year. The school is a bring-your-own-device (BYOD) institution. Cell phones are allowed in class. Students have access to an LMS and Microsoft Office 365. Digital citizenship and technology use are taught at the beginning and throughout the year. Students complete both lab work and classwork. The teacher has access to a lab setting with counters, stools, and various equipment, and a traditional classroom setting with desks and chairs.

Learner Characteristics

Institutional Review Board (IRB) approval was obtained to report the following percentages:

- Sophomore (10th grade) high school students.
- 100% of the students had iOS devices (iPhones).
- 64.1% of students preferred to handwrite their answers while 25.64% preferred to type their answers (10.26% indicated handwriting and typing preference).
- 79.49% of students stated they knew which app to use for a QR code and 92.31% of students indicated they know how to access a link after scanning a QR code.
- 87.17% of students agreed they preferred a physical piece of paper for their work with 94.87% of students stating they like having access to a digital version of the printed worksheet.
- Students are still learning the challenges of Chemistry models and how to use and critique them effectively.
- In 9th grade, students take a mix of math courses (e.g., Geometry, Algebra 1/2). Most students (95%) took Physics in 9th grade.

Instructor Characteristics

The Chemistry teacher had a master's degree in education and 16 years of experience teaching science. The Learning Design & Technology faculty member had a PhD in Instructional Design and Technology and 18 years of experience teaching PK-12 and higher education.

Fit within Larger Curriculum

The Chemistry class is divided into seven units. This set of lessons falls within Unit 3 on Bonding, typically presented in the middle of the school year. Prior to this unit, students learned states of matter, physical changes, separations, atomic structure, and trends in the periodic table. Students should understand the Bohr atomic model and be confident with the vocabulary of valence electron shells. Familiarity with the groups on the periodic table and how these relate to the number of valence electrons is useful. Covalent and ionic bonding are taught within this unit. It is immaterial whether ionic or covalent bonding is taught first and, often, the order of teaching responds to student questions about atom stability. This set of lessons focuses on covalent bonds in simple molecules.

The bonding unit falls after the atomic structure and electron configuration unit and spans approximately 12 lessons. The unit begins with information such as atoms rarely existing alone and that atoms must join in specific patterns (following specific rules) to make molecules and structures called compounds. The primary drivers of the bonding process are the structure of atoms and arrangement of valence of electrons achieving stability. Covalent bonding was focused on second, after ionic bonding, so these three lessons were taught near the middle of Unit 3 (Lessons 5-8 of 12).

The work increases in complexity and subtlety as the lessons progress, so the students collaborate and actively explore each other's perspectives. Assessment of student learning is largely formative in these lessons with small group discussions during the lesson and question/answer sessions to assess knowledge and its application. The collaborative

learning environment allows students to build confidence in their groups, so any questions are dissociated from any particular individual and corrections are a shared responsibility.

Learning Representation

Objectives

By the end of this three-lesson sequence, three learning objectives are met. Students can:

1. Apply the octet rule to complete the valence shells of atoms by sharing pairs of electrons.
2. Demonstrate how nonbonding and bonding pairs of electrons impact the shape of molecules.
3. Decipher and encode molecular structures in three different conventions.

Lesson 1-Single Covalent Bonds

Review

Begin the first lesson with a review of atomic structure and electron configurations of the first 36 elements. Using the squares of clear plastic (or mini white boards), the Bohr model diagram, and counters, ask student groups to create diagrams and electron configurations (see Figure 1). Students should make and draw 2D electron arrangements in shells and give numerical electron arrangements as the teacher draws parallels between the atom's position on the periodic table and the atomic structures. Most of the lesson is focused on this review.

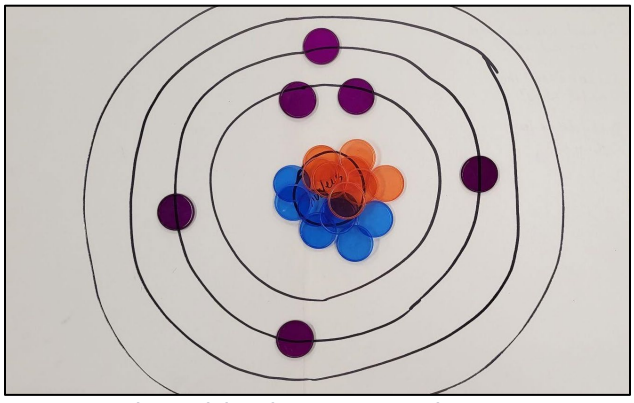


Figure 1. Bohr Model and counters to indicate protons, neutrons, and electrons.

