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Journal Editors

Editorial Board

Journal of Technology-Integrated Lessons and Teaching Contents

Volume 4 Issue 2 December 2025

Front Matter

Learning Representations

Competition Award Winners

Special Call for Manuscripts: Artificial Intelligence in Education

The Journal of Technology-Integrated Lessons and Teaching will publish a special issue regarding artificial intelligence in June 2026. Manuscripts should be submitted by the end of January 2026.

Topics

Potential lesson topics include (but are not limited to):

- Lessons focused on tool awareness, purposes, and/or uses
- Training content specific chatbots or AI with natural language processing
- Generating visuals in the age of AI
- Leveraging chatbots as tutors
- Using AI for pattern recognition, task automation, and/or data analysis
- AI prompting techniques for teachers and/or students
- Lessons that use AI for troubleshooting, feedback, and/or assessment
- Using AI to differentiate instruction and/or promote Universal Design for Learning
- Leveraging AI to help students solve ill-structured problems
- Navigating Copyright and/or ethics in the age of AI

Manuscripts should be original and unpublished elsewhere (personal blogs and websites do not count as publications).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 sufficient detail so that others can implement them as is. Submissions should follow the JTILT Author Guidelines and use the provided Manuscript Template. Supplemental files needed for lesson implementation (e.g., presentations, video recordings, rubrics, game components, assessments) should be included with the submission as separate attachments and use the formatting templates provided in Author Guidelines.

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

Important Dates

January 31, 2026: Initial manuscripts due
February 22, 2026: Reviewer feedback provided
March 8, 2026: Manuscript revisions due; second review begins
March 29, 2026: Reviewer feedback provided on revised manuscript
April 12, 2026: Revisions due; Copyright editing begins
May 3, 2026: Copyright feedback provided
May 17, 2026: Final revisions due; copy and layout editing begins
June 2026: Special issue published

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Introduction

Craig E. Shepherd, Editor-in-Chief

Articles in This Issue

As the end of 2025 approaches, the JTILT editorial team is pleased to publish another issue. Thank you to those who have submitted or reviewed manuscripts, leveraged published resources, shared the journal with others, or helped in other ways. JTILT could not exist without your efforts! This issue includes nine peer-reviewed articles, three award winning articles, and a call for a special issue on the use of artificial intelligence in education.

The first two articles focus on helping students develop their voice through writing. *Creating and Sharing Zines with Video Tools for Online Humanization"* by Alexandra J. Reyes and Lucas John Jensen engages online graduate students to develop magazines and video presentations that highlight the writer's culture. *Emojis: Developing Enthusiasm in Writing* by Laurie MacGillivray and Jasmine Worthen focuses on students of all ages in an after-school, in-person, writing club. During three lessons, students use emojis to scaffold original stories.

Podcasts and Practice: An approach for Teaching Vocabulary by David J. Mulder leverages podcasts to help in-person preservice teachers recognize and unpack professional language associated with InTASC standards. Whereas *Thematic Analysis Using Accountability Partners and Collaborative Writing* by Ali Krzyzaniak pairs 8th grade students in an in-person English Language Arts class to co-write a literary analysis essay using Google Docs for feedback and revisions.

The next three articles leverage artificial intelligence tools to achieve learning goals. *Differentiating Instruction with AI Tools* by Tonia Bauer asks preservice teachers in an in-person course to leverage ChatGPT and Ludia to differentiate instruction with Universal Design principles. In *Biomimicry and Human Design: Observing Bird Structures and Functions to Create Flying Machines with Artificial Intelligence* by Heejung An, Triada Samaras, and Woonhee Sung, fifth grade students consider attributes of birds to help them prototype and reflect on a flying machine they create. In *Robot Sharks: An AI and STEM Adventure for 5th Grade Students* by Meize Guo, Kristen Apraiz, Yongju Jeon, Michael J. Johnson, Gayle Evans, and Maya Israel, students leverage artificial intelligence to consider shark recognition, adaptation, and tagging before designing their own shark.

The eighth article, *Youth-Led Experiential Research by First-Year Undergraduates: Investigations into Youth, Technology, and Society* by Joan E. Hughes, Anna R. Oliveri, and Michelle Read focuses on a 14-week, in-person, introductory research course for first-year undergraduate students that centers around technology-use in society.

The final peer-reviewed article, *Modeling Sampling Distributions in an Advanced Placement Statistics Lesson* by Colin Ferreira focuses on an in-person high school course where students use statistical applets and current events to consider how sample size influences population estimates.

Lesson Competition Winners

Technology-Rich Lesson Competition

Within the past six months, the JTILT team hosted a lesson competition where educators submitted original, technology-rich work. While similar in appearance to other JTILT articles, these submissions were reviewed by an awards panel, as opposed to the traditional peer-review process. Lessons submitted by the two winners of this competition are published in this issue. *Building Vocabulary with Canva: Digital storytelling for 3rd and 4th grade English Language Learners* by Claire Sanderlin describes an in-person, three-day lesson where students develop their vocabulary through word visualization, sentence construction, and verbal communication as they construct Canva presentations.

Digital Fingerprints: A Technology-Enhanced Forensic Investigation by Rocky Elmore takes place in an in-person, high school, forensic science class over two 80-minute block sessions. During the first day, students identify their right-thumb fingerprint type and compare the class averages with national averages. The next day, they sample fingerprint types across multiple classes, compare the larger sample averages to national averages, and discuss principles of sample size.

Teacher Education Division Competition

During the annual convention of the Association for Educational Communications and Technology (AECT), held October 20-24, 2025, attendees were challenged to produce an original technology-rich lesson associated with a tool revealed at the convention. This year, participants used Genially, a tool to create interactive presentations, infographics, and assessments.

In addition to other conference duties, participants familiarized themselves with Genially and developed an original, concise lesson that included a prototype made with the tool. This year, Crisianee Berry won the competition with her activity *TechQuest Classroom*. During this 20-minute activity, preservice teachers within an in-person or online classroom use Genially to align technology-integration approaches with various learning theories.

Current Lesson Competition

This issue also has a call for lessons associated with artificial intelligence that will be published in a special issue in June 2026. As part of this issue, the Teacher Education Division of AECT is seeking brief lessons associated with Canva AI tools. Winners of this competition will have their lessons published in the special issue. Canva AI lesson competition details are posted in the Announcements section of the JTILT website and are due March 9, 2026.

Freely Share and Modify Lessons

Whether or not you submit manuscripts for the journal or participate in lesson competitions, I hope you use, share, and modify journal resources. Unless otherwise noted, all JTILT articles, posted presentations, assignments, rubrics, job aids, and so forth are published under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International license (pictured below):

This license allows you to freely use and share these resources for non-commercial purposes! You may also make and share modifications of these lessons and resources by identifying the original authors, indicating what modifications were made, using the materials non-commercially, and licensing modifications under the CC BY-NC-SA 4.0 license.

Get Involved!

JTILT strives to bring higher education, PK-12 experts (and their international equivalents), and related professionals together to consider technology-integrated instruction. The journal has made strides in this area, but more work is needed. The JTILT editors and editorial board continue to examine how to simplify processes, make them more relevant to practitioners, and disseminate materials that are immediately useful.

We need and welcome your voice! Reach out to the editorial team to get involved. Share your ideas and suggestions. Volunteer to review manuscripts. Information about the peer-review process and how to volunteer as a reviewer is located on the JTILT website. Additionally, share what you are doing in your learning environment by submitting an original manuscript. Author guidelines for manuscript submissions are found on the JTILT website. JTILT editors also recently updated journal policies on the use of artificial intelligence for manuscript and lesson preparation. JTILT is growing! Please participate with us!

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Creating and Sharing Zines with Video Tools for Online Humanization

Alexandra J. Reyes and Lucas John Jensen, Georgia Southern University

Overview

This activity is built around the creation and online sharing of culture zines via video-sharing tools, demonstrating content knowledge while humanizing an online course. Using crafting and repurposed materials, students in an asynchronous, graduate education course created zines—essentially handmade magazines—showcasing aspects of their culture. Students shared their finished zines by recording and posting short videos and responded to their classmates' work. They then wrote reflections about the entire experience. By engaging with each other's zines, students expanded their understanding and appreciation of other cultures. This activity highlights the potential for community building, creative assessment, cultural expression, and humanizing the learning process within an asynchronous online course.

Topics: Creative Assessment, Culture, Humanization, Video Sharing Tools, Zines

Time: Two weeks

Materials

- Zine-making materials (e.g., newspapers, magazines, paper, fabric, photos, printed art, stickers, markers, tape, glue, scissors)
- Internet access for instructor and students
- Computer with a mic and camera for each student
- Video capturing/screen casting tool for each student (e.g., Canva, ScreenPal, Screencastify)
- Video-sharing platform for instructor and students (e.g., Padlet, Screencastify)
- Culture Zine Assignment Instructions
- Intro to Zines Presentation
- Illustrated 8-Page Zine Instructions
- Creating Zines Resource Padlet
- Evaluation Rubric

Context-at-a-Glance

Setting
A graduate course about Cultural Diversity and Teaching English to Speakers of Other Languages (TESOL) at a large, comprehensive university in the Southeastern United States.

Modality
Asynchronous online

Class Structure
A 3-credit, 16-week course with biweekly modules.

Organizational Norms
Thematic modules include readings, discussions, and application-based and reflection assignments designed to provide background knowledge (i.e., historical, theoretical, pedagogical) that can be applied to the learners' teaching contexts.

Learner Characteristics
The graduate learners are practicing P–12 teachers, spanning grade levels and content areas and come from various geographic regions and experiences.

Instructor Characteristics
The instructor and collaborator have 20+ years combined experience with online teaching. The instructor prepares teachers to work with diverse and multilingual learners and has implemented arts-integrated pedagogies since she taught P–12. The collaborator, an instructional technology educator, previously worked as an instructional designer.

Development Rationale
Create an opportunity for learners to engage culture while humanizing the online classroom. This fulfilled a desire for greater technology integration and creative assessment in the course.

Design Framework
Social Presence Theory

Setup

Note: This assignment was originally conducted using the video-based discussion website Flip, formerly (and more commonly) known as Flipgrid. Unfortunately, Flip was sunsetted by Microsoft in July 2024, shortly after this project ended. Another video-based discussion tool (e.g., Padlet, Screencastify) can be used.

This activity is part of a 2-week module on identity and culture, situated toward the beginning of the semester. Resources (i.e., assigned readings, presentations, videos, and guiding documents) should be organized in a learning management system (LMS) so learners can easily access them asynchronously. The module readings provide background knowledge on identity and culture, while the additional resources elaborate on these topics and provide guidance on the activity. A description of the readings, resources, and activity sequence is provided in the Activity Structure: Culture Zine section.

Instructors and students must have a method to record and save video, whether via smartphone, tablet, or computer. They must also have access to a video-sharing site and a central discussion board. The authors suggest tools like Screencastify, ScreenPal, or Canva for screen recording and Padlet or Screencastify for hosting video-sharing discussions. In the wake of the sunsetting of Flip, several platforms are stepping in to try to fill the void.

To create their zines, students may use any combination of newspapers, magazines, paper, fabric, printed images/text, photographs, drawn art, stickers, markers, pens, tape, glue, and any other crafting supplies. They would create these analog zines at home (asynchronously). See figure 1 for an example culture zine.

Video recording tools are used to make short explainers, in which learners show their analog zines and describe their meaning. The video sharing/discussion tool is used to post, view, and respond to others' work.

Standards

This course is the first in a three-course series that leads to a state English to Speakers of Other Languages (ESOL) teaching endorsement. The ESOL endorsement requires teacher candidates to be prepared around five standards: (a) knowledge about language, (b) language and culture, (c) planning and implementing instruction, (d) assessment and evaluation, and (e) professionalism and leadership.

In addition to alignment with state and national standards related to initial teacher preparation for Teaching English to Speakers of Other Languages (TESOL International Association [TESOL], 2019), this activity aligns with international standards related to technology education (a) for students and (b) for educators (International Society for Technology in Education [ISTE], 2016, 2017). Specifically, the following standards are addressed in this assignment:

- TESOL (2019) Standard 2: ELLs in the Sociocultural Context (2a; 2c)
- ISTE (2016) Standard 1: For Students (1.2.b; 1.4.a; 1.6.b; 1.6.c; 1.6.d; 1.7.a)
- ISTE (2017) Standard 2: For Educators (2.4.d; 2.5.a; 2.5.b; 2.6.a; 2.6.d; 2.7.a)

Figure 1. An example student culture zine.

Context and Setting

The Culture Zine Activity was implemented in a 16-week asynchronous online graduate course in a College of Education. The course is an introduction to teaching culturally and linguistically diverse students,

with an emphasis on contextual and educational factors that impact English learners (ELs). On average, 20 students enroll in each course section.

The Cultural Diversity and TESOL course is not only part of the ESOL endorsement but is also a requirement for most of the college's initial certification education programs. This means that learners in the course have varying experience with, interest in, and commitment to working with ELs and multilingual students. Learners in the course engage with a variety of readings, multimedia resources, video lectures, discussions, interviews, and creative assignments.

The course explores identity, culture, and language, and is organized in three parts: historical context, theoretical perspectives, and pedagogical application. Each part is further organized into two-week modules (M), as follows:

- M1-Who Are We?
- M2-Identity & Culture*
- M3-Who Are 'Americans'?
- M4-Education vs. Schooling
- M5-Historical Access to Schooling
- M6-Responding to CLD Students
- M7-Supporting CLD Students
- M8-Creating Meaningful Instruction

*The Culture Zine activity is an M2 assessment.

In Spring 2024, the instructor taught the Cultural Diversity and TESOL course, teaching it once before. Based on their previous experience, the instructor recognized the unique challenge of creating community in asynchronous online learning spaces. The course instructor reached out to their colleague for guidance on developing assignments that would engage the learners' humanity and creativity through technology-integrated assessments. The two collaborated on a set of creative projects that addressed the need for humanization and connection online, while meeting course objectives.

Social Presence Theory

Social Presence Theory attempts to understand how technology-mediated communication creates social presence, giving communicators the feeling of being and interacting with "real" people on the other end of technology (Kear et al., 2014; Short et al., 1976; Weidlich et al., 2018). Online courses often communicate little in the way of socio-emotional information, meaning that the feeling of human interaction can be diminished (Kear et al., 2014; Weidlich et al., 2018). The more social presence, the more a learner feels that they are a real person interacting with other real people, which might have motivating factors for learners in a classroom (Jensen & Kim, 2024; Yang et al., 2016).

This activity attempts to humanize online classes by increasing the social presence of learners through sharing their culture zines in a video discussion. Online courses, particularly asynchronous ones, often struggle with building a community online, leading students to feel dehumanized and isolated, potentially leading to higher attrition rates (Jensen & Kim, 2024; Phirangee & Malec, 2017). Because so much of asynchronous online education is text-based, students might miss these humanizing interactions that provide socio-emotional information necessary for building social presence and community (Kear et al., 2014; Weidlich et al., 2018).

Learning Representation: Culture Zine

The culture zine activity described here was implemented in a 16-week asynchronous online graduate course and can be easily adapted to work in other instructional modalities (e.g., synchronous online, hybrid, face-to-face) and applied to a range of content matter and learning contexts. For example, students in a science class might be tasked with creating a zine that explores the solar system, or social studies students might make a zine that elaborates upon a significant historical event. The instructor has used a zine creation assignment twice in addition to the implementation detailed here: previously in an in-person undergraduate Elementary Arts Integration course, and afterward in a hybrid undergraduate version of the Culture/TESOL course.

Course Module Alignment

Each module includes multiple items (i.e., course pages, links, and PDFs. The first item in each module is the Module Overview page that introduces the module by situating it within the larger course context. In addition to introducing and contextualizing the module, the overview page provides objectives and a task list. Discussion prompts, assignment details, assignment rubric(s),

and supporting materials are included with relevant details within the module.

Prior Learning (M1 Description)

Before engaging in the deep interrogation of culture in Module 2, learners explored identity and were introduced to culture in Module 1 (M1).

In Module 1: Who Are We?, learners explored identity and culture broadly and interrogated their own identities. First, they read three book chapters—one from Kohls (1996; Chapter 6) and two from Takaki (2012). Learners also read a web article (Why identity matters, n.d.) and watched embedded videos. Then, they watched a video lecture in which the instructor presents a social identity wheel graphic and describes how identity is multidimensional. The instructor also provided guidance and examples of the Identity Constellation assessment for Module 1.

After completing all assigned readings from M1, learners were prompted to respond in the asynchronous LMS discussion board. Learners identified two things from the readings they found interesting or surprising, made one connection between the readings and a personal experience, and posed one question that they had about the readings. Students were instructed to use direct quotes and APA citations where appropriate. Examples of response frames were provided.

Learners were then tasked with creating an Identity Constellation that illustrated the various dimensions of identity, making use of color, size, and distance to indicate relationships. These were shared on an asynchronous discussion board, where learners could view and comment on their classmates' work. After sharing their work in the discussion area, learners uploaded a written reflection along with an image of their Identity Constellation to the assignment dropbox.

M2: Identity & Culture (Description)

After exploring identity in M1, learners were introduced to Funds of Knowledge (Moll et al., 1992), levels of culture (as described in Hammond, 2015, Chapters 1 and 2), and provided historical context for the cultural diversity in U.S. schools. They were then challenged to interrogate their own cultures through the creation and video-sharing of, and reflection on, analog culture zines. As the course progresses, learners build on their knowledge of identity and culture to gain understanding of how historical, theoretical, and pedagogical perspectives inform students' schooling experiences.

The following describes Module 2 in detail. *The text in italics represents the course content, as presented to learners.* A step-by-step guide for instructors follows in the Activity Structure: Culture Zines section.

M2 Overview: Identity & Culture

In Module 1, we explored identity and began to learn about culture. In M2, we will continue to explore what identity and culture are, and how we understand our own cultures. We will also explore how identity and culture are engaged in educational settings.

Learning Objectives

At the completion of this learning module, you will be able to:

- *Define culture.*
- *Differentiate between identity and culture.*
- *Describe your own culture.*
- *Analyze how different aspects of culture inform how we understand identity.*
- *Identify issues that may arise due to cultural misunderstandings.*
- *Design, create, and share a zine that represents your culture or some aspect of your culture.*
- *Draw connections between course readings and relate them to your own experiences.*

Task List

For Module 2, please do the following:

- *Read Hammond (2015), Chapters 1–2.*
- *Read Takaki (2012), Chapters 2–4.*
- *Read Moll et al. (1992) "Funds of Knowledge".*
- *Read Clark et al. (2018) Green Card Youth Voices (a.k.a. GCYV), introduction–p. 37.*
- *Review additional M2 materials and resources.*
- *Post a reading response to the M2 discussion area. See the discussion area for the prompt.*
- *Create a zine that showcases your culture or some aspect of your culture. See the assignment description and rubric for details.*

Readings, Resources, & Discussion

Learners were assigned varied theoretical, empirical, and pedagogical readings about culture (e.g., Hammond, 2015; Moll et al., 1992). They were assigned chapters from ongoing readings on the U.S. as a multicultural society (Takaki, 2012) and K–12 students' recent immigration experiences (Clark et al., 2018). Learners also reviewed additional resources (e.g., instructor-recorded video presentation about zines, assignment rubric) to gain an understanding of zines and their utility for expression.

Learners then responded to the following prompt, using the LMS discussion area:

After completing all assigned readings from M2, respond to the following.

1. *Connect one quote from Hammond (2015; see* Chapters 1 and 2*) to a quote from one of the other M2 readings. Use direct quotes and/or specific examples in your response.*
2. *Explain why you chose these particular quotes and/or examples and how you see the quotes and/or /examples connecting to each other, to personal experience, or to other course content.*

Please use direct quotes and APA citations as appropriate (see example below). Post your responses by 11:59 pm on Sunday.

Culture Zine Instructions

Now that we have explored the concepts of identity and culture, let's share our cultures with each other by creating culture zines! For this assignment you will:

1. *Create a physical (analog) zine that showcases your culture or some aspect of your culture.*
2. *Record a video and post it to the class Flip. Show your entire zine and explain what you included on each page. [link to Flip.]*
3. *Watch your classmates' Flips and respond to at least one.*
4. *Upload an image of your zine and a written reflection to the assignment dropbox. In your reflection:*
   a. *Explain your creative process, curation choices, and the significance of the zine content.*
   b. *Discuss your feelings during creation and video recording, as well as your feelings about viewing your classmates' work.*
   c. *Connect this project to identity, culture, and course readings/content.*
   d. *Use APA (7th ed.) citations and references as appropriate.*
5. *Refer to the assignment rubric for evaluation criteria.*

Activity Structure: Culture Zine

Instructors can follow this general structure while conducting this activity:

Video-Sharing Discussion Board

Designate a platform for the sharing of culture zine videos between classmates. Students should have access to this space, so they can add their own videos, plus comment on their peers' submissions. Providing a commenting system is essential for this activity's success in terms of developing an online community. The authors created a refresher video on how to use the video-sharing tool and posted it in the module.

Note: The authors used the tool Flip in the implementation of this activity. Because Flip is no longer readily accessible, we recommend something like a Padlet board or a tool like Screencastify, though you can use the video uploading tools and sharing tools within your Learning Management System.

Teach About Zines

Provide students with resources to learn about zines (e.g., Todd & Watson, 2006). Review the Illustrated 8-Page Zine Instructions (DOCX) attachments. The instructor recorded a video elaborating on the Intro to Zines Presentation (PPTX). The authors also created a Resource Padlet that provides history, context, ideas, visual instructions, and resources about creating and sharing zines (see Creating Zines Resource Padlet, DOCX).

Assign the Zine Activity

After assigning readings about culture and providing an introduction to zines, assign the culture zine activity. Task the learners with creating a culture zine that will be shared with the rest of the class. Provide

them with instructions and the grading rubric so they know how their work is being evaluated (see Culture Zine Assignment Instructions, DOCX; Evaluation Rubric, DOCX). Assure them that you are not judging their artistic ability, but the content and effort of their work. Post examples of zines for inspiration (see Figures 2 and 3 for examples).

Encourage learners to use any number of art and crafting supplies and repurposed media to make an 8-page zine, representing some aspect of their culture. This zine might focus on something like the food, art, or history of a culture. The students might use various types of paper, printouts, photographs, fabric, text, magazine/newspaper cutouts, stickers, markers, pens, and much more to create their zine.

Direct learners to the platform where they will post 3-5-minute videos showing and explaining their zines. Remind students to capture legible footage of the zines on camera, so that their classmates can see what they look like. They must watch all the videos posted and comment on at least one.

Evaluate Zine Activity Using Rubric

Use a rubric to evaluate student learning (see Evaluation Rubric, DOCX). The rubric criteria should focus on the culture zine (content, form, and sharing) and the written reflection (content and form & mechanics), rather than perceived artistic talent.

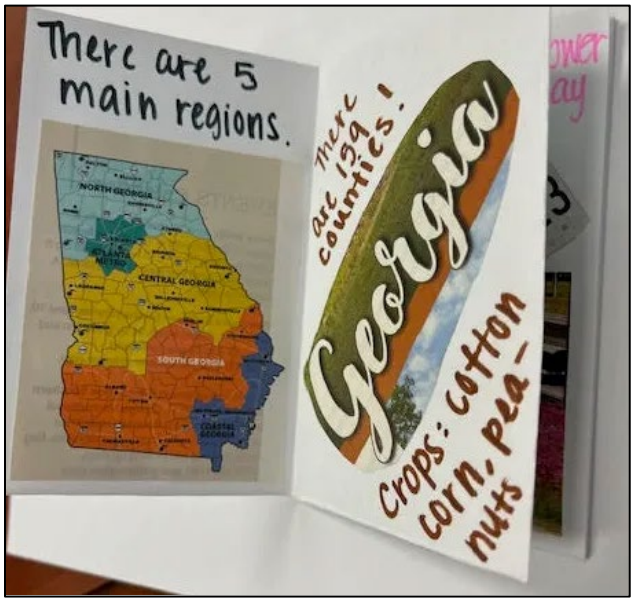

Figure 2. An example student culture zine.

Figure 3. An example student culture zine.

Critical Reflection

The zine activity was implemented in the second learning module of an asynchronous TESOL graduate course in Spring 2024 at a large public regional university. Students participated using the tool Flip, sharing their homemade culture zines with each other via short videos and providing feedback via the Flip comment section. Since initially implementing this activity, we have co-presented professional development workshops on zine-making to TESOL practitioners at two different events. We have also presented our initial zine study findings at a national conference, and the first author has refined and adapted the activity for use with an in-person undergraduate course. Here, we reflect on the online learners' responses, technology integration element, subsequent work, and the overall experience.

The Online Learners' Responses

Students were excited to share aspects of their culture. The zines themselves often featured topics that were extremely personal and significant to the students, highlighting aspects of their culture like food, faith, language, social justice, and more. The students' videos of their zines, however modest in construction, displayed warmth and personality.

One student commented in their written reflection, "I loved watching my other classmates' zine videos and getting the opportunity to better understand them as a whole!" This indicates that the combination of the project (creating a culture zine) and presentation format (recording a video explanation) humanized learners to one another. Another learner reflected that the activity "gave [them] a sense of connection" through "learning about the other students." This suggests an increase in social presence and feelings of being "real" to others in this digital environment.

The Technology Integration Element

As far as the technology integration itself, we felt that integrating video into the classroom helped humanize the students, as it gave an added dimension to their communication that wasn't there before. Teaching online can often mean teaching to a list of names on a screen, so this was a video reminder that our students are human beings with cultures to share. The goal of this technology integration was to increase social presence through these technology-mediated discussions. We felt that the power of student-recorded video, at least for us, increased that sense of feeling in an online community that comes from social presence (Tu & McIsaac, 2002). Video-sharing tools available to online educators facilitate these discussions.

Students felt comfortable using video-sharing tools, and it helped some overcome anxiety about sharing videos of themselves. One student reported they "get nervous when [they] have to video" and "started to notice hives on [their] neck." They reflected, "[the assignment] brought me out of my comfort zone...I think that it allowed me to feel a sense of happiness." This experience speaks to the humanization aspect of using video sharing in online classrooms.

There was nothing the authors could have done about Microsoft's surprise sunsetting of the tool Flip on July 1, 2024, which happened just after the semester ended. It remains a deep and significant pedagogical loss for this course, as Flip was in perfect alignment with this assignment. This left the authors looking for alternatives, which we have found, for now, in other third-party tools like Padlet and Screencastify. Neither is a perfect analogue, but they both allow for the easy making and posting of videos to a central discussion board. Furthermore, both platforms regularly add new features that bring them closer to the Flip experience. Whatever tool you choose, it is important that you know the tool beforehand, so that you might troubleshoot it more effectively should issues arise.

More recently, the authors have volunteered to pilot Harmonize, an external learning tool which the university is considering for adoption. We are hopeful that this technology may fill the void.

Subsequent Work around Zines

The instructors originally developed the culture zine activity because of its accessibility and low demand for resources. In addition to allowing learners to connect their learning about culture to their personal lives, it created the opportunity to connect with one another. We also hoped that learners would feel empowered to use zine-making in their own teaching, after having done so themselves.

With this wide application in mind, the authors presented this activity in a professional development format at a regional TESOL conference. After a brief introduction to zines, education professionals constructed zines onsite using old magazines and crafting supplies. The educators created their zines while discussing the potential for using zines for communication and instruction and learning about zine-sharing tools. This activity was positively received, and the authors were invited to present on this topic at a subsequent symposium.

The authors also presented initial findings at a national conference from a research study on the data collected from the initial graduate course implementation of this activity. Across multiple contexts, the concept of zines alone proved attractive to educators, students, and scholars alike. Because of the relatively low expense of making zines, zines democratize student creativity and expression, which appealed to the educators in attendance.

The Overall Experience

Overall, we felt that this activity was a success, both pedagogically and logistically. One student even mentioned on the end-of-course evaluation that the zine activity was their favorite assignment.

The low-cost, democratized nature of zine creation meant that learners could easily participate, which they did enthusiastically. The Flip tool made it easy to implement the activity in a virtual, asynchronous setting. The students and instructors learned from the sharing of cultures, and the activity succeeded in humanizing the online learners and increasing social presence. The integration of hi-fi video-sharing technology and lo-fi zines worked well. With a few suggested changes, gained upon reflection, the activity could be even more successful.

Areas of Improvement

One area for improvement would be to include more specific parameters for the assignment. For example, the instructor could specify a video length (minimum and maximum) and include more detail in the individual rubric criteria. After implementing the culture zine activity, we determined that we would like to encourage more discussion and engagement between the learners. While student engagement was generally effusive and inquisitive, the overall discussion could have been richer in quantity and depth. An effective way to accomplish this would be to increase the minimum response requirements (i.e., greater expectations for the quantity and quality of replies to one another), as detailed in the assignment rubric. We might encourage video replies to amplify interactions, if the tool allowed this feature.

An additional place for improvement would be in the prompt for the written reflection. We would add language to the prompt that explicitly encouraged students to connect the culture zine activity and their own classroom practice. While one learner wrote in their reflection that they "actually made zines with [their] class this past week to use for their visual vocabulary, and they enjoyed it as well, " the prompt did not explicitly ask learners to describe how zines might be used in their own teaching. The instructors could have directed learners in the class to identify ways they might use zines in their own classroom practice as a means for student self-expression and an alternative assessment on a chosen subject (e.g., all students make zines on the Great Depression).

This activity provided a rich opportunity for exploration and creative thought, for the authors, the online learners, and the later workshop attendees. The zine activity is unique in its accessibility, applicability, and adaptability. Though this lesson was initially targeted toward graduate students who were practicing PK-12 teachers, it can be easily modified to work in many instructional settings around any subject. Educators of any type might use zines in their classrooms, whether online, hybrid, or face-to-face, as they are low-cost and can be made with fairly commonplace and inexpensive supplies. Zines are a malleable format, and we have had students create zines for subjects as diverse as sandwiches and Shaquille O'Neal. Whether used to build social presence, practice communication skills, develop creativity, or demonstrate learning, zines can add a humanizing element to any learning context.

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Emojis: Developing Enthusiasm in Writing

Laurie MacGillivray and Jasmine Worthen, University of Memphis

Overview

This technology-infused lesson leveraged learners' interest in emojis to develop vocabulary, fluency, and confidence as writers. Drawing upon emojis from smart phones awakened learners' enthusiasm for writing. We chose this common form of technology based on the resources available in the after-school setting. This lesson is part of a semester-long afterschool writing club which meets once a week. Drawing on Graves' (1983) writing process model, learners wrote stories over three weeks using emojis to scaffold their writing. Some had difficulty with figuring out the integration of emojis into their compositions. However, through examples and conversing with others, this barrier was overcome. This is an instructor-friendly activity which can be implemented in schools.

Topics: Creative Writing, Emojis, Technology-Infused Composing, Texting, Writing Club, Writing Process

Time: Three lessons, one hour each; three hours total

Materials

- Smart phones
  - Those without phones can share or classroom tablets can be used
- Blank white paper
- Pencil, markers
- Prepared examples of emoji stories
- Enough copies for each student to take one of three different sheets of paper with 15 enlarged emojis (Figure 1)
- At least two instructor-created emoji stories
- Five to 10 sheets of all different emojis cut into individual squares
- Enough sheets of lined paper so each student can write on one or more

Context-at-a-Glance

Setting
A writing club at an after-school not-for-profit.

Modality
In-person delivery

Class Structure
The activity is composed of three, one-hour sessions.

Organizational Norms
This writing club's aim is to mentor and develop fluency and confidence for young writers.

Learner Characteristics
The learners were ages thirteen through seventeen. They were familiar with emojis, smart phones, and basic writing skills even though students' abilities varied.

Instructor Characteristics
Two instructors co-taught the class, although only one was necessary. They both had prior experience teaching writing in public schools.

Development Rationale
Writing in schools is often test driven. There are few opportunities for students to self-select topics. Students were growing bored of writing club. So, the instructors drew on the habits of teenagers' digital communication to entice the learners.

Design Framework
Graves (1983) writing framework emphasizes fluency and Moll et al.'s (1992) concept of funds of knowledge stresses the importance of connecting learning to personal knowledge. The goal of this lesson is to build upon learners' interests in emojis to develop their writing.

Standards

This lesson utilized the Common Core State Standards Initiative (n.d.) writing standards for grade 6.

- CCSS.ELA-LITERACY.W.6.3
  Write narratives to develop real or imagined experiences or events using effective techniques, relevant descriptive details, and well-structured event sequences (CCSS, n.d.).
- CCSS.ELA-LITERACY.W.6.4
  Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience (CCSS, n.d.).

Setup

Create three sheets of paper with approximately 15 random emojis (about the size of a U.S. quarter) on each sheet. The instructor needs to write three stories using the different emoji sheets. These will introduce the writing process and serve as examples for the learners.

Arrange tables so that learners can work independently and participate in small and whole group discussions.

Context and Setting

The after-school writing club sessions occurred at the site of a nonprofit organization focused on supporting academic, physical, and socioemotional health. Learner's input was integral to the planning of afternoon activities. Based on their feedback, the space was redesigned from a regular meeting room with office chairs and round tables to feel like a reading and writing nook. Giant bean bags, LED ceiling lights, floral wall stickers, movable plastic tables and chairs, along with window coverings created a relaxed ambiance for writers. Snacks were available during each writing club session.

The center attracted students of all ages from nearby public schools. Most of them walked to the site and a small number were dropped off by their parents. The schedule remained the same each day. The initial period was spent unwinding from school. There were staff ready to facilitate board games and other activities. Then learners were encouraged to work on their homework prior to a more organized time in age-group activities. Dancing, gardening, or playing a sport were options as well as writing club. Dinner was served before the learners went home.

Prior to implementing this writing lesson, we created a space for writers to express themselves in positive ways. Despite staff encouragement, some learners were hesitant. After a few weeks, we were told that the writing club was too much like school, and the learners did not want to attend. This encouraged us to move toward activities which focused on their interests. The response was overwhelmingly positive. The emoji lesson was the learners' favorite.

Some of the learners liked composing and considered themselves writers. Others found composing to be boring and difficult. Engagement across the board increased during the emoji activity.

The decision to use emojis as inspiration for writing was based on the desire to draw on their funds of knowledge (Moll et al., 1992). Given adolescents tendency to rely on digital communication as frequently as direct interactions (Boutet et al., 2021), we pivoted and introduced a social media component. According to Boutet et al. (2021) emojis allow rich emotional expressions and provide a more nuanced form of communication than the teenagers' oral vocabulary.

Topics were based on their interests, not traditional writing prompts. Writing was a tool (Moje, 2000) to express their emotions and beliefs. Colloquial language was also embedded in the writing and responding, another facet of the activity that drew on funds of knowledge (Moll et al., 1992).

In this lesson, the primary connection to technology is drawing on (digital) emojis which were rooted in the teenagers' interests. Learners interacted with their phones throughout the lesson. In the Critical Reflection section, there are ideas on how to strengthen the connection to technology.