Main Lesson

The main lesson includes a short lecture about atoms coming together to complete their valence shells and the Octet Rule to achieve stability. After the lecture, students engage with an interactive activity from PBS (Bruce, n.d.).

After engaging with the interactive PBS activity, students draw valence shells and their valence electrons for some Period 1 and 2 elements (from the periodic table) on clear plastic sheets and overlap the shells (sheets) to share pairs of electrons and complete the outer valence shells (see Figure 2). The worksheet for Lessons 2 and 3 is introduced, and students begin converting these models into diagrams on their worksheet (see Table 1).

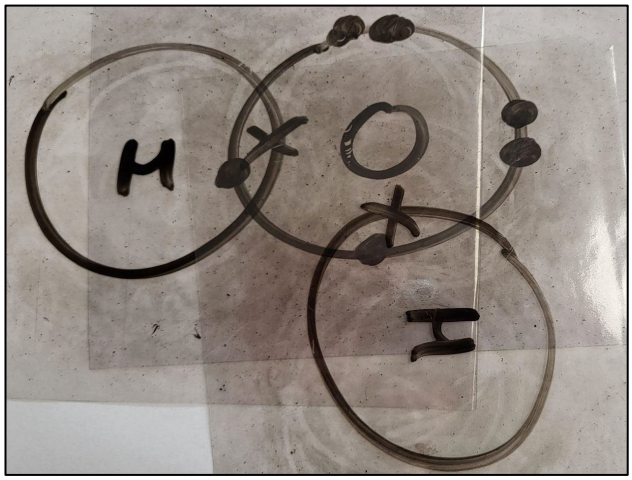


Figure 2. Water showing overlapped valence shells and their valence electrons.

Name	Formula	Atoms	Dot Cross & Lewis diagram	Structure
Water		2 x H 1 x O		H20
	CO_2			CO2 Double Covalent Bond

Table 1. Example of worksheet given to students with water and Carbon Dioxide (CO_2).

Students have access to the 3D experiences for the single bonded compounds in this lesson but tend to run out of time to view these experiences. They are focused on in Lesson 2.

Formative Assessment

During the main lesson portion of Lesson 1, the teacher circulates the room engaging each group in where they are in the activities (i.e., PBS, drawing valence shells, worksheet), and what questions they have. It is helpful for the teacher to redirect students who are off-task and ensure students are progressing at a pace that allows the whole class to be ready for Lesson 2.

Lesson 2-Single Covalent Bonds Continued

Review

Start the lesson with a review of prior lesson content. Using clear plastic squares and dry erase markers, ask students to work collaboratively and make simple covalent bonds and molecules to reengage the content from lesson 1 (see Figure 2).

Main Lesson

The main work of the lesson starts with a short teacher-led explanation introducing the rules governing bonding pairs of electrons and nonbonding pairs of electrons and how these influence the shape of molecules while simultaneously satisfying the octet rule for each atom.

Students work in cooperative groups to complete the formulas and dot cross models on the worksheet (Table 1), focusing on creating simple molecules with single covalent bonds. Table 2 is a completed version of the worksheet focusing on water (H_2O). The worksheet contains information for a total of 11 simple molecules, seven of which use single covalent bonds. The simple molecules presented on the worksheet get progressively more complex. This article is only showcasing one single bonded molecule, water (H_2O; Bal & Ure, n.d.-b).

Students used the 3D experiences to interact with and visualize the bond formation and the geometric arrangement of bonding and nonbonding electron pairs around the atoms (see Figure 3 for the water 3D experience). The 3D experiences animate the traditional 2D models and support further discussion on the rules governing molecular shapes and number of covalent bonds formed.

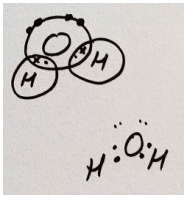
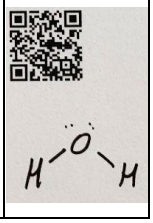
Name	Formula	Atoms	Dot Cross & Lewis diagram	Structure
Water	H_2O	2 x H 1 x O		

Table 2. Completed worksheet questions for water (Single Bond).