Learning Representation

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

First Lesson (50 minutes)

Gain Attention (5 minutes)

In a class discussion, begin asking the following questions to hook learners:

- *Has anyone used an emoji recently? Which one?*

(Wait for responses). Ask learners,

- *Which ones are your favorites?*
- *How do you know what an emoji means?*
- *When do you use emojis in your lives?*
- *What are the emojis you use most often?*

Encourage learners to share emojis from their phones to activate their funds of knowledge. After learners respond, the instructor should ask what role emojis play in their communication. Answers may include expressing emotions or adding humor to text messages. Explain that writers can get what's called, "Writer's block" when they cannot figure out anything to write. Working with emojis is one way to unlock a stuck writer. It also builds fluency and confidence.

Next, the instructor can share examples from the emojis in their own text messages and discuss how they carry different meanings depending on the audience and context.

Introduction (10 minutes)

For this first session, the instructor shares a sheet of 12 emojis, each the size of a U.S. quarter, spread out in rows on a white piece of paper. Then, the instructor reads aloud their prepared story, discussing the decisions they made while composing. This talk about the writing process captures the flexibility of the meaning associated with emojis. For example, one can refer to the emoji of a diving board as swimming or as a metaphor for diving into the unknown. Point out that a writer may compose one sentence per emoji or string several emojis together in one sentence. The instructor's description of their writing process and the finished draft is important for the learners' confidence and ability to be successful. See Figure 1 for an example of the emoji handout created using openmoji.org.

Essential Questions

1. How can emojis scaffold creative writing?
2. What ways can emojis be used when writing a story?

Recall Prior Knowledge

Next, engage the learners in what they currently know about emojis and how they use them to communicate. When facilitating this lesson, all the learners had a sense of a story with a beginning, middle, and end. They were also familiar with the writing process model of drafting and revising (Graves, 1983). All the learners shared their emoji text messages as part of the writers' club.

The teenagers had a wealth of experiences with emojis and routinely integrated them into texts. Seamlessly integrating emojis and text reflected a flexibility of mind. The use of emojis developed their ability to briefly convey content related to, for example, directions, questions, and feelings. The learners' behavior in writing club reflected a knowledge of what was considered appropriate based on audience and context. Their texts reflected shared meanings of families, friend groups, community, and culture. Related to emojis, learners were fluent, familiar and excited.

Figure 1. Example emojis from openmoji.org/.

Practice (25 minutes)

In the practice time, learners write individually and discuss the meaning of emojis, their stories, and spelling. The instructor can encourage meaningful conversation with questions such as, *Will you share with me?* or *What you have written so far?* The instructor should also nurture conversations about different meanings of emojis as the learners create their own stories. For example, if the instructor notices a student staring blankly at one emoji, they might say, "Oh I used that one the other day in a text to my friend. What does it mean to you?" Then the instructor could open up the conversation asking other learners if they have used that emoji.

Sharing/Assessment (10 min.)

Learners have the option of reading their piece aloud at the end of class. If a student is too shy to share, they may choose to have a peer, or the instructor, read it aloud to the group. Learners may clap after each piece, name a favorite part and/or ask questions. If they are not finished, the writers may bring their creative story home to complete it.

Formal assessment is not necessary because it is not a classroom activity. However, instructors examined the presence of original content to assess engagement.

Second Lesson (45 minutes)

The second lesson follows the writing process by focusing on revisions and ownership of the learners' compositions. The lesson begins with the instructor showing the learners a new grid of emojis and sharing the instructor-completed piece. However, this time the story contains new emojis and writers have the option to add their own hand-drawn emojis or cross-out and ignore provided emojis when writing their stories. See Figure 2 for an example of the emoji handout. This activity scaffolds learners' ability and desire to revise (Graves, 1983).

Once again, the learners write independently with light conversation about the meaning of emojis and their stories or even the spelling of a word. The instructor might ask, *Which emojis are you crossing out and why?* or *What emojis have your created?* The conclusion involves learners reading aloud their pieces and talking about the decisions they made when adding and deleting emojis.

Figure 2 shows the emojis used in the activity. Example stories created by students using these emojis are provided in the next subsection. Note how students interpret the meaning of the emojis differently to create their narrative.

Figure 2. Emojis used in the add/delete emojis story activity.

Example Stories From Students

Two example stories from students are provided. These stories were composed based on the emojis presented in Figure 2.

"Digital Life"

> It makes sense that the explosion of technology caused chaos in our world. We began to hear more of the world and see the grins of those miles away. But I often find myself putting out digital fires caused by the mindless zombies who worship the mindless doom scroll, rather than the thread that connects us, turning a mile of physical footsteps into a millisecond between contact. Both the natural and unnatural world has been affected by the flight of technology. And the ideas were born from its origins. The world can either become a beautiful paradise or a twister of mixed omens depending on how we move forward. But if we do want to find paradise, and I'm sure we all do, then we must sport the mindset needed to keep our minds from melting into the endless progression of technology.

Celebrating her composition the author wrote the following evaluations on her own paper, "Slay!" "100%" "10/10" "I ate that so hard." Happy with her piece, she added these comments even before sharing with her peers. The use of colloquial language captures her comfort and confidence as a writer. This emoji activity invited and affirmed her funds of knowledge (Moll et al., 1992).

Viewing the same emojis, another learner created a different narrative.

"Untitled"

> I heard the explosion outside when all the power went out. As the world outside silenced, I felt sharp teeth in the side of my neck while things broke and shattered around me. Then, I was in the air being carried firefighter style by a sparkling white man with dead eyes. He was the most beautiful thing I have ever seen and now I owe him my life for saving mine. We finished our travel through the woods when we arrived at his uncle's house where I was welcomed by all except one...

The descriptive language captures the author's creativity and romantic flair which intentionally leaves the audience in suspense.

Side-by-side examples capture how the same emojis scaffolded two students to explore writing in meaningful and inventive ways.

Feedback and Challenge

The instructor, after hearing a few learners' stories, shared, *I notice no one is using the ____ emoji* or *The ____ emoji is being used in lots of different ways*. One challenge includes keeping learners with a variety of writing abilities and confidence engaged. Teachers can bridge the differences by pointing out something one student is doing well or an interesting sentence someone else wrote. The instructor's comments can encourage students to continue writing and even further developing their piece.

Lesson Three (45 minutes)

The third lesson follows the pattern of the previous two. This time there are five to 10 sheets of all different emojis cut into squares, so their order is not predetermined. The instructor shares their story which is composed of a variety of emojis glued down between words.

The learners have the option of 1) continuing their previous story, 2) revising by gluing on new emojis over old ones, or 3) starting a new story. At the end of the time, the group comes together again for sharing and a discussion of what it was like to organize the emojis in their own preferred order. The instructor might say, *what was it like selecting the emojis you wanted and determining the order?* Some students might have enjoyed the freedom of creating the order of the emojis and words, but others may have experienced writer's block with so few parameters.

Critical Reflection

Each lesson described above was implemented once in the writing club. The activity helped invigorate learners' writing and increase engagement. The emojis offered an open-ended beginning, middle, and end in which the writers could develop their own stories. Exchanges among peers were positive and affirming.

The learners were motivated to start writing and discussing emojis with their peers. Conversations included emoji meanings coupled with sharing excerpts of their writing.

Participants nurtured each other's voices acting as a community of writers. The enthusiasm that filled the space was palpable. Writers eagerly shared their writing with the whole group. The writers attentively listened and affirmed their peers' unique styles and creativity. In future lessons, there are changes we plan to implement which would further increase the role of technology.

Lesson Updates

During the first lesson, the instructor could share the beginning of their story using digital emojis in a Google Doc. This would contain approximately 12 emojis which the teacher would integrate into her story. Then learners could be invited to take advantage of any set of emojis including creating their own. Students could also write their own stories in Google Docs. The technology would enable learners to share their screens to discuss the meaning and use of an emoji.

Another possibility is for the instructor to model using the digital emojis on a social media platform. Rather than using a Google Doc, the instructor could create a social media page, and post emojis with

text. Instructor and learners could share their social media platform on a whiteboard or on their own personal devices.

To extend the activity, students could continue to interact with each other in the social media account in upcoming days. They could generate or introduce new emojis using platforms such as Canva, an online graphic design tool, and collectively compose stories. This change promotes agency and motivates high schoolers to continue writing.

Lesson Benefits

We found three benefits from this lesson.

First, the lesson scaffolds writers. For hesitant writers or those who have difficulty coming up with a topic, emojis are a framework that can be used to start writing stories.

Second, creativity is nurtured by emoji writing. Learners are exposed to different styles and genres. They can explore romance, horror, and realistic fiction. As participants wrote freely, they discovered different ways to use emojis. The writer's creativity is reflected in their use of action verbs, adjectives, and metaphors.

Lastly, this activity nurtures a sense of community as learners create stories, participate in impromptu discussions, read aloud their pieces, and consider the meanings of emojis. Conversations about emojis can act as a catalyst for cultivating relationships and promoting writing in new ways.

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Podcasts and Practice: An Approach for Teaching Vocabulary

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Overview

This article explains an approach to support students' mastery of vocabulary utilizing brief, instructor-created instructional podcasts and low-stakes formative assessment. Students learned the vocabulary outside of class time by listening to podcasts and had repeated opportunities to take and retake quizzes to work towards mastery of the essential vocabulary for the course. The students described in this article were undergraduate students taking a foundations of education course, but the practice is flexible and could be adapted for use in many different content areas and grade levels.

Topics: Educational Podcasting, Formative Assessment, Vocabulary Development

Time: Variable. In this article, students spent approximately 60 minutes each week learning and practicing vocabulary, spread out across 10 weeks of the semester.

Materials

- Vocabulary words and definitions
- Podcast recording software (e.g., GarageBand)
- Microphone
- Learning Managements System (LMS; e.g., Canvas or Google Classroom)
- Internet-capable devices for students
- Podcast for Standard 3-Learning Environments (MP3 file)
- Script for Standard 3-Learning Environments (MS Word document)

Context-at-a-Glance

Setting
A foundations of education course for first-year undergraduate students in a teacher preparation program at a private, faith-based university located in the northern Midwest United States.

Modality
Face-to-face with a learning management system (LMS)

Class Structure
The course is a 15-week face-to-face course that meets one 75-minute period each week. Students taking the course also participate in a 10-hour field experience (one hour per week for 10 weeks of the semester) and have substantial outside-of-class work to learn new content and synthesize their learning through reflective writing.

Learner Characteristics
First-year undergraduate students (N = 68) exploring education as their major.

Instructor Characteristics
A university professor with over 25 years of experience teaching in PreK-12 and higher education who has taught more than 20 instances of the course.

Development Rationale
This approach was developed to support future teachers' mastery of educational jargon. The focus was to move beyond rote memorization of vocabulary words to a working facility of terminology used by professionals in the field.

Context and Setting

This project was developed in the context of an educational foundations course for first-year undergraduate education majors at a private, faith-based university located in the northern Midwest United States. The course, entitled *Introduction to Education*, is the prerequisite course for all other coursework in the program, and is designed to help future teachers understand the whole field of education, and begin to develop a "teacher imagination."

There were 68 students taking the course during the 2022-2023 academic year. These students were divided into three class sections: two sections in the fall semester with 28 students in each section, and one section in the spring semester with 12 students. All participants were exploring the field of education, but a wide variety of grade levels and many different content areas were represented among these students such as early childhood, elementary classroom, middle school subject areas, high school subject areas, PreK-12 subject areas, and special education.

The course is laid out over a 15-week semester, with one 75-minute class meeting each week. Along with class meetings, students taking *Introduction to Education* also participate in a 10-hour practicum (one hour each week for ten weeks of the course) as an early field experience. This field work gives these future teachers the opportunity to observe the things being discussed in class first-hand, and to have opportunities to work with real students in real classrooms at the grade level and content area they imagine themselves teaching.

With only one class meeting each week, students need to do a fair bit of out-of-class work to ensure they are prepared for the time spent in the classroom. This out-of-class work includes reading, reflective writing, and developing a working facility with key vocabulary used in the profession.

The learning representation described in this article focuses on the mastery of vocabulary. Because the course is intended to give a 30,000-foot view of the whole landscape of the teaching profession, future teachers taking *Introduction to Education* are expected to learn professional language utilized by contemporary educators. The goal is that they will have a working facility with the jargon regularly used in the field. Students are expected to learn the vocabulary prior to coming to class for the week and then be able to effectively recognize it and utilize it as part of their in-class learning. To support students' learning and practicing of this vocabulary, the instructor created short instructional podcasts, to introduce the professional language, and low-stakes quizzes to practice and demonstrate their learning of the vocabulary.

Learning Representation

Introduction

Like most professions, the field of education has its own jargon, and preservice teachers need to become familiar with the professional language used by colleagues in the field. School reform advocate, Diane Ravitch (2010) described this teacher jargon in a slightly tongue-in-cheek manner as "the exotic and mysterious language spoken by educators" (p. 2). The question that arose when designing this course was, how can teacher educators best support future teachers' mastery of this professional language?

I taught over 20 instances of *Introduction to Education* to first-year undergraduate students over the past twelve years. Over that time, I developed an approach utilizing podcasts, low stakes quizzing as part of the learning process, and practice assessments to foster mastery of a collection of approximately 120 vocabulary terms and acronyms.

The *Introduction to Education* course is a sweeping survey of the entire field of education. It is intended to give first-year students a foundation in all aspects of the profession such as professionalism and ethics, an exploration of learners and learning environments, an investigation of content knowledge and curriculum, and an introduction to pedagogical practices involved in planning, assessment, and instructional methods.

The learning sequence in this course is structured around an introduction to the InTASC Standards (Council of Chief State School Officers, 2011), which serve as a framework for our teacher preparation program. Along the way, students are expected to learn vocabulary related to these standards to ensure their understanding of key facets of the teaching profession.

There are three components included in the approach to teaching and practicing the professional language introduced in this course. First, students can learn the professional language by considering it in the context where it is used, rather than simply memorizing a list of definitions. Next, students can rehearse and demonstrate initial proficiency with the vocabulary by taking low stakes online quizzes. Finally, students can take practice assessments multiple times to approach mastery of the professional language.

The Approach for Teaching and Practicing Vocabulary

The approach utilized in this course for teaching vocabulary is rooted in the Formative Assessment Framework developed by Black and Wiliam (2009). In particular, this learning sequence leverages the first three aspects of the framework:

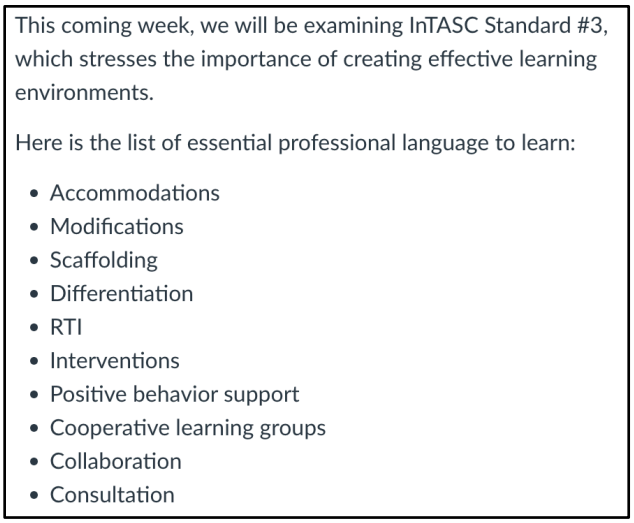
1. Clarifying and sharing learning intentions and criteria for success.
2. Engineering effective learning tasks that elicit evidence of student understanding.
3. Providing feedback that moves learners forward.

The approach for teaching and practicing professional language follows these aspects in sequence.

Clarifying and Sharing Learning Intentions

Early in the semester, I introduce the professional language component of the course, explaining it as an opportunity for preservice teachers to develop a working facility with the jargon used by professional teachers. I break down the full list of 120 vocabulary terms into subgroupings of 10-15 terms that correspond to the ten InTASC standards. For 10 weeks of the semester, we focus on one standard a week. Students listen to a podcast created by the instructor. They are expected to learn the jargon associated with that standard and use it fluently in class as we discuss the meaning and importance of the standard. I clearly lay out reasons for learning this professional language and the methodology for learning and practicing the professional language.

Each professional language list is shared with students through the LMS. I created an assignment page for each week to guide students with professional language (see Figure 1).


This coming week, we will be examining InTASC Standard #3, which stresses the importance of creating effective learning environments.

Here is the list of essential professional language to learn:

- Accommodations
- Modifications
- Scaffolding
- Differentiation
- RTI
- Interventions
- Positive behavior support
- Cooperative learning groups
- Collaboration
- Consultation

Figure 1: Screenshot of an assignment in the LMS, introducing the professional language to be learned and practiced as students prepared for the class meeting.

Engineering Effective Learning Tasks

To help students become familiar with the way teachers use the vocabulary, rather than just memorizing a list of terms and definitions, the instructor decided to create short podcasts that illustrate the professional language being used in context. Researchers recently explored educational podcasts as a useful strategy to support vocabulary acquisition, particularly in the field of language acquisition (see Elekaei et al., 2020; Hasan & Hoon, 2013; Indahsari, 2020). However, other researchers have specifically explored podcasts as a way of developing vocabulary within content-oriented courses, and advocate for this approach (see Kennedy et al., 2014; Putman & Kingsley, 2009). A total of 10 podcasts were created for the course.

A brief script was written for each podcast a that included the vocabulary to be learned that week in context. Each script was approximately two pages long, which was just long enough to give examples of how the 10-15 vocabulary words for that week are used by actual educators These scripts were read and recorded verbatim.

The podcasts are short, being only about five minutes long. Drew (2017) advised for the “quick burst” genre of educational podcast (p. 205) which was followed

in the creation of the 10 podcasts. GarageBand, on a MacBook, was used to record the podcast episodes. A short song using loops was also created in GarageBand as introduction and closing music for each podcast. This music was used to give a consistent feel to each "episode." I used a Blue Yeti microphone (Logitech, n.d.) to record my spoken audio and did a little light editing in GarageBand to correct the audio (see Figure 2).

Figure 2: Editing a podcast episode in GarageBand.

I should note that I use GarageBand because it's a tool I have used for several years for audio projects. It is an easy-to-learn tool, and free to use if you have access to Apple products. There are, however, a wide variety of tools, including many useful apps that are free for users, that can be used to create audio podcasts. For example, a smartphone with a free voice recorder app could be used very effectively to create such podcasts. A professional podcasting studio is certainly not required! There are a variety of free apps that can be used—both device-specific downloadable apps (like GarageBand, which I used in this instance, or Voice Recorder on a Windows-based PC) or web-based podcasting apps. If you are interested in exploring different tools, a quick web search for "free podcasting apps" will result in many different possibilities for tools you might utilize.

I saved the podcast episodes as MP3 files, and I embedded the audio files in pages in our LMS for easy access by students. I also saved my scripts for each podcast as PDFs and posted these on the assignment page alongside of the audio files, seeking to utilize Universal Design for Learning principles for supporting all learners (Tobin, 2014).

A sample podcast introducing the professional language for InTASC Standard 3: Learning Environments is included (see Podcast for Standard 3-Learning Environments MP3). The script used for that podcast episode is also included (see Script for Standard 3-Learning Environments PDF).

Providing Feedback that Moves Learners Forward

The author believes that feedback helps you grow, and feedback must be timely, specific, and actionable (Wormeli, 2023). Receiving immediate feedback *while practicing* is a research-based promising practice for closing the gap between students' current performance and where they need to be (Hattie & Timperley, 2007).

To provide students with the opportunity to rehearse the vocabulary and get immediate feedback on their performance, low-stakes online quizzes were created in Canvas, the utilized LMS. Students can retake these quizzes as many times as they like, with the intent that multiple attempts will allow them to practice the terms they do not (yet) know in a low-stress approach to work towards mastery (Hinze & Rapp, 2014). Low-stakes quizzing for practice is considered a promising instructional practice for vocabulary development and retrieval practice (Kenney & Bailey, 2021; Rausch & McKenna, 2020).

The quiz feature in Canvas has several features that facilitate low stakes quizzes with repeated attempts. A question bank was created for each quiz with objective questions (i.e., multiple choice) for the vocabulary of the week (see Figure 3). Using multiple choice questions allowed the quizzes to be self-scoring for immediate feedback to students.

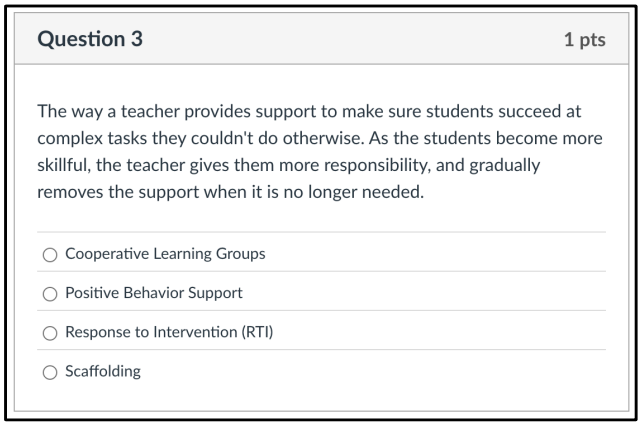


Figure 3: Screenshot of a sample quiz question. If students saw this question in a subsequent quiz, answer choice ordering differed, pushing them to understand the term being described, rather than rote memorization.

In each student attempt of the quiz, Canvas would pull in ten questions from the question bank and place them in a random order on the quiz page. This resulted in a unique quiz each time the student would take it. Also, Canvas allows the randomization of the answer choices, so even if a student saw the same question on a repeated attempt, they would not be able to just memorize, "Oh, the answer for that question is 'C'" as the multiple choice answers would be mixed up. These features made the quizzes more of an opportunity for real practice, rather than just an exercise in rote memorization.

It was explained it to the students, "If you take the quiz and get six out of ten correct, that's great—you knew six of the terms after listening to podcast! But you should get ten out of ten on each quiz. So, if you missed some, go back and listen again, or read the transcript. Then come and retake the quiz as many times as you need to score 10/10."

Students took advantage of this retake approach. Being able to reimagine the quiz as an opportunity for practice resonated with them, and most students wound up scoring 10/10 after practicing.

Summative Assessment: Closing the Loop

At the end of the semester, a summative assessment of all the professional language students learned throughout the semester was given as a part of their final exam. A Canvas quiz was used for this final professional language assessment, but there were a

few differences from the quizzes. First, for the final assessment, a random sample of 30 of the 120 learned vocabulary terms were pulled (similar to the question bank in the quizzes). The students did not have to demonstrate their knowledge on all 120 terms. Instead, they received 30 terms in the final assessment. Second, the final assessment is higher stakes, so students were allowed two attempts instead of the unlimited number of attempts in the quizzes. Since the question bank included all 120 learned vocabulary terms from the semester, most students would not receive the same words on their second attempt as they did on their first. The higher of the two scores was used in the gradebook as the final assessment evidence for learning this professional language.

To help students prepare for this higher-stakes final assessment, a practice exam was provided that students could take as many times as they wanted. This practice exam allowed students to get a feel for how the final (higher stakes) assessment would unfold. Being able to practice an exam in a lower stakes setting first can help students adapt to the high stakes setting (Hinze & Rapp, 2014). A majority of students took the practice quiz at least once.

The students responded well to this whole approach of listening to podcasts, taking weekly quizzes to demonstrate their learning, and having practice exams for the higher-stake testing. They clearly learned the professional jargon throughout the semester, and the evidence is clear in both the way they use the vocabulary throughout the class meetings, as well as in their scores on the final assessment.

Critical Reflection

I used this podcasting and practice approach for teaching educational jargon in *Introduction to Education* for several years, and I found it to be generally successful as a means of helping students develop working facility with the professional language. The results of the summative assessment are very encouraging. During the 2022-2023 academic year, 34 of my 68 students (50%) scored 30/30 on their final assessment. Another 20 of the 68 (29%) scored 29/30, and 4 of 68 (6%) scored 28/30.This means only 10 of the students (15%) scored lower than an "A" on this final assessment.

Interestingly, the analytics in Canvas also reveal how many times students took the quizzes as they practice. Most students (approximately 70%) attempted the quizzes two or three times. About 15% of the students attempted just one time, and about 15% attempted more than three times. One interesting outlier was one student who took fourteen attempts to score 10/10 on one quiz, demonstrating real tenacity in practicing.

After considering this data, I wanted to learn more about my students' perceptions of how the podcasts and practice method worked. I created a brief survey with three open-ended questions and had students complete it via Google Forms at the end of the semester. The questions were:

1. What were the pros of our approach for learning professional language?
2. What were the cons?
3. What else should I know?

The results were interesting, but not entirely surprising. The majority of the responses were very positive and affirming and gave a variety of reasons for their appreciation for this approach. Here are a few of the students' responses to the first question, what were the pros of our approach for learning professional language:

- "I liked that I got to practice a lot and got 10/10 on every quiz."
- "multiple retakes >>>>>>>>"
- "podcasts were good. short enough but still told me what I needed to know"
- "I was glad you always included the transcript because I preferred to read instead of listen."

In response to the question about the cons of this approach, the most common response was "nothing!" which was gratifying for me. In fact, very few students named any critique of this approach at all. However, some students shared thoughtful comments, including:

- "Sometimes I wasn't sure what the quiz questions meant because it wasn't phrased the same way as what you said in the paper. But it worked out because I just retook the quiz until I got everything."
- "The final quiz was harder than I thought it would be."

Only a few students responded to the third, very open-ended prompt of "What else should I know?" Their comments were important, however:

- "I never listened to the podcasts, I just took the quizzes until I got them all right."
- "Thanks for the way you structured this part of the class, I feel like I learned a lot!"
- "It seemed as if the professional language quizzes each week were just 'tacked' onto the content. They weren't connected to much in class or outside of class, other than the quizzes."

The comment about never listening to the podcasts caught my attention. I also assume that this student did not read the transcripts, though this was not explicitly stated. This comment has me wondering about this student's approach. It was apparently successful (enough?) that they did not feel that the instructional aspect was needed.

Likewise, this final comment about the tacked-on nature of the professional language assignments prompted some introspection on my part. While I was intentionally using the professional language as part of my lessons, they perhaps did not notice or realize this. Moving forward, I plan to be more intentional at naming the ways I am using the vocabulary as part of our lessons. I am also considering ways to have the students explicitly practice using the vocabulary as part of our in-class work, such as collaborative whiteboarding to define a few vocabulary words as part of the lesson. As another playful approach, I'm considering putting the list of the week's professional language up on the board and challenging the whole class to speak aloud each word on the list throughout our class discussions, with the person who correctly uses the term in context running up to erase the word from the list.

This approach to developing a working facility with vocabulary has proven valuable and effective for my students. I believe this approach could be adapted to any content area and to almost any grade level.

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Thematic Analysis Using Accountability Partners and Collaborative Writing

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Overview

In an 8th-grade English Language Arts (ELA) classroom, students co-wrote a literary analysis essay, serving as accountability partners throughout the writing process. The purpose of the lesson was to support student collaboration and foster a sense of community. Prior to the writing task, students read and analyzed a novel. During the week of writing, each accountability partner pair established mutual goals and regularly checked in with one another to ensure progress on the essay. Technology was integrated, primarily using Google Docs, for drafting, sharing feedback, and tracking revisions. The desired outcomes included improved writing skills, enhanced critical thinking through peer discussions, and a stronger sense of community as students supported each other's work.

Topics: Accountability Partners, Writing, Collaborative Learning, English Language Arts

Time: Between 1-2 weeks (divided into daily 50-minute class periods); Novel study completed 3 weeks prior

Materials

- Computers with internet access
- Google Doc access
- Assigned novel or literary text for analysis
- Digital communication tool access (e.g. email)
- Literary Analysis Essay Presentation
- Literary Analysis Essay Brainstorm Worksheet
- Individual Literary Analysis Rubric
- Daily Progress Check Questions

Context-at-a-Glance

Setting
8th-grade students in a public, suburban middle school in the United States.

Modality
Face-to-face

Class Structure
Students meet daily for a 50-minute class period.

Organizational Norms
The goal is to support student learning utilizing the required school ELA curriculum. The lesson will align with Common Core State Standards for English Language Arts. These standards emphasize various aspects of writing, such as producing clear and coherent writing and developing and strengthening writing.

Learner Characteristics
8th-grade students (13-14 year olds) with a range of ELA background and skill levels. Typical audience ranges from 20-30 students (per class period). Students have varying attitudes towards ELA, from enthusiastic eager learners to apprehensive learners.

Instructor Characteristics
A middle school ELA teacher interested in partner dynamics, making learning collaborative, and promoting a sense of community in the classroom.

Development Rationale
To enhance students' collaborative skills and sense of community with the use of accountability partners during a writing task.

Design Framework
Backwards Design

Setup

The instructor should estimate about an hour to organize materials that students will use, such as writing rubrics and reference texts. The instructor will need to set up the tool students will use to co-write (e.g., Google Docs) and make sure desks in the classroom are physically arranged to appropriately support student collaboration and discussion (e.g., small groups/pair configuration).

Standards

The Common Core ELA Standards for Writing (Council or Chief State School Officers, & National Governors Association, 2010) were used:

- W.8.1: Write arguments to support claims with clear reasons and relevant evidence.
- W.8.4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- W.8.5: With some guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on how well purpose and audience have been addressed.
- W.8.6: Use technology, including the Internet, to produce and publish writing and present the relationships between information and ideas efficiently as well as to interact and collaborate with others.
- W.8.9: Draw evidence from literary or informational texts to support analysis, reflection, and research.
- W.8.10: Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Context and Setting

This lesson involved 8th-grade students in a public, suburban middle school in the U.S. The classroom modality was face-to-face, with students meeting daily for a 50-minute class period. The lesson lasted one-two weeks, but required prerequisite knowledge through a novel study, which occurred approximately three weeks before the beginning of this lesson. The typical class size ranged from 20-30 students, which influenced the lesson design by emphasizing the use of accountability partners and collaborative tasks to effectively manage the dynamics of both small and large group sizes. The choice to use accountability partners specifically helped ensure that all students could participate meaningfully in discussions and peer feedback, allowing for more individual support and engagement in a larger class setting.

Learner Characteristics

The students in the 8th-grade class demonstrated varying levels of proficiency in English Language Arts (ELA). Some were highly motivated and showed a strong interest in literature and writing. These students typically had a solid understanding of literary analysis, strong writing skills, and a desire to improve further. On the other hand, there were also students who approached ELA with hesitation or apprehension. These students often lacked confidence in their reading and writing abilities, struggled with comprehension, or found it difficult to express their ideas in writing. The students' engagement levels also fluctuated, with some needing more encouragement and support to participate fully in class activities. For these students, providing structured opportunities for peer interaction and support through accountability partners was a deliberate strategy aimed at reducing anxiety and increasing confidence. This peer collaboration not only offered personalized support but also helped these students feel less isolated in their learning process, which allowed for a more inclusive and engaging environment.

Instructor Characteristics

This lesson was taught by a middle school ELA teacher committed to creating a collaborative classroom environment that promotes engagement and a sense of community. For writing tasks, the instructor supported partner dynamics through strategies like peer reviews, small group discussions, and, in the case for this lesson, accountability partners. Future instructors for this lesson should have an understanding of effective collaboration in classroom settings and managing group dynamics related to peer interactions, accountability, and supporting diverse learning styles.

Development Rationale

Research supports that a thoughtfully designed lesson that emphasizes collaboration has the potential to significantly enhance student engagement and promote deeper learning. Wicks et al. (2015) suggest that classes fostering high levels of collaboration encourage openness, meaning making, and the co-construction of knowledge, which are essential for creating a meaningful learning experience. Additionally, Bickle et al. (2019) emphasize that factors such as peer interaction, a strong sense of community, and instructor responsiveness are key contributors to student satisfaction. Similarly, collaboration can support improved student engagement/participation, and student critical thinking and communication skills (Acharya et al., 2024). In this lesson, the use of accountability partners is integral to supporting these collaborative dynamics. As Hanningan-Page (2023) points out, accountability partners act as supportive allies who help maintain focus, provide encouragement, and ensure continued progress. These partners enable students to take shared responsibility for their work, promoting accountability while also fostering a deeper sense of community.

Through the structured collaborative tasks in this lesson, students not only developed their writing skills but also strengthened their ability to work together effectively, creating a richer, more interactive learning environment. The integration of accountability partners enhanced the social aspects of learning, which in turn lead to more engaged and motivated learners. To support these collaborative efforts, technology integration was utilized strategically. Tools such as Google Docs allowed accountability partners to work together, regardless of physical proximity. This type of technology helps to facilitate the sharing of ideas, feedback, and revisions, which enhances the writing process and encourages ongoing communication. Additionally, the instructor can monitor progress and offer targeted support through Google Docs, ensuring that students stay on track and continue to collaborate effectively.

Design Framework

Backward Design is an instructional approach that begins with identifying the desired outcomes or goals for students. Educators first identity the specific skills or knowledge students should acquire as a result by the end of the lesson. Then, they define what will serve as evidence of that learning. Only after these steps are completed do they plan the instructional activities and design the learning experiences that will guide students toward achieving those outcomes (Culatta, n.d.). The rationale for using Backward Design is grounded in the principle that starting with clear, measurable goals allows the educator to make more intentional decisions about how to structure the lesson.

For this lesson, the desired outcome was for students to co-write a literary analysis essay using Google Docs that connected a theme from both a play and a movie. By identifying this specific goal at the outset, the instructional planning process became targeted and student-centered. Every activity contributed directly to the development of these skills. Google Docs was chosen with backward design in mind because it provided a collaborative, accessible, and flexible platform that supported students in the specific goal of co-writing a literary analysis essay. Also, accountability partners played a key role in this process since each student was paired with a peer to collaborate throughout the assignment. This partnership fostered ongoing communication and peer feedback which allowed students to share ideas, ask questions, and refine their work together. By working with accountability partners, students not only stayed on track but also took ownership of both their learning and their partner's progress, which ensured that the co-writing process was collaborative, and that each student was fully engaged in reaching the final goal of the literary analysis.

Learning Representation

Introduction

Students began this literary analysis assignment after reading *The Diary of Anne Frank* play (Goodrich & Hackett, 1955) and watching the movie (Krejci et al., 2001). This lesson could be adapted to work with any novel, though it was used here with *The Diary of Anne Frank* play by Francis Goodrich and Albert Hackett (1955) and the 2001 movie adaptation, *Anne Frank: The Whole Story* (Krejci et al., 2001).

The assignment's primary goal was to analyze thematic elements from both the play and the movie through collaborative writing. In alignment with the Backward Design framework, the lesson was planned with the desired outcome in mind: for students to co-write a literary analysis essay that connects themes across two different mediums, while also developing their analytical and writing skills. As accountability partners, each student was responsible for not only contributing their portion of the essay but also providing support and motivation to their partner. This dynamic encouraged a sense of shared responsibility and helped foster deeper engagement with the material.