H20

Figure 3. Water (H_2O) 3D experience.

Formative Assessment

During the main lesson, the teacher formatively assessed learning progress and challenged the students to consider the geometry of molecules such as water, ammonia, and methane using the position of nonbonding and bonding pairs of electrons to justify the molecular shapes. It is helpful for the teacher to intermittently check group worksheet responses to ensure accuracy, redirect students who are off-task, and ensure students are progressing at a pace that allows the whole class to be ready for multiple covalent bonds (Lesson 3).

Lesson 3-Multiple Covalent Bonds

Review/Formative Assessment

Start the lesson with a formative assessment using the mini whiteboards. Ask students to give the

formulas and draw the dot cross models of molecules studied in Lesson 2 (e.g., water, methane).

Elicit, though a collaborative snowball discussion, the reasons for geometric molecular shape and how the covalent bonds satisfy the octet rule for each atom. This is both a review for students and a formative assessment for the teacher.

Main Lesson

If further time is needed to master the single bonded molecules, dot cross model, and the octet rule content, then it can be given here before moving on. It is imperative that students understand single bonds before moving to multiple bonds.

Using the squares of clear plastic (or mini white board) and dry erase markers, students explore the formation of multiple bonds to complete octet electron arrangements whilst simultaneously creating stable electron arrangements. Students work out the valence electron arrangements in oxygen gas, nitrogen gas, and carbon dioxide (see Figure 4). The 2D models are limited because the electrons cannot move. The 3D experiences provide animated, interactive visualization of electron rearrangement in the shells as they are shared between the pairs of nuclei (see Table 3 and Figure 5). Students can use the 3D experiences to create models of all types for multiple bonded molecules.

Figure 4. Carbon Dioxide showing overlapped valence shells and their valence electrons.

Students then return to the worksheet to complete the multiple covalent bonds. Four of the 11 items on the worksheet are multiple covalent bonds. This article is only showcasing one multiple bonded molecule, Carbon Dioxide (CO_2; Bal & Ure, n.d.-a).

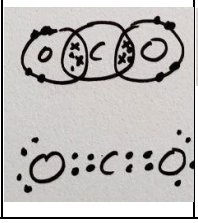
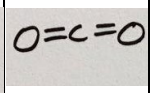
Name	Formula	Atoms	Dot Cross & Lewis diagram	Structure
Carbon Dioxide	CO_2	1 x C 2 x O		

Table 3. Completed worksheet questions for Carbon Dioxide (double bond).

CO2 Double Covalent Bond

Figure 5. Carbon Dioxide (CO_2) 3D experience.

Formative Assessment

The teacher should circulate the classroom, assessing student understanding of molecular structure and the multiple bonds being formed. Close questioning can elicit whether the students are using the octet rule and an understanding of why each atom forms the number of bonds with different types of atoms. The teacher should also check worksheet responses to ensure accuracy.

The resulting completed worksheet is a comprehensive study guide for simple molecules that the students frequently refer to in their HS Chemistry lessons. It also provides the teacher with formative assessment feedback on the ability of students to apply prior learning on atomic structure to the formation of simple compounds.

Critical Reflection

This lesson sequence has been implemented annually from 2022-2024. These three covalent bonding lessons fit within a larger bonding unit, and the two featured 3D experiences, along with several others that were developed, provide an effective way for students to visualize the process of bond

formation when incorporated into a sequence of other activities throughout the unit. Implementing the lessons requires clear instructions to students on the appropriate use of phones in the learning environment to avoid distractions or misuse. The experiences are web based which avoids the need for downloading apps, but instructors need to test the QR codes prior to each lesson to ensure the experiences are working. Further consideration is needed in the design of these experiences to ensure they continue to be available regardless of software updates, acquisitions, and discontinuations.

The students were more engaged when using the 3D experiences in this complex topic than in prior years without the experiences. The students were challenged to work collaboratively and construct their understanding of the concepts after group and class discussions. This collaboration extended their abilities and vocabulary as they had to articulate their understanding of the observed bond formation and relate this to prior learning on atomic structure.