Theme Selection & Planning

After finishing both the play and the movie, students were paired with their writing accountability partner (either chosen by the teacher or through student selection). First, the teacher reviewed what a literary analysis essay is, what themes are, ways to find themes in a text, and prompts to guide students' thinking when determining the themes (see Literary Analysis Essay Presentation [PPT], slides 2-5). Then, the whole class brainstormed themes to choose from (see Literary Analysis Essay Presentation [PPT], slide 6), such as:

- It is human nature to look for the good in any situation.
- Having hope can help get people through tough times.
- In spite of extraordinary circumstances, people deal with many normal problems of adolescence.
- Difficult circumstances cause people to suffer many hardships.

Students (as pairs) were required to choose one of these themes for their essay and brainstorm evidence from the both the play and the movie to support the chosen theme. If none of these themes interested them, they had the option to research and propose a different theme, but this had to be approved by the teacher before continuing. By allowing for student choice, the lesson provided an element of differentiation, catering to diverse interests and learning preferences while maintaining the overall structure. The lesson maintained flexibility while ensuring that students were working toward the end goal of writing a cohesive literary analysis essay. This approach adhered to the principles of Backward Design by ensuring that the activities (theme selection, brainstorming, and evidence gathering) directly supported the final goal of analyzing and writing about thematic connections between the play and movie.

Once a theme was selected, students determined, within their accountability partnerships, who would be responsible for writing each section of the essay (see Literary Analysis Essay Presentation [PPT], slide 7). Each partner took ownership of two paragraphs, which included evidence from the play and movie. The conclusion was written collaboratively. The structure of the essay was as follows:

- Introduction: Co-written with the teacher as a class exercise and to model collaborative writing.
- Body Paragraph 1: Evidence from the play that supports the chosen theme (responsibility of Partner 1).
- Body Paragraph 2: Further evidence from the play supporting the theme (responsibility of Partner 2).
- Body Paragraph 3: Evidence from the movie that supports the theme (responsibility of Partner 1).
- Body Paragraph 4: Additional evidence from the movie supporting the theme (responsibility of Partner 2).
- Conclusion: Written collaboratively by both partners.

Technology Integration

In line with the Backward Design framework, the integration of technology was purposefully chosen to support the final goal of co-writing a literary analysis essay. Students primarily used Google Docs to co-write their essays in real time, facilitating both in-person and online collaboration. Each day's focus was on drafting one paragraph, and students wrote together during class using shared documents, which allowed both partners to monitor progress. This structure aligned with the Backward Design model, as it helped break down the larger task (writing an entire essay) into manageable steps to help guide students toward the final goal.

Writing Activity Breakdown

Day 1: Introduction Writing

First, the teacher reviewed the expectations of accountability partners (see Literary Analysis Essay

Presentation [PPT], slide 8). Then, as a class, the teacher guided students in writing the introduction to ensure a strong opening for the essay. This was co-written with the teacher's direct involvement, modeling proper structure and tone for the rest of the essay. The introduction paragraph, along with sentence starters and stems to support differentiation, was structured into three main parts as follows (see Literary Analysis Essay Presentation [PPT], slides 9-12):

- Hook
  - Rhetorical Question
    - "Do you…?" "Have you ever…?"
  - Direct Quotation
    - A quote from the play or movie
  - Figurative Language Statements
    - "Imagine…"
    - Simile or metaphor
  - Definitions
    - Define one of the keywords in your theme, such as "hope"
- Background information (What basic facts about the play/movie/about Anne are important for your reader to know?)
  - Introduce me to Anne Frank
    - Anne Frank was a young girl who…
  - Tell me about her diary
    - During her time in hiding…
  - Introduce me to the play and movie
    - A play version of Anne's diary was made called *The Diary of Anne Frank* by Frances Goodrich and Albert Hackett (1955).
    - Later, several movies were made, one being *Anne Frank: The Whole Story* (Krejci et al., 2001).
- Thesis statement (How can you summarize your entire paper in one sentence?)
  - One theme from *The Diary of Anne Frank* is…..because….
  - From Anne's story, a lesson to be learned is….because…..
  - A common theme in both the play and movie version of Anne Frank's diary is…because…

Days 2-6: Body Paragraph Writing

Each writing workday focused on one of the main body paragraphs.

- Day 2: Partner 1 wrote Body Paragraph 1, while Partner 2 supported by providing ideas, feedback, and suggestions.
- Day 3: Partner 2 wrote Body Paragraph 2, while Partner 1 offered support and feedback.
- Day 4: Partner 1 wrote Body Paragraph 3, while Partner 2 offered support and feedback.
- Day 5: Partner 2 wrote Body Paragraph 4, while Partner 1 offered support and feedback.
- Day 6: Partners worked together to write the conclusion.

Prior to students writing, the teacher reviewed the different components of body paragraphs (see Literary Analysis Essay Presentation [PPT], slides 13-18). Students used Google Docs and worked together in person during class time. Partners completed the Literary Analysis Essay Brainstorm Worksheet [DOC] indicating who was writing each section and the possible evidence, based on their chosen theme, that could be used to support their claims.

After the Literary Analysis Essay Brainstorm Worksheet [DOC] was completed and reviewed by the teacher, the students could begin writing. If it was Partner 1's turn to write, Partner 2 provided support and acted as their accountability partner. They mediated ideas and offered feedback, and vice versa. This approach helped maintain accountability and it also allowed each student to contribute meaningfully to the essay. Each body paragraph was structured as follows:

- 2nd paragraph (body paragraph 1), 5-8 sentences
  - Topic sentence
  - #1 example/evidence/reason that supports theme from the play
  - Analysis of evidence/how does it support the chosen theme?
- 3rd paragraph (body paragraph 2), 5-8 sentences
  - Topic sentence
  - #2 example/evidence/reason that supports theme from the play
  - Analysis of evidence/how does it support the chosen theme?
- 4th paragraph (body paragraph 3), 5-8 sentences
  - Topic sentence
  - #1 example/evidence/reason that supports theme from the movie
  - Analysis of evidence/how does it support the chosen theme?
- 5th paragraph (body paragraph 4), 5-8 sentences
  - Topic sentence
  - #2 example/evidence/reason that supports theme from the movie
  - Analysis of evidence/how does it support the chosen theme?

- 6th paragraph (conclusion), 5-8 sentences
  - Restate/summarize thesis from introduction
  - Discuss significance of theme/recap main points from body paragraphs
  - Concluding sentence

In alignment with the Backward Design framework, assessment methods were carefully structured to ensure students met the final goal. To assess student progress, partners completed daily progress checks/exit tickets (completed using Google Forms; see Daily Progress Check Questions [DOC]) that required them to reflect on their collaboration and how well they worked with their accountability partner that particular day. These served as check-ins to ensure both partners were fulfilling their roles and allowed for the instructor to adjust any instruction based on student responses (a form of differentiation). The final essays were graded using a rubric which focused on their analysis of the play and movie, their ability to connect evidence to the theme, and the overall structure and flow of their writing (see Individual Literary Analysis Rubric [DOC]).

Scaffolds & Differentiated Instruction

In this lesson, scaffolds and differentiated instruction were integral in supporting students at various skill levels. Sentence starters/stems served as one of the main scaffolding tools that offered structured guidance to students who needed extra help organizing their thoughts and starting their writing. Providing these supports helped to ensure that all students, especially those who struggled with language or writing structure, could participate meaningfully in the assignment without feeling overwhelmed.

At the same time, differentiation was incorporated through various strategies. For instance, students who needed more of a challenge were encouraged to select or propose their own themes which offered them an opportunity to engage in deeper, more critical analysis. This allowed for a level of flexibility in the task to accommodate different skill levels that gave students more control over their learning while still adhering to the lesson's objectives.

The accountability partner system also played a role in differentiation. By pairing students with a partner, opportunities were created for peer support, where stronger writers could guide their peers, and students that needed more assistance had someone to rely on. This peer collaboration was essential not only for fostering a sense of community but also for meeting individual learning needs, as students were able to work at their own pace with the help of their partner.

Although not applicable in this setting since students were well-versed in using Google Docs, in the future, if an instructor feels that students may vary in their ability to effectively use Google Docs for collaboration, accommodations could be made. For example, students who are less familiar with the platform could receive a brief tutorial on how to use the comment and suggestion features within Google Docs, or they could be paired with more tech-savvy peers to support their collaboration. This would help bridge the gap for students who may need additional guidance in using technology effectively and ensure that the collaborative aspect of the lesson remains accessible to all learners.

In future implementations, I, or other instructors teaching this lesson, might consider adding more multimedia options for students to express their ideas, such as allowing them to create videos, infographics, or podcasts in addition to, or instead of, writing a traditional essay. This would enhance differentiation by accommodating different learning preferences and providing students with varied ways to demonstrate their understanding. For example, students who struggle with writing might be given the option to record a video analysis or create a visual representation of their thematic connections, which would allow them to engage with the content in a way that aligns with their strengths. This approach would help make the assessment process more inclusive and provide students with a variety of ways to showcase their skills.

Critical Reflection

The lesson was implemented during the school year with the primary goal of supporting student collaboration and fostering a sense of community through the use of accountability partners. The lesson's structure, which encouraged students to co-write their essays using Google Docs, allowed students to collaborate in real-time while holding each other accountable for their assigned work. This collaborative effort met the intended goals, as students engaged in meaningful dialogue, supported

each other's writing, and offered constructive feedback.

While the lesson was successful in many respects, one observed challenge was that some pairs struggled with the accountability aspect when one partner was absent or less engaged. In these cases, the workload became uneven, and certain students took on more responsibility, which impacted their overall experience. For cases where one partner was absent, it may have been helpful to create a "backup plan," such as allowing students to submit their individual progress and having a contingency plan for the remaining work. In most cases, students showed strong collaboration and engaged in deep discussions about the themes of the play and the movie. For example, one pair of students worked exceptionally well together and demonstrated not only strong thematic understanding but also effective collaboration skills, offering each other constructive feedback and refining their arguments.

In terms of fitting into the larger instructional context, the lesson aligned well with the broader objectives of the ELA curriculum. It integrated writing skills, critical thinking, and thematic analysis while promoting collaboration. The lesson specifically connected to Common Core ELA Standards for Writing (Council or Chief State School Officers, & National Governors Association, 2010):

- W.8.1: Students were required to develop a clear argument (thematic analysis) and support it with evidence from both the play and the movie.
- W.8.4: The structured approach to co-writing essays allowed students to create clear, focused, and well-organized essays.
- W.8.5: The use of accountability partners allowed students to collaborate, plan, revise, and strengthen their writing.
- W.8.6: The integration of Google Docs facilitated real-time collaboration and allowed students to use digital tools to enhance their writing process.
- W.8.9: Students were required to incorporate evidence from both the play and the movie to support their thematic analysis, which aligned with the expectation to use evidence from texts.
- W.8.10: The daily writing tasks and collaborative nature of the assignment allowed students to engage in sustained writing over an extended period.

To ensure that assessment tools such as the Individual Literary Analysis Rubric [DOC] and Daily Progress Check Questions [DOC] were closely aligned with these objectives, the rubric was designed to evaluate specific aspects of the thematic analysis (W.8.1), organizational clarity (W.8.4), and evidence integration (W.8.9; (Council or Chief State School Officers, & National Governors Association, 2010). Daily progress checks were incorporated at key stages in the process to monitor student collaboration, understanding, and writing development. It offered opportunities for feedback and revision that directly supported the standards and learning goals.

The effectiveness of the accountability partner approach was evident in the overall engagement and quality of the final essays. Students who were actively engaged in their partnerships tended to produce higher-quality work and demonstrate a deeper understanding of the thematic connections between the play and the movie in their writing. Future data collection, such as collecting feedback from students on their accountability partnership experience, could provide further insight into the impact of accountability partners on student success.

For future implementations, modifications such as more structured progress check-ins or rotating accountability roles could be beneficial. Additionally, providing more scaffolding or extra support for students who need help staying on task would ensure both partners contribute equally. Overall, while the lesson supported collaboration and community effectively, further refinements could help address occasional imbalances in partner participation.

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About the Author

Ali Krzyzaniak is an 8th grade English Language Arts educator of six years. Passionate about blending education with technology, Ali most recently earned her Doctorate in Educational Technology from Central Michigan University where her research focused on enhancing social presence, collaboration, community, and motivation for online learners in higher education settings. Ali is eager to bring her expertise in educational technology and online learning to new opportunities in the field.

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Differentiating Instruction with AI Tools

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Overview

In their junior year, preservice teachers engaged in a lesson to facilitate the effective development of an integrated inquiry unit. Preservice teachers had to design at least three lesson plans they implemented during their clinical week. To assist preservice teachers in differentiating instruction, they experimented with using ChatGPT and the Poe feature Ludia to learn ways to differentiate instruction by unpacking the Science, ELA, Social Studies, or Math Standards.

The goal of this lesson was to ensure that preservice teachers understood what the standards meant and to provide ideas for differentiating their units and incorporating Universal Design for Learning (UDL) to meet student needs. Preservice teachers experimented with both AI tools to achieve these goals and reflected on the one they preferred with a rationale.

Topics: Artificial Intelligence, Differentiation, Integrated Unit Plan, Universal Design for Learning, Unpacking Standards

Time: one 75-minute class session

Materials

List materials needed for your learning representation:

- Differentiation and UDL Nearpod Presentation
- Comparing AI Tools Checklist
- Rubric for Integrated Inquiry Unit-Assessment Focus on Reflection
- AI websites (ChatGPT, Poe: Ludia)
- State K-12 standards (ELA, Science, Social Studies, Math)
- Laptops

Context-at-a-Glance

Setting
The lesson occurred in a public, four-year, accredited university in the southeastern United States.

Modality
In-person instruction

Class Structure
This session comprised a group of eight preservice teachers in a junior-level undergraduate course, six females and one male ranging from ages 21- 29, including seven Caucasians and one Latino. They created an integrated unit plan to implement during a clinical week in a K-3 grade setting in a local elementary school. The course involved a mix of lecture-based, discussion-based, hands-on, and project-based learning. This session was 75 minutes in length.

Organizational Norms
Preservice teachers worked collaboratively and respectfully with each other, sharing different perspectives as they explored using ChatGPT and Ludia to clarify the meanings of the standards and obtain ideas for differentiation instruction incorporating UDL.

Development Rationale
The goal of this lesson was to assist preservice teachers with using AI to help simplify state standards as they worked on developing an integrated unit plan.

Design Framework
Gagné's Nine Instruction Events (Gagné & Medsker, 1996; Ullah et al., 2015)

Setup

This lesson occurred in a classroom where preservice teachers sat in groups of two around a rectangular table. Organizing the preservice teachers in groups took approximately two minutes. Each group had copies of the standards for the subject area for their integrated inquiry unit.

Standards

Revised SC Literacy Competencies Indicator 4.7:
"The teacher will be able to Differentiate instruction to meet the needs of all preservice teachers" (South Carolina Department of Education, 2024, p. 15).

INTASC Standard 4:

> The teacher understands the central concepts, tools of inquiry, and structures of the discipline(s) he or she teaches and creates learning experiences that make these aspects of the discipline accessible and meaningful for preservice teachers to ensure mastery of the content (CCSSO, 2013, p. 24).

Context and Setting

This lesson occurred in a face-to-face classroom with eight undergraduate preservice teachers in a 400-level literacy course. It was a 75-minute session where preservice teachers worked with peers in a small group setting. The preservice teachers created an integrated unit plan, implemented during their clinical week in an elementary school in grades 1-3. The instructor grouped the preservice teachers with similar topics. For instance, three preservice teachers decided to work on habitats and chose to complete the group work for this lesson together. Groups consisted of 2-3 preservice teachers. The instructor guided group formation, but preservice teachers had some autonomy if their topics aligned.

Preservice teachers did not have assigned specific roles but collaboratively determined how to divide the task, drawing on norms established at the beginning of the semester such as respecting each other's opinions, refraining from using cell phones during class time, and engaging in class discussions.

Prior to the lesson, most of the preservice teachers had some experience with ChatGPT and had little to no experience with Ludia. This was determined with a quick Nearpod Poll which showed that 67 % agreed to having used ChatGPT and 87% stated they had no knowledge of Ludia (Differentiation and UDL Nearpod Presentation [PDF], slides 28-31). This led to providing a pre-written prompt to students to scaffold their use of the AI tools. The prompt was to help ease cognitive load and to model effective prompt engineering which is a critical skill when integrating AI into instructional planning. In terms of tool selection, the instructor chose ChatGPT because of its broad accessibility and preservice teachers' familiarity with it. The instructor selected Ludia specifically for its alignment with the Universal Design Principles. These AI tools simplified the standards, provided learning goals, and generated differentiation ideas using the Universal Design for Learning.

Learning Representation

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

Introduction

First, preservice teachers had to join the lesson via Nearpod by going to https://nearpod.com/ and entering the instructor provided code. The instructor used Gagné's first instruction event to gain the preservice teacher's attention by asking, *Differentiating, what is it? Moreover, what is it not?* to activate thinking about the lesson's central concept. The preservice teachers wrote their responses using the collaborate feature within the Nearpod lesson and applying the second event of instruction-informing preservice teachers of the objectives (Gagné & Medsker, 1996; Differentiation and UDL Nearpod Presentation [PDF], slides 1-2). The instructor presented four goals for the lesson. One objective was *Preservice teachers will be able to use generative AI Tools: ChatGPT and Ludia to simplify teaching standards and obtain ideas for differentiating instruction* (Differentiation and UDL Nearpod Presentation [PDF], slide 3).

The instructor stimulated recall of prior knowledge (Gagné & Medsker, 1996) by engaging preservice teachers in a Think, Ink, Pair, share activity to answer the discussion prompt: *List all of the differences*

between preservice teachers, which may account for ways we should match learning to them

(Differentiation and UDL Nearpod Presentation [PDF], slide 4). Preservice teachers responded, "Some may be visual preservice teachers, while some are more hands-on," and "attention span."

Content Presentation

The instructor employed Gagné's fourth instruction event- presenting the content (Gagné & Medsker, 1996) by utilizing Nearpod slides to explain and elaborate on the meaning of differentiation regarding the planning of content, process, and product (Differentiation and UDL Nearpod Presentation [PDF], slides 5-15). Content refers to the knowledge and skills preservice teachers need to master; the method relates to the activities preservice teachers use to master the content, and the product deals with the instruction output (Tomlinson, n.d.). The instructor asked preservice teachers to share reasons for why we differentiate. The instructor provided a simplified definition of differentiation, which included instructing in various ways to meet preservice teachers' needs and maximize their opportunities for success (Tomlinson, n.d.).

The instructor explained some factors to consider when planning (Figure 1). These factors started with making decisions after giving a pre-assessment. These decisions included the curriculum, student readiness, interest, prior knowledge, content, process, and product (Oaksford & Jones, 2001, as cited in Hall, 2002).

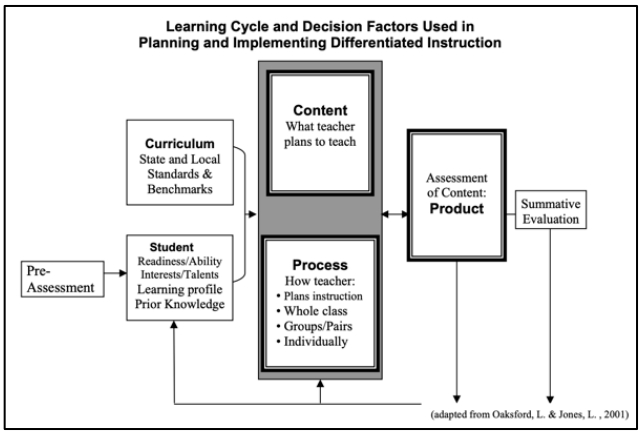

Figure 1. Learning cycle and decision factors.

The instructor explained the principles of a differentiated classroom. For example, the instructor explained that assessment and instruction are inseparable. Also, content, process, and product are tailored in response to student readiness, interests, and learning profile. The instructor elaborated on what differentiation is not (chaotic, individualized instruction, just modifying an assignment) and what it is (proactive, rooted in assessment, student-centered, and multiple approaches to content, process, and product). A short discussion ensued on the advantages of differentiation. Then, preservice teachers had the following discussion question: *What do you think are some of the key challenges associated with implementing differentiation in the classroom?* (Differentiation and UDL Nearpod Presentation [PDF], slide 16). See Figure 2 for some of the preservice teachers' responses where lack of time seemed to be the biggest challenge.

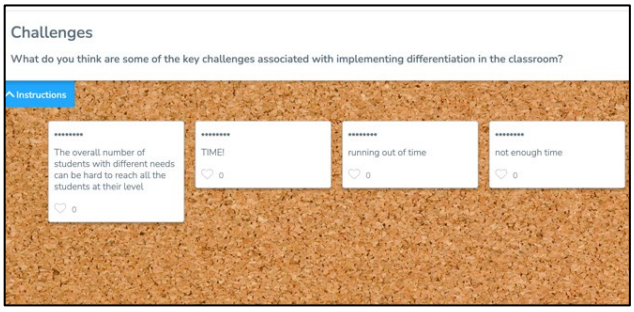

Figure 2. Challenges of differentiation.

The instructor presented essential tips to be mindful of, such as the need for learning activities to be engaging and exciting and the importance of balancing student-selected and teacher-selected assigned tasks. After the lecture and discussion, the instructor asked preservice teachers to share their prior experiences with the Universal Design for Learning (UDL) by completing an activity in Nearpod (Differentiation and UDL Nearpod Presentation [PDF], slide 20), which indicated that six preservice teachers had no prior knowledge of Universal Design for Learning knowledge.

The instructor explained that UDL is a scientifically valid framework for guiding educational practice (Differentiation and UDL Nearpod Presentation [PDF], slide 21). It provides flexibility in how educators present content and how preservice teachers respond or demonstrate knowledge and skills (CAST, n.d.). It also removes barriers to learning (U.S. Department of Education, 2024). Preservice teachers looked at images depicting equity and accessibility

regarding UDL (Differentiation and UDL Nearpod Presentation [PDF], slide 22). Preservice teachers had to differentiate between differentiation and UDL by engaging in small groups (Differentiation and UDL Nearpod Presentation [PDF], slides 23). Two photos of road signs were on a slide. One stated, "Beware of

Moose" in four different languages; the other was a picture of a moose and a car. Preservice teachers engaged in a short discussion by answering the following questions:

- *Which sign is differentiated?*
- *Which is UDL?*
- *Which would you put in a public road?*

Preservice teachers shared their responses with supporting rationale. The instructor guided preservice teachers in understanding the connections between differentiation and UDL (Differentiation and UDL Nearpod Presentation [PDF], slides 24-27). For instance, UDL focuses on multiple means of representation that connect with content from differentiation. The differentiation process is closely related to the various means of action and expression in UDL, and the product from differentiation aligns with multiple means of engagement and different means of action and expression in UDL.

Practice

After explaining UDL, the instructor provided another poll in Nearpod with two questions and four responses to prepare preservice teachers to use ChatGPT and Ludia to simplify standards and ask for ideas to differentiate instruction for their integrated unit plan (Differentiation and UDL Nearpod Presentation [PDF], slides 28-31). One question asked, *How often do you use ChatGPT?,* and the other asked, *How often do you use Ludia?.* The answer choices were *daily*, *weekly*, *occasionally*, or *never*. The poll showed that 67% of students admitted to using ChatGPT occasionally, and 83% of students never used Ludia.

The instructor placed preservice teachers in small groups based on the similarities between the subjects/topics they were integrating into their unit plan. The instructor then provided learning guidance (Gagné & Medsker, 1996) to support preservice teachers as they applied their knowledge of differentiation and UDL using ChatGPT and Ludia (Differentiation and UDL Nearpod Presentation [PDF], slide 32). Preservice teachers used the written directions supported by the instructor's explanation of each step to complete the following tasks:

1. *Select a standard from your integrated unit plan and copy it.*
2. *Google the AI tools "Poe-Ludia" and "ChatGPT"*
3. *Use the following prompt to interact with both AI tools:*

a. *Prompt: "Simplify the following standard, provide learning goals and differentiated instruction ideas using the Universal Design for Learning (UDL), followed by a colon (:)*

4. *After the colon, paste the standard you copied from your unit plan.*
5. *Generate responses from both ChatGPT and Ludia.*

The preservice teachers engaged in the activity, eliciting their performance (Gagné & Medsker, 1996). An example of a preservice teacher's prompt for a first-grade unit on plants was: "Simplify the following standard, provide differentiated instruction ideas using the Universal Design for Learning (UDL), followed by a colon: 1-LS1-1. Use materials to design a solution to a human problem by mimicking how plants and/or animals use their external parts to help them survive, grow, and meet their needs" (Next Generation Science Standards, n.d.).

The preservice teachers evaluated both AI tools based on the provided criteria. Comparing AI Tools [DOC] highlights criteria, including ease of use, alignment with standards, differentiation, and UDL strategies. The preservice teachers shared their thoughts about each tool. For instance, one learner stated that he preferred ChatGPT because it was more detailed and even explained the characteristics of UDL, although he did not ask it to. Another noted that she preferred Ludia because it provided specific examples to help differentiate preservice teachers with different needs.

Assessment

The instructor provided feedback (Gagné & Medsker, 1996) and conducted informal assessments as preservice teachers discussed and shared responses regarding differentiation with UDL using the AI tools. For enhancement and transfer (Gagné & Medsker, 1996), the instructor asked: *After using Ludia and ChatGPT, which tool do you prefer to simplify*

standards and provide differentiation ideas using UDL? (Differentiation and UDL Nearpod Presentation [PDF], slides 34-35). Figure 3 reveals that 50% of students stated both, 33% of students stated ChatGPT, and 17 % did not respond.

Figure 3. Preservice teachers preferred AI tool.

As an additional means of assessing preservice teachers' understanding of differentiating instruction using UDL, the instructor reviewed the preservice teachers' lesson plans for evidence of differentiation when they submitted it for approval before implementing it during the clinical week. Preservice teachers participated in a structured clinical experience carefully designed to support the application of skills learned in class and preparation for student teaching. The College of Education Field Placement Coordinator did the clinical placement, ensuring each preservice teacher was assigned to a public elementary school in grades K-3. Even when some preservice teachers were placed at the same school, they worked in different grade levels, ensuring each preservice teacher had an individualized experience. Preservice teachers were expected to implement all three lessons at their placement.

At the end of the preservice teachers' clinical week, they compiled their units, including a reflection on the implementation process, which they submitted via Blackboard LMS. The instructor assessed the preservice teachers' performance (Gagné & Medsker, 1996) using a rubric to evaluate their units, focusing specifically on the reflections submitted (see Rubric for Integrated Inquiry Unit-Assessment Focus on Reflection [DOC]). Additionally, the instructor evaluated the effectiveness of using ChatGPT and Ludia to simplify standards and generate ideas for differentiation instruction using UDL. All eight preservice teachers performed well. Presented are some sample excerpts from their reflections:

- “The biggest celebration for me was seeing the students go from such little knowledge of goods and services to building an understanding of them. I think seeing how much knowledge they could grasp in such a short amount of time was impressive. They surprised me with how they built their understanding in a few lessons."
- "Overall, I think this inquiry unit was informative and engaging for the students, but helpful in developing my ability to design engaging, student-centered lessons based on state standards. My lessons effectively captured student interest, promoted active engagement, and supported extended learning through Bloom's taxonomy."

Closing

To enhance retention and transfer (Gagné & Medsker, 1996), the instructor summarized the lesson and reminded preservice teachers to use AI as a tool for ideas rather than relying on it to write their papers. Preservice teachers shared how they plan on using these tools in the future for designing instruction and reflected on key insights gained from the lesson.

Critical Reflection

Overall, the lesson met its objectives. Preservice teachers were able to distinguish between differentiation and UDL and noted the connection between the two. They also effectively used ChatGPT and Ludia to simplify standards and obtain ideas for differentiating content, process, and product using UDL. At the end of the clinical week, preservice teachers turned in the entire unit with a reflection, which I evaluated using a rubric. The reflection from them demonstrated growth in understanding the state standards and using engaging activities during the implementation process. They also reflected on the student's development and how well it piqued their interests.

The instructor learned a few lessons throughout this process. The instructor spent more time on differentiation and less time on UDL. Since the preservice teachers had no prior knowledge of UDL, the instructor will plan another lesson in future iterations to solidify the concept for preservice teachers. Also, the instructor engaged more in lecturing with a few discussions within the lecture. In future lessons, the plan will be for preservice teachers to actively learn and construct knowledge with the instructor as a guide or facilitator.

Additionally, a preservice teacher asked the instructor if they could use their own prompt. In the future, the instructor will provide more time for preservice teachers to explore different prompt engineering opportunities and create their own prompts.

Another limitation is the ethical aspect of using AI as a tool. This became evident when a short discussion occurred regarding academic dishonesty. This observation demonstrated curiosity about the appropriate use of AI in academic and instructional settings. In future lessons, the instructor will build discussions on ethical uses of AI within lesson planning and create/implement scenarios where these tools are used unethically in higher education classrooms such as submitting AI generated work without citations or relying on AI to complete assignments. Additionally, using information gathered from the scenario discussions, the instructor would work with preservice teachers to create guidelines for utilizing generative AI ethically in the classroom. Finally, in future lessons or studies, preservice teachers will be given time to measure the effectiveness of AI tools by using provided criteria to determine the accuracy, quality, and developmental appropriateness of AI in designing instruction.

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About the Author

Tonia Bauer, Ed.D., is an Assistant Professor of Early Childhood and Elementary Education with over 16 years of experience teaching in K–5 public schools. As an educator and researcher, she specializes in literacy instruction grounded in the Science of Reading, focusing on designing innovative, developmentally appropriate strategies for the classroom. Her work bridges theory and practice, particularly through integrating technology to support instructional planning and enhance student learning.

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Biomimicry and Human Design: Observing Bird Structures and Functions to Create Flying Machines with Artificial Intelligence

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Overview

Using the 5E model, this lesson engages fifth graders in exploring biomimicry and flying machines to inspire original designs. Students build design thinking and observation skills through bird observation using photos, videos, and audio, followed by discussion, sketching, brainstorming, testing, revising, and artistic creation. An artificial intelligence (AI) image generator supports visual inspiration. The lesson concludes with students sharing and reflecting on their flying machines. Hands-on activities and technology are integrated throughout to enhance engagement and interaction.

Topics: Artificial Intelligence, Biomimicry, Design Thinking, Flying Machine, Observant Thinking

Time: The lesson sequence takes about 5 days to complete based on daily 40-minute classes. In keeping with differentiated instruction, teachers can speed up or slow down the sequence as they wish, following the lead of the students.

Materials

- Multiple photographs of owls and hummingbirds
- Internet-connected devices for students (e.g., laptops, iPads, Chromebooks)
- Projector or interactive whiteboard
- Student access to OpenAI's (n.d.) DALL-E platform or similar AI image generation tool
- Biomimicry Rubric
- Art materials (e.g., paper, pencils, markers, scissors, rubber bands, straws, string, hole punchers, popsicle sticks, glue sticks, glue, tape)

Context-at-a-Glance

Setting
Fifth graders at an urban, public, elementary school in the Mid-Atlantic region of the United States.

Modality
In-person instruction

Class Structure
A flexible classroom setup with options for small-group arrangements to encourage collaboration (e.g., seating three to five students at small tables to foster discussion, teamwork, and a sense of community).

Learner Characteristics
Fifth graders from predominantly Hispanic backgrounds. Students have a basic knowledge of birds and work with their hands to create artwork. Students are familiar with computers and have used art supplies before. Students are enthusiastic about art making and the use of AI image generators to learn more about owls and hummingbirds. Some students do not speak English well.

Instructor Characteristics
Teachers should be familiar with an AI image generator tool to guide students through. Co-teaching with an art teacher is recommended.

Development Rationale
Elementary students will have a unique opportunity to encourage observant thinking, creativity, and innovation while engaging in hands-on learning with an AI image generator, which fosters design thinking in the study of biomimicry.

Design Framework
5E Model of Instruction (Bybee, 2015)

Setup

This lesson sequence spans about five days. During the five lessons, students work in small groups. It should take 10-15 minutes to set up the environment each day. Each group receives the following materials:

- Day One: No materials are needed. Students might stand and use their bodies and, therefore, need adequate physical space to do so.
- Day Two: Owl and hummingbird hand-outs are placed on each table. Each student is provided with one 8½ x 11" sheet of paper and a pencil.
- Day Three, Part A: Each student is provided with two 8½ x 11" sheets of paper and a pencil, one sheet for sketching and one sheet to write prompts.
- Day Three, Part B: Each student (or student pair) receives a laptop computer with DALL-E ready to use.
- Day Four: Each student (or student pair) receives a laptop computer with DALL-E ready to use.
- Day Five: A variety of art materials are placed on the table, including light-weight white construction paper, white printer paper, markers, scissors, rubber bands, light white paper, straws, string, hole punchers, glue sticks or glue, tape and popsicle sticks.

Standards

ISTE Standards for Students:

- 1.4.a "Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts, or solving authentic problems" (International Society for Technology in Education [ISTE], 2016).

National Core Arts Standards:

- Anchor Standard 1: "Generate and conceptualize artistic ideas and work" (National Coalition for Core Arts Standards [NCCAS], 2014).
- 5th VA: CR1.1.5.a: "Combine ideas to generate an innovative idea for art-making" (NCCAS, 2014).
- Anchor Standard 2: "Organize and develop artistic ideas and work" (NCCAS, 2014).
- 5th VA: Cr2.1.5.a: "Experiment and develop skills in multiple art-making techniques and approaches through practice" (NCCAS, 2014).

Context and Setting

Leonardo da Vinci wrote, "Human subtlety will never devise an invention more beautiful, more simple or more direct than does nature because in her inventions nothing is lacking, and nothing is superfluous." (da Vinci, 1970, p. 126)

da Vinci's drawings of airplanes and parachutes, drawn long before humanity conceived of these inventions, continue to fascinate us after all these years. For example, in 1505, he discussed the fundamental concepts of gravity and birds lifting their wings to introduce the idea of flying (da Vinci, 1970). His keen observational skills have helped generations of thinkers reimagine what's possible. Indeed, many innovations throughout history have been inspired by analyzing the behavior of birds, fish, insects, and other animals.

This field, known as biomimicry, is defined as the "design and production of materials, structures, and systems that are modeled on biological entities and processes" (Arizona State University Online, 2022, para 1). In other words, humans apply nature-inspired designs, emulating biological forms, processes, patterns, and systems in engineering and invention to solve human problems (Kennedy, 2017).

Making meaning from observed natural phenomena requires detailed observation, creative problem-solving based on observation, and design thinking. In this process, sketching or drawing can be used to visualize and scaffold observations, which then lead to creative and innovative problem-solving and creation. Biomimicry promotes this sensibility grounded in our surroundings, which is essential for creators, producers, or designers. Design thinking is fundamental to this creative problem-solving process by fostering innovation that harnesses sensibility and methods (Eklund et al., 2022). As such, biomimicry is an effective booster for design thinking, using designers' sensibilities and techniques to create things that meet people's needs and develop into values (Brown, 2008; Micheli et al., 2019). Nature can inspire designers and other creators to develop new and usable inventions. For example, the flexible ribs on the sides of a leaf informed the design of the hollow ribbed structure of the Crystal Palace Conservatory in Hyde Park, London (Figure 1; Goss, 2009).