In the 2023-2024 academic year, students' (n = 34) perceptions were collected at the end of the unit with most students reporting a positive learning experience. When asked if they liked using the apps and 3D experiences on their phones, 85.29% of students agreed. Students also agreed (91.18%) that the apps and 3D experiences helped them understand the materials. Students value the opportunity to interact with electrons, see bond formation, and manipulate the final molecules to visualize the 3D structures. There are limitations to the created 3D experiences because inner electrons are not shown and the electrons remain static in the valence shells, but these are similar considerations when using the 2D Bohr models or ball and stick plastic molecular models.

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AI-Enhanced Writing Self-Assessment: Empowering Student Revision with AI Tools

JTILT Lesson Competition Winner

Robin Dazzeo, University of Hawai'i at Mānoa

This lesson won the 2024 JTILT Technology-Rich Lesson Plan Competition. It was not peer reviewed.

Overview

This technology-rich, three-day lesson for 9th-12th grade English Language Arts students leverages artificial intelligence (AI)-enhanced rubrics and writing analysis tools (Ouyang & Jiao, 2021) to improve student writing and self-assessment skills. Students explore AI-enhanced digital rubrics, use AI tools to analyze their writing, and apply AI-generated feedback to revise their work. This approach enhances current writing assignments and develops critical thinking skills and digital literacy. Assessments include AI-generated feedback reports, peer evaluations, and final revised writing samples demonstrating improvement based on AI and peer input, equipping students with valuable skills for future writing tasks.

Topics: AI-Enhanced Rubrics, Peer Review, Revision Strategies, Writing Self-Assessment

Time: Three 50-minute class periods

Materials

- Computers with internet access (one per student)
- Access to a student-friendly AI writing assistant (e.g., MagicSchoolAI, n.d.)
- Student guide to understand AI-Enhanced rubrics
- Student-friendly AI prompts for self-assessment
- 4-step process to ace AI-enhanced rubrics
- AI-Informed Peer Review Worksheet
- Student writing samples from recent assignments or a teacher/AI-generated sample essay
- Projector or large screen for demonstrations
- Whiteboard or digital space for class discussions

Context-at-a-Glance

Setting
Hawaii's public secondary schools, serving diverse students in a formal educational environment.

Modality
In-person classes over three 50-minute sessions

Class Structure
Flexible classroom setup with options for U-shaped or small group arrangements for collaboration.

Organizational Norms
The schools reflect Hawaii's push for technology integration, driven by geographical isolation and the need for global connectivity. Most schools have 1:1 device programs and internet access.

Learner Characteristics
The learners were 9th-12th grade students across content areas with varying levels of English proficiency and diverse linguistic backgrounds.

Instructor Characteristics
Teachers should be familiar with AI writing tools and digital rubrics and be able to guide students through technology-enhanced writing assessments.

Development Rationale
This lesson was created to address key challenges in writing instruction: a limited teacher time for detailed feedback, the need for immediate guidance on revisions, and varying English proficiency levels.

Design Framework
Collaborative elements reflecting Pacific Island cultural values; leveraging AI tools to provide equitable access to writing feedback

Setup

Prior to the lesson, complete the following items:

- Ensure all devices are charged and connected to the internet.
- Test the chosen AI writing assistant on school devices to confirm student access.
- Prepare digital handouts (e.g., via a learning management system or shared drive) or print handouts for easy distribution.
- Arrange the classroom to allow for both individual work and pair discussions. Consider a U-shaped or small group setup to facilitate collaboration.
- Set up the projector or large screen for demonstrations.
- Create a digital collaborative space (e.g., Padlet) for class discussions and sharing insights.

Standards

This lesson aligns with the following Council or Chief State School Officers and National Governors Association (2010) standards for Writing, Grades 9-12:

- CCSS.ELA-LITERACY.W.9-12.5: Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.
- CCSS.ELA-LITERACY.W.9-12.6: Use technology, including the Internet, to produce, publish, and update individual or shared writing products.
- CCSS.ELA-LITERACY.W.9-12.9: Draw evidence from literary or informational texts to support analysis, reflection, and research.

Learning Objectives

By the end of this three-day lesson, students will be able to:

- Interact with AI writing assistants.
- Engage in peer reviews informed by AI feedback.
- Produce revised essays.

Instructional Strategies

This three-day lesson supports the following instructional strategies:

Guided Practice
The teacher demonstrates the use of AI tools and guides students through initial interactions, providing scaffolding for new technology use.

Collaborative learning
Pair work for rubric analysis and peer review encourages discussion and multiple perspectives, leveraging diverse student backgrounds.