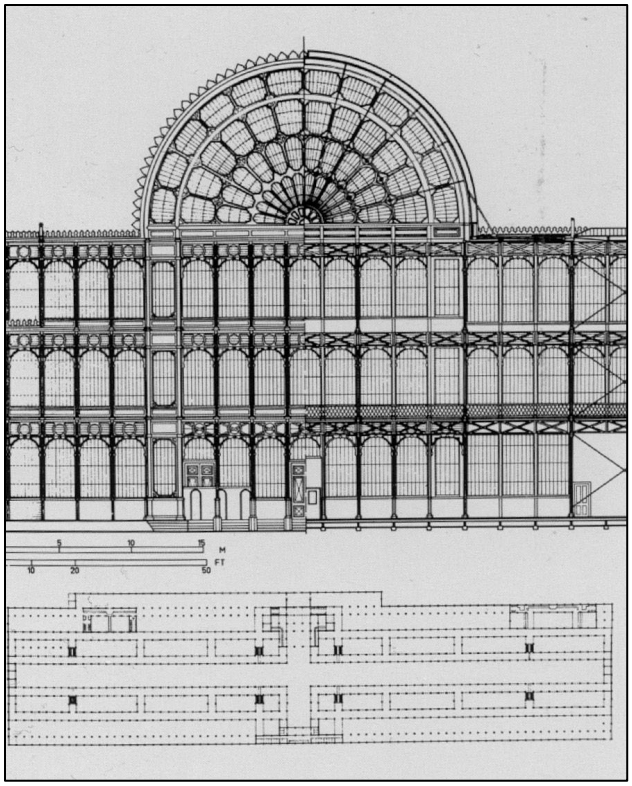

Figure 1. Crystal Palace Conservatory by Sir Joseph Paxton (1803-1865) Note. Self-scanned; public domain. https://bit.ly/42ou5hW

In recent years, design thinking has increasingly become emphasized in the K-12 curriculum as a necessary 21st-century skill. For example, some states, such as New Jersey, embrace design thinking as part of students' learning standards (see New Jersey Student Learning Standards, 2020), making it a critical area to teach today's students. In this context, biomimicry has a unique advantage as a vehicle for fostering design thinking and creating a flying machine, particularly for interdisciplinary aspects of arts and technology-integrated lessons and projects.

An important skill of design thinking is journey mapping (also known as "experience maps"), which visualizes the progression of work over time (Howard, 2014; Stobierski, 2022). One of the tools that might help students visualize unknown things is an artificial intelligence (AI) image generator. One such AI image generator, DALL-E (https://chatgpt.com/g/g-2fkFE8rbu-dall-e), was revealed by OpenAI in January 2021. Based on text-to-image models and using deep learning methodologies, digital images are generated from natural language descriptions, called "prompts." DALL-E can foster design thinking and stimulate creativity and divergent thinking.

Following the 5E instructional model of Engage, Explore, Explain, Extend (or Elaborate), and Evaluate (Bybee, 2015), this article presents a lesson that explores the intersection of biomimicry and the creation of flying machines. It is also designed to help students (a) post their work in stages and (b) share and reflect throughout the design thinking processes.

The lesson starts with engagement, which should be informed by students' close observation and previously acquired knowledge. Students' subsequent exploration and research will inform ideation, prototyping, and creation. The lesson also emphasizes sharing and reflection during the Explain and Elaborate stages, encouraging students to express their thinking through the use of online bulletin board tools.

The following lesson is designed for fifth graders. The use of a 5E instructional model (Bybee, 2015) takes into consideration students' prior experiences and how they may affect their learning of content before introducing them to the lesson.

Learning Representation

Objective:

How can we observe birds in flight to inspire us to create our own flying machines?

Essential Questions:

- What can humans learn about aeronautical design from nature?
- How can nature inspire human design?
- How can artificial intelligence empower humans to be more creative and divergent thinkers?

Day One

Engage

The teacher introduces an exploratory discussion using some of the following questions and presents videos of birds in flight, photographs of birds, and

other resources on the Promethean or any interactive digital whiteboards.

- Have you ever seen a bird in flight? Did you see it up close?
- Did you know what type of bird it was? What did you notice about the flight of this bird? Did you wonder how it was able to stay in the air?
- What part of the bird keeps it in flight?
- How do you think birds differ in their flights? Are their bodies different?
- Have you ever seen an owl or a hummingbird up close?
- What did you notice about the way the two birds fly?
- Have you tried to capture it in a photo or sketch?
- Why are pictures important in science?

As a closing activity for the lesson, the teacher might (a) ask students to stand up and try to re-create some aspect of the birds' flight using their bodies; (b) ask students to use their hands to create the birds; or (c) play different bird sounds using audio files.

Day Two

Explore: Science and Art Observing Closely and Sketching

Prior to class, the teacher should print out photographs of an owl and hummingbird and distribute copies to each student or group of students (see examples in Figures 2-5). In addition, photos are available on desks or worktables as resources for the students to engage with.

First, the teacher cultivates student exploration through more discussion using photos of two types of birds (owls and hummingbirds) to develop observational skills and design thinking while sketching. At the same time, the teacher might also play audio files of these birds.

Each student is provided with an 8½x11 sheet of paper and a pencil and asked to sketch an owl or a hummingbird in flight based on the provided photographs. This stage focuses on students' learning about how the structures of owls and hummingbirds assist in their flying abilities, how both birds look in flight, and how to record this information in a sketch. Students will create a drawing of an owl or a hummingbird in flight to demonstrate this understanding. The teacher explains that later in this lesson plan sequence, they will use these sketches to inspire them to create/design an imaginary flying machine.

Questions teachers might use during sketching activities include:

- Have you ever seen an owl or a hummingbird in flight?
- What did you notice? How do these birds look in flight?
- How are the wings of an owl different from the wings of a hummingbird?
- What else do you notice about their similarities and differences?
- Can you sketch one of these two birds in flight?
- Where will you start?

The teacher shows videos of owls and hummingbirds in flight such as the following:

- Barn owl in flight (Feather Light Photography, 2021)
- Only bird that can fly forward, backward, upside-down and hover (Nature Notes, 2021).

The teacher then asks the following questions to cultivate design thinking:

- What are the most interesting features of this bird and its unique flight patterns and maneuvers?
- What changes when it is in motion? How does this change affect the way the birds fly?
- What do you see when birds are both stationary and moving?
- Can you predict the differences in flight for these two birds?

Towards the end of the session, the teacher asks several students to stand up and show their drawings to their fellow students, explaining their sketching and their thinking. Other students also record their responses explaining their processes. Drawings are displayed on a board in the classroom while the students speak and write their responses to the questions about the way owls and hummingbirds look in flight. The students may respond to questions from their fellow students as an open discussion.

Figure 2. *Realistic Owl Portrait on White Background [Stock photo], by R. Javed, 2024, Shutterstock (https://www.shutterstock.com/image-photo/realistic-owl-portrait-on-white-background-2564093319). Copyright 2024 by R. Javed. Used under license.*

Figure 3. *Male great horned owl (Bubo virginianus), also known as the tiger owl has a low overflight [Stock photo], by M. Ninger, 2023, Shutterstock (https://www.shutterstock.com/image-photo/male-great-horned-owl-bubo-virginianus-2287394585). Copyright 2023 by M. Ninger. Used under license.*

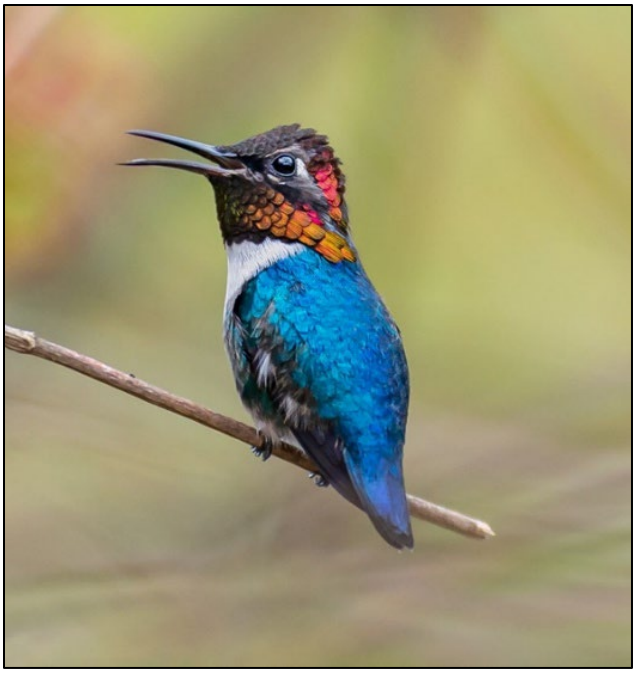

Figure 4. *Bee hummingbird (Mellisuga helenae) male perched with green background at Playa Larga Cuba [Stock photo], by P. Poznan, 2022, Shutterstock (https://www.shutterstock.com/image-photo/bee-hummingbird-mellisuga-helenae-male-perched-2143984955). Copyright 2022 by P. Poznan. Used under license.*

Figure 5. *Hummingbird violet sabrewing flying next to flower [Stock photo], by O. Prosicky, 2014, Shutterstock (https://www.shutterstock.com/image-photo/hummingbird-violet-sabrewing-flying-next-beautiful-235104346). Copyright 2014 by O. Prosicky. Used under license.*

Day Three

Explore: Create a Flying Machine With a Sketch and an AI Image Generator

Part A

Each student is provided with an 8½x11" sheet of paper and a pencil and asked to sketch an imaginary flying machine inspired by their knowledge of owl and hummingbird flight, or biomimicry. Selected guiding questions for students include:

- What might your imaginary flying machine look like? How will it fly?
- What will your imaginary flying machine be able to do? (How many passengers will it hold? How far will it be able to travel? Where will it be able to go? Will it have special powers?)
- How will you use what you already know about the flight of the owl and the hummingbird to design your flying machine (biomimicry)?

Part B

The teacher conducts a brief review of the flying machine sketches and engages students in a discussion about the design process and how it works. The teacher also asks students if they think an AI image generator might help them design their flying machine? How?

Selected guiding questions for students include:

- Is anyone familiar with AI image generators?
- If yes, how can an image generator help with the designing of our flying machines? What would we prompt it to do?

At this stage, the teacher introduces students to the AI image generator DALL-E as a way for them to learn to use AI as an "assistant" to create a unique flying machine. Since DALL-E is a text-to-image model for generating digital images based on prompts entered by the user, the teacher points out that it is important to make the prompts specific and descriptive. Students can tweak their prompts and re-generate their images, as needed. The teacher then prompts DALL-E to create a flying machine and explains to the students what words to use. The teacher first demonstrates how to enter prompts and then provides a list of prompts students can explore. Some keywords may be *flying machine, plane, three-dimensional, art, realistic, shapes, lines*, or words taken from the elements of art and the principles of design (Trust, 2011). Teachers should stress that the prompt is a "dialogue" with the AI and that the results may be surprising because the images from AI can be different from our common thoughts or expectations (see Resources for Teachers section).

The teacher now asks questions such as:

- What happens when you use these prompts in DALL-E: *flying machine, plane, three-dimensional, art, realistic, shapes, lines*?
- Is the image DALL-E created what you expected?
- What is the same as what you imagined? What is different?

After the students experiment for a while, the teacher refocuses their attention on how to enhance their prompts with new explanations and instructions to help students understand how subtle changes in the words they use can greatly affect the DALL-E output.

- What happens when you take a vocabulary word and make it into a verb; for example, *thrust* to *thrusting*, *lift* to *lifting*, *flying, gliding, soaring, cruising*, etc.? (Teachers may provide students with a pre-made word list or encourage them to create a list of their own.)
- What are some nouns and adjectives that relate to our topic?
- What happens when you add nouns and adjectives to the prompts (e.g., *red lifting flying machine* or *soaring blue flying machine cruising at a high altitude*)? (Teachers may provide students with a pre-made word list or encourage them to create a list of their own either individually or as a group.)

The teacher provides the following prompts and encourages students to use the same prompts several times since DALL-E generates different images even with the same prompts.

- "Create planes inspired by owls" (Figure 6)
- "Create images of planes that mimic flying owls" (Figure 7)
- "Create planes inspired by hummingbirds" (Figure 8)
- "*Create images of planes that mimic flying hummingbird*s" (Figure 9)

Students have to come up with prompts that will tell DALL-E what to do. To that end, they will need nouns, verbs, and adjectives to express their ideas in a language that the DALL-E can understand. After attempting the above suggestions, students are encouraged to invent their own prompts. Students and teachers might create a word list together (or students can make up their own) suitable for creating interesting flying machines that look like specific birds, or the teacher may provide a few of the introductory prompt words or prompts that can be shared by the entire class as cooperative learning. When coming up with prompts, flexible thinking and thinking outside the box is important.

After viewing the images generated by DALL-E, students can compare them to the sketches they created on Day Two and refine and finalize them.

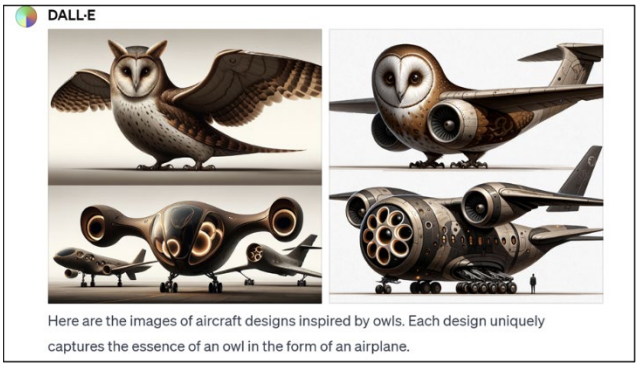

Figure 6. AI generated image from prompt, "Create planes inspired by owls." Note. Images generated using the prompt "Create planes inspired by owls," by OpenAI, DALL-E, 2024 (https://openai.com/dall-e-2).

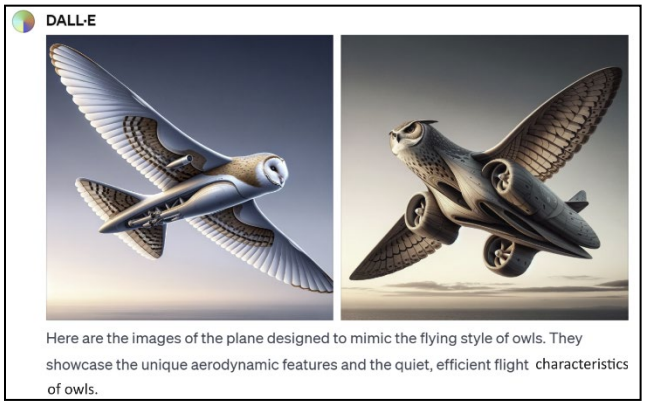

Figure 7. AI generated image from prompt, "Create images of planes that mimic flying owls." Note. Images generated using the prompt "Create images of planes that mimic flying owls," by OpenAI, DALL-E, 2024 (https://openai.com/dall-e-2).

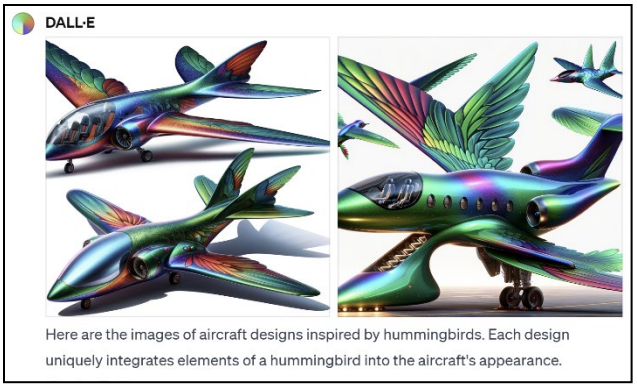

Figure 8. AI generated images from prompt, "Create planes inspired by hummingbirds." Note. Images generated using the prompt "Create planes inspired by hummingbirds," by OpenAI, DALL-E, 2024 (https://openai.com/dall-e-2).

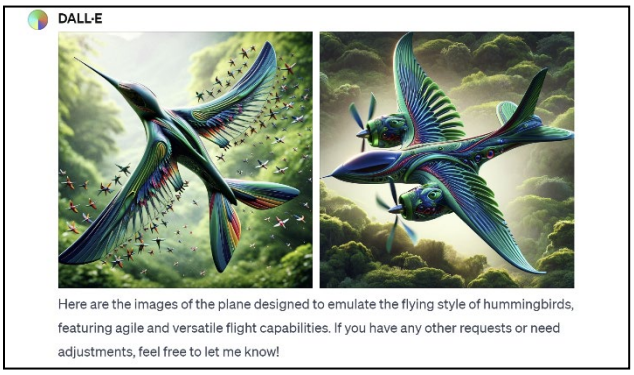

Figure 9. AI generated images from prompt, "Create images of planes that mimic flying Hummingbirds." Note. Images generated using the prompt "Create images of planes that mimic flying hummingbirds," by OpenAI, DALL-E, 2024 (https://openai.com/dall-e-2).