Individual Application
Students apply AI feedback to their writing, promoting ownership of the revision process and personalizing the learning experience (Su & Yang, 2023; Panadero & Romero, 2014).

Reflective Discussions
Regular reflection helps students process new concepts and consider the role of AI in their writing practice, developing critical thinking skills.

Scaffolded Technology Integration
Gradual introduction of AI tools, from demonstration to independent use, accommodates varying levels of tech proficiency.

Culturally Responsive Teaching
Incorporating collaborative activities and allowing for multilingual support respects the diverse backgrounds of Hawaii's students.

Differentiated Instruction
The AI tool provides personalized feedback, allowing students to focus on specific areas for improvement.

Context and Setting

Hawaii's public secondary schools serve a uniquely diverse student population, presenting opportunities and challenges in writing instruction. The state's push for technology integration is driven by geographical isolation and the need to prepare students for a globally connected world. Many schools have a 1:1 device program, making this technology-rich lesson feasible across various settings.

AI tools in writing instruction address key challenges: limited teacher time for detailed feedback, the need for immediate guidance on revisions, and varying levels of English proficiency among students (Su & Yang, 2023). This lesson introduces AI-enhanced rubrics to provide more equitable access to high-

quality writing feedback and demystify AI as a tool to enhance human judgment in writing (Ouyang & Jiao, 2021).

The lesson is adaptable to different classroom setups, which is crucial given the varying technological resources across Hawaii's schools. It incorporates collaborative elements like peer review and group discussions, reflecting Pacific Island cultural values. AI tools can provide feedback in multiple languages, respecting students' diverse linguistic backgrounds.

The three-day lesson structure fits well within typical school schedules, allowing time for reflection and revision between classes. This three-day time also accommodates busy high school students who may need more time outside of class for extensive writing assignments. *In this article, italic text identifies questions or prompts for the learners.*

Learning Representation

Day 1: Introduction to AI-Enhanced Rubrics (50 minutes)

Opening Discussion (10 minutes)

To start the Day 1 lesson:

- Engage students in a discussion about their experiences with rubrics and self-assessment.
- Prompt students with questions such as: *"How do you usually evaluate your own writing?" "What challenges do you face when trying to improve your essays?"*
- Introduce the concept of AI-enhanced rubrics and their potential benefits in developing self-regulation and performance (Panadero & Romero, 2014). See A Student Guide to Understanding AI-Enhanced Rubrics for benefits.

AI-Enhanced Rubric Demonstration (15 minutes)

After the opening discussion, spend some time demonstrating an AI-enhanced rubric:

- Display a sample AI-enhanced rubric on the main screen (see A student Guide to Understanding AI-Enhanced Rubrics).
- Compare it to a traditional rubric utilized in your classroom/school. Highlight key differences. See A Student Guide to Understanding AI-Enhanced Rubrics for a comparison of traditional and AI-enhanced feedback.
- Explain how AI can provide more specific and actionable feedback.
- Open/display the AI tool on the projector/large screen.
- Demonstrate how the AI tool analyzes a sample essay. Utilize similar prompts found in the Student-Friendly AI Prompts for Self-Assessment for this AI analysis. Point out the detailed feedback AI generates.

Guided Practice (20 minutes)

After the demonstration, allow students to explore the AI-enhanced rubric:

- Distribute A Student Guide to Understanding AI-Enhanced Rubrics digitally (or via printouts).
- Have students analyze the rubric in pairs, identifying key criteria and performance levels.
- Using a shared document or collaborative digital space, ask pairs to rewrite one criterion to be more specific and measurable.
- Circulate to provide support and encourage critical thinking about rubric design. It is helpful if the teacher ensures students stay on task and are ready to share in the closing reflection.

Closing Reflection (5 minutes)

At the end of the lesson:

- Facilitate a brief class discussion on the potential benefits and challenges of AI-enhanced rubrics.
- Have students share one insight they gained about writing assessments.
- Preview the next day's activities, asking students to bring a piece of their writing to class. You can pre-load this piece of writing by implementing this three-day lesson near the end of a writing lesson/unit. It is helpful if students complete self-assessments of their writing prior to Day 2.

Day 2: Using AI for Self-Assessment (50 minutes)

Review and Introduction (10 minutes)

To start the Day 2 lesson:

- Recap the AI-enhanced rubrics.
- Introduce the Student-Friendly AI Prompts for Self-Assessment showcasing prompts that can be used in AI.
- Open/display the AI tool on the projector/large screen.
- Demonstrate how to input a writing sample and rubric into the AI tool.
- Address any student questions or concerns about using the AI tool.

AI Tool Exploration (15 minutes)

After the review and introduction, guide students in an exploration of the AI tool:

- Distribute a digital sample writing/essay and rubric for students to practice with as a whole group. Have students open/download the sample writing/essay and rubric.
- Have students log into the AI writing assistant.
- Guide students through inputting the sample writing/essay and rubric in the AI tool.
- Analyze the AI-generated feedback as a class, discussing the strengths and limitations.
- Highlight how to interpret different aspects of the feedback (e.g., grammar, structure, content).
- Distribute and review the 4-Step Process to Ace AI-Enhanced Rubrics.

Individual Practice (20 minutes)

After guiding students in the exploration, have students practice individually:

- Students should access their piece of writing they completed after Day 1 or prior to this three-day lesson.
- Have students input their piece of writing and the corresponding AI-enhanced rubric into the AI tool (see A Student Guide to Understanding AI-Enhanced Rubrics).
- Students should review and take notes on the AI-generated feedback, focusing on identifying patterns and key areas for improvement. Have students use the 4-Step Process to Ace AI-Enhanced Rubrics to assist them with this review.
- Encourage students to compare the AI feedback with their self-assessments (if completed).
- During this individual practice, the teacher should circulate the room supporting any technical needs and guiding students on how to read and understand their AI-generated feedback.

Reflection and Sharing (5 minutes)

At the end of the lesson:

- In pairs, have students share one insight from their AI feedback.
- Facilitate a brief class discussion on the usefulness of the AI feedback and any surprising discoveries.
- Assign homework: Students should review their AI feedback in detail and come prepared to discuss their revision plans. This three-day lesson could be extended and/or modified for this detailed review if homework is not feasible. Have students continue to use the 4-Step Process to Ace AI-Enhanced Rubrics to assist them with this detailed review.

Day 3: Applying AI Feedback and Peer Review (50 minutes)

Opening Discussion (5 minutes)

To start the Day 3 lesson:

- Discuss the importance of critically evaluating AI feedback.
- Explain the revision and peer review process.
- Emphasize the role of human judgment in the revision process.

Individual Revision (20 minutes)

Prior to peer-reviewing, have students individually review their AI-enhanced feedback and writing:

- Students should review their AI feedback and identify 2-3 key areas for improvement.
- Using the AI suggestions and their judgment, students should revise their writing samples.

- Encourage students to track their changes and note their reasoning for accepting or rejecting AI suggestions. It is important for students to maintain their original work, so they have an original and edited/revised version for the peer-review.
- During this individual revision, the teacher should circulate the room supporting any technical needs and chat with students on the 2-3 key areas for improving their writing. Teachers should support students in making decisions on accepting and rejecting the AI suggestions if they need it.

Peer-Review (15 Minutes)

After students had time to individually revise their writing, they should begin the peer-review process:

- Introduce the AI-Informed Peer Review Worksheet explaining how to use the worksheet and what the students will do. Distribute this worksheet to students digitally (or via printouts).
- Have students get in pairs and exchange their original work, AI feedback, and revisions.
- Using the AI-Informed Peer Review Worksheet, students should offer additional suggestions and discuss the effectiveness of the changes.
- Prompt peers to consider *"How well did the writer address the AI feedback?" "What human insights can you add?"*
- Have students exchange the completed AI-Informed Peer Review Worksheet to one another and provide time for students to reflect on the feedback provided to them by their peer. It is helpful if students write a brief reflection for teacher review.
- During this peer-review, the teacher should circulate the room to ensure students are on task and providing constructive feedback to one another. It may be helpful to facilitate peer-review feedback in prior classes to support students in giving constructive, deep feedback to one another.

Final Reflection (10 minutes)

At the end of the lesson:

- Facilitate a class discussion on the benefits and limitations of using AI for self-assessment.
- Have students share how they plan to use AI-enhanced rubrics in future writing tasks.
- Collect final revised essays, AI-Informed Peer Review Worksheets, and student reflections on the revision process.

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About the Author

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technologies, emphasizing the creation of inclusive, technology-rich learning environments that promote student self-assessment and academic achievement.

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