Day Four

Explain

Students post their 2D sketches and 3D flying machines and their reflections on online sticky notes such as those in Padlet (https://padlet.com/), which provides online boards for posting and presenting any types of work, including texts, links, images, and videos. As such, sites like Padlet can be used to store students' product development and reflection. In addition, the teacher can post reflection questions using organizing tools (see the example in Figure 10). Prompts that the teachers could ask to elicit reflective thinking include:

- What made you sketch your flying machine the way you did?
- In what ways did observing bird pictures and watching videos of flying birds inspire you to sketch your flying machine?
- In what way did sketching the birds inspire you to create your 3D flying machine with the art materials?
- If any, how did using the AI image generator (DALL-E) help you create an image of your flying machine?
- What do you think works best to create the flying machine?

Based on what students have added to Padlet, the teacher can encourage a class wide discussion by asking students to share the features of birds they observed in photos and videos that influenced the design of their flying machines. The goal of such discussions is to help students recognize that birds can inspire human aircraft design and to introduce students to the concept of biomimicry.

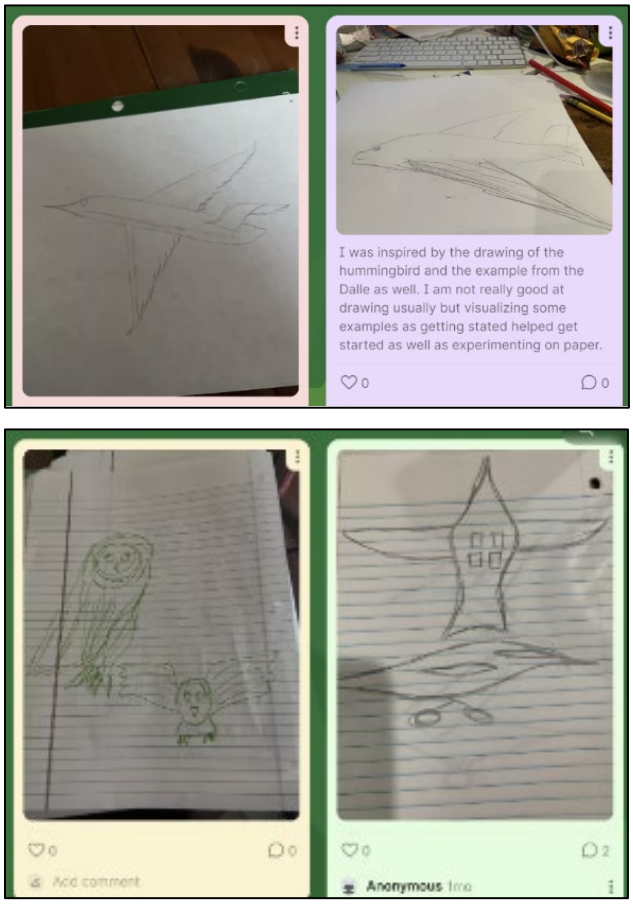

Figure 10. Example of students' works and their reflections on the Padlet.

In this stage, students can also watch some videos on biomimicry and discuss the themes. For example, in "From Birds to Brothers – The Evolution of Flight," students can gain a better understanding of how birds fly and how humans obtain a scientific understanding of this phenomenon through keen observations, experiments, and created inventions. Similarly, in "Tunneling with a Mechanical Worm on Steroids," students learn another example of biomimicry, in which engineers in Mexico City developed a boring machine that follows the same tunneling processes as a worm.

- From Birds to Brothers – The Evolution of Flight (Smithsonian National Air and Space Museum, 2021)
- Tunneling with a Mechanical Worm on Steroids (Science Channel, 2015)

Day Five

Elaborate

In this stage, the teacher encourages students to review the ideas behind their 2D drawings done on Day Two and to imagine a 3D model. The teacher poses some of the following questions:

- Could a hummingbird or an owl inspire the design of an imaginary flying machine?
- Can you imagine making a flying machine out of art materials after seeing these birds?
- Could you make it fly? Why or why not?
- How would you do that?
- Which traits of a hummingbird or an owl might be incorporated into the design of such a contraption?
- Can you think of any real things that fly (airplanes, etc.)?
- What part of the bird do you think was copied? Why?

The teacher points out that Leonardo da Vinci's flying machines only stayed as ideas in a sketchbook due to the limitations of his time and emphasizes the role of creative brainstorming with art materials as a valid basis for scientific inventions that might come later.

Students use the final version of the sketch they have drawn to create a 3D flying machine. For this activity, teachers can set up centers in the classroom to cultivate collaboration verbally and visually, with peer

learning among students (see Figure 11). Students can choose materials that the teacher brings in, including construction paper, markers, scissors, rubber bands, softer types of white paper (e.g., sheets of paper towels), straws, string, hole punchers, glue sticks (or Elmer's glue), and popsicle sticks.

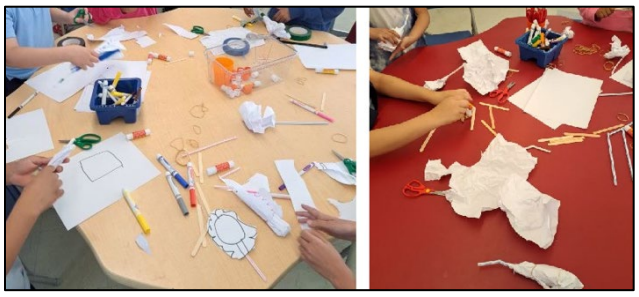

Figure 11. Centers with sample materials.

The teacher inspires students to work with these materials by demonstrating a few uses of the materials joined together. This is an open-ended activity, with students using the materials to try out various things. The teacher provides a brief explanation of the theory of flight, specifically covering the four forces of flight – lift, weight, thrust, and drag – and points out the relationship among them. Furthermore, the teacher elaborates on how humans are not built to fly. More information on this topic may be found at the National Air and Space Museum (n.d.).

Towards the end of this session, the teacher asks several students to show their 3D flying machines and explain the processes used to design them. Students also name their creations (e.g., "Ornithopter). This process is recorded as a formative assessment used at the Evaluate stage to see how students' thoughts have developed.

Evaluate

In this final stage, students are evaluated on the quality of the flying machine they designed and the explanations they posted on the Padlet during the Explain phase (see Biomimicry Rubric). A rubric for this purpose may consist of the categories "Flying Machine" and "Reflections on the Padlet." AI-produced images are analyzed by teachers using the rubric "AI-Produced Images," which analyzes the level of impact AI image generators had on creating and explaining the flying machine.

The categories, performance levels, and descriptions may be adjusted to fit students' needs and circumstances. For example, the "Flying Machine" category could assess creative ideas and structural details of the flying machine, and the "Reflections on the Padlet" category could assess constructive thoughts on design thinking and the impacts of an AI image generator on design thinking.

Critical Reflection

This lesson sequence has been implemented twice in the same urban school district in New Jersey, where many students have limited English proficiency. It effectively helps students visualize both the flight of owls and hummingbirds and the process of creating a flying machine. The lesson is best suited for students from Grade 4 through middle school, as learners at these levels are able to understand how a two-dimensional sketch can inspire a three-dimensional artwork. Younger students tend to engage more spontaneously with art materials and may struggle with this conceptual leap.

Using sketching to study owls and hummingbirds has proven highly effective, as it allows students to directly engage with the birds' anatomy and flight patterns, even if they cannot depict them with complete accuracy.

The technology component, utilizing DALL-E, requires careful guidance from the teacher for several reasons. First, generating and refining AI prompts necessitates a level of English proficiency that may be challenging for English language learners. Second, keeping students focused on the flying machine project is essential, as some students—especially those familiar with AI image generators—may be tempted to explore unrelated topics.

In addition, teachers should prepare in advance for the managerial and technical aspect of using DALL-E. Some school networks may block certain websites. Therefore, teachers should check access to OpenAI's (n.d.) site in advance or seek school or district approval for using generative AI tools and request IT support if needed. Further, using DALL-E involves setup time for opening accounts and helping students as needed. That is, while some students might navigate the tool independently, others may face a learning curve.

For schools in low-resource settings where students don't have access to internet-connected devices, teachers can demonstrate DALL-E on a large interactive board or projector. Students can suggest prompts, and the teacher can enter them in real time, making it an interactive, whole-class activity. This approach allows all students to engage with DALL-E even if individual devices are not available.

For the hands-on construction of flying machines, teachers may need to assist students with threading and tying materials through holes made with hole punchers. Given the time required for this process, it may be beneficial to extend the project over two class sessions, allowing students to fully engage with both the materials and the construction process.

Students' prior knowledge of some owl and hummingbird flight facts, as well as an introduction to the concept of inventing flying machines, is preferred but not required. While the lesson sequence offers a rich and engaging learning experience, the pacing may be challenging for some students. Adjustments should be made as needed to support diverse learners

Classroom Management Tips

To make sure the activities in this lesson are successful, it is important to build rapport with the students. As many of the activities involve questioning and answering, students should feel comfortable sharing their thoughts, opinions, and reflections. Additionally, the teacher should set clear rules and expectations for the activities that students are asked to do. Minor disturbances should be ignored, as students might get excited and sidetracked by the images that DALL-E might generate. For DALL-E activities, provide clear expectations for the work to be generated. Specific classroom management tips for groupings include teaching students to both talk and listen to each other, as they will have many opportunities to share their thoughts.

Conclusion

The term *scaffolding* (Bruner, 1983) is generally used to describe an instructional process in which the instructor provides carefully programmed support, reducing the amount of support as the learner gradually progresses through and masters learning. The approach used in the lesson described here goes beyond what can be achieved through lectures alone by showing how AI tools, coupled with teacher guidance, can be used to scaffold students' design thinking and divergent thinking to generate their own sketches for flying machines. Additionally, by creating their flying machines based on the sketches they draw while observing bird photos, videos, and AI-generated images, students achieve a greater understanding of the concept of biomimicry, which can expand their concrete artmaking experience into more developed and scaffolded products.

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Resources for Teachers

- Biomimicry in Action: https://bit.ly/3XShdiL
- How to Write the Most Effective AI Image Prompt for DALL-E: https://bit.ly/3YrDp3m
- OpenAI's DALL·E Platform: Teachers can create an account and start generating images directly through OpenAI's platform: https://openai.com/dall-e

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Robot Sharks: An AI and STEM Adventure for 5th Grade Students

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Overview

This five-lesson artificial intelligence (AI) and STEM integrated unit was designed for 5th graders in an informal learning context. Each lesson featured 45 minutes of instruction following the 5E model, which centered on the topic of sharks. Students explored sharks from multiple disciplinary perspectives, including computational thinking (CT), math, statistics, and science. They then employed educational robots (Sphero Bolt) to design and program their own robot sharks through inquiry-based activities oriented in the engineering design process. This course concluded by having the students design and code their robots to represent and explain the knowledge they gained about sharks.

Topics: Artificial Intelligence, Computational Thinking, Computer Science, Integration, K-12, STEM

Time: 45- 60 minutes per lesson, five lessons in total

Setup

Each lesson plan and accompanying material should be reviewed carefully before teaching. The teacher should be familiar with the student's background knowledge, skills, capabilities, and grouping preferences. The teacher should plan for at least 30 minutes for preparation, such as printing the worksheets, preparing the game cards, charging the robots and iPads, and filling the storage bins/baby pool with water. This lesson was designed for a small group of students in an informal learning context. The learning environment should include internet access, tables and chairs, flat-open areas for students' movements, and accessible water faucets and drain areas.

Context-at-a-Glance

Setting
Twelve groups of two preservice teachers collaborated with 4-5, fifth-grade learners. They offered an informal learning experience to elementary students in afterschool programs in a suburban area of the southeastern United States.

Modality
In-person

Class Structure
Five 45-minute lessons across five weeks.

Organizational Norms
This unit addressed Florida CPalms standards and AI4K12 big ideas, introducing AI concepts, developing AI literacy, integrating AI with STEM disciplines, and developing knowledge of AI, CT, CS, and STEM through hands-on designing and programming experiences.

Learner Characteristics
Although this unit can support K-5 learners, this article focuses on 5th graders.

Teacher Characteristics
The teachers were novice preservice teachers with strong math or science backgrounds but less CS/CT pedagogical knowledge.

Development Rationale
This lesson aimed to develop elementary students' AI literacy, CS/CT knowledge, and shark knowledge through inquiry-based activities. Meanwhile, it provided math, science, and computer science preservice teachers with opportunities to teach AI, CT, and CS-integrated STEM content.

Design Framework
5E Model of Instruction

MATERIALS

Lesson One - AI Meets Sharks:

- Lesson One Packet (Guo et al., n.d.-a)
- Printed materials in the lesson plan
- Paper and pencils

Lesson Two - Shark Statistics:

- Lesson Two Packet (Guo et al., n.d.-b)
- Printed materials in the lesson plan
- iPads with an internet connection
- Ocearch Tracker Website (OCEARCH, n.d.)
- Tape measures
- Masking tape
- Paper and pencils

Lesson Three - Shark Adaptations:

- Lesson Three Packet (Guo et al., n.d.-c)
- iPads with an Internet connection
- Shark teeth
- Magnifying glass
- A large bowl of water
- Balloons
- 40ml vegetable oil
- Paper and pencils

Lesson Four -Robot Sharks:

- Lesson Four Packet (Guo et al., n.d.-d)
- Printed materials in the lesson plan
- iPads with an Internet connection
- Sphero robots with Nubby covers
- Storage bins/baby pool with water
- Rubber bands
- Plastic folders
- Aluminum foil
- Gaff tape
- EVA foam sheets
- Bubble wrappers
- Paper and pencils

Lesson Five - Design Your Own Shark:

- Lesson Five Packet (Guo et al., n.d.-e)
- The rest of the materials are the same as those in Lesson Four

STANDARDS

AI4K12 AI Guidelines Big Idea #3 (AI4K12.org, n.d.):

- Definition of machine learning
- The role of training data
- Learning phase vs. application phase

Florida CPalms Math Standards (Florida State University, n.d.):

- MA.5.DP.1.1 Collect and represent numerical data, including fractional and decimal values, using tables, line graphs, or line plots.
- MA.5.DP.1.2 Interpret numerical data, with whole-number values, represented with tables or line plots by determining the mean, mode, median, or range.

Florida CPalms Science Standards (Florida State University, n.d.):

- SC.5.N.2.1 Recognize and explain that science is grounded in observations that are testable, explanation must be linked to evidence.
- SC.5.L.17.1 Compare and contrast adaptations displayed by animals and plants that enable them to survive in different environments, such as life cycle variations, animal behaviors, and physical characteristics.

Florida CPalms Computer Science Standards (Florida State University, n.d.):

- SC.5.PE.2.3 Analyze the data from a given scenario.
- SC.5.PE.1.3 Create a program using arithmetic operators, conditionals, and repetition in programs.

CONTEXT AND SETTING

To support a group of math, science, engineering, and computer science preservice teachers in teaching K-5 students in afterschool programs, the team designed a five-lesson AI and STEM-integrated unit on sharks, titled “Robot Sharks: An AI & STEM Adventure.” This unit created a locally relevant and engaging learning experience for K-5 students in Florida, U.S. The team members included researchers and experts from Mathematics Education, Science Education, and Computer Science Education at the University of Florida. The original lesson plans and materials were designed and pilot-tested in one local elementary school. The team revised the lesson plan, activities, and materials based on preservice teachers’ practice. Finally, refined lesson plans and

materials were implemented in another elementary school. The whole unit included detailed lesson plans and customized teaching materials tailored to different grade levels. The lesson designers intentionally aligned the content with academic standards from Florida CPalms and incorporated AI guidelines from AI4K12.org (n.d.).

During the Fall 2024 semester practice, 23 preservice teachers (organized into 12 teaching groups) delivered this lesson to 53 elementary students across various grade levels. Each teaching pair worked with 4-5 students for 45 minutes per week over five weeks. This learning representation uses the 5th-grade lesson plans, teaching materials, and activities as examples to illustrate how AI, CT, and CS were integrated into STEM lessons.

This five-lesson AI and STEM-integrated unit followed the 5E model of instruction (Bybee, 2014). The teaching activities in each lesson were aligned with the phases of Engage, Explore, Explain, Elaborate, and Evaluate. Although this lesson addressed Florida CPalms academic standards, the Evaluation phase utilized formative assessment due to the informal learning context.

This unit centered on the topic of sharks to create a locally relevant real-world context (Figure 1). The lessons aimed to enhance students' understanding of AI literacy, statistics, animal adaptations, algorithmic thinking, robot coding, and engineering design processes via a multidisciplinary integration approach (Vasquez et al., 2013). The students explored sharks from various disciplinary lenses, such as AI, CS, math, and science, and then used educational robots to simulate and represent their knowledge through engineering design. In addition, the students had CT and CS backgrounds, such as algorithmic thinking and block coding, but it was their first time experiencing the educational robot Sphero Bolt.

The educational robot Sphero Bolt (Sphero Central, n.d.) was selected for this unit because it is waterproof and equipped with sensors. However, the teacher could use alternative educational robots to tailor students' backgrounds in Lesson Four and Five. For example, the team also incorporated Ozobots (Ozobots, n.d.) as "land sharks" for lower elementary grades to accommodate younger learners' small hands. The activities related to using robots to collect and analyze data in Lesson Four were adjusted accordingly. Please contact us for detailed lesson plans and materials tailored to different grade levels.

Lesson One: AI Meets Sharks

Lesson One, AI Meets Sharks, introduces the fundamentals of machine learning and data features through unplugged activities within the context of sharks. The real-world connection focuses on machine learning applications in image and facial recognition. The guiding questions for this lesson are "What makes a shark a shark?" and "How do computers identify an image as a shark?" Before teaching, the teachers should review the Lesson One Packet for printable materials (PDF; Guo et al., n.d.-a).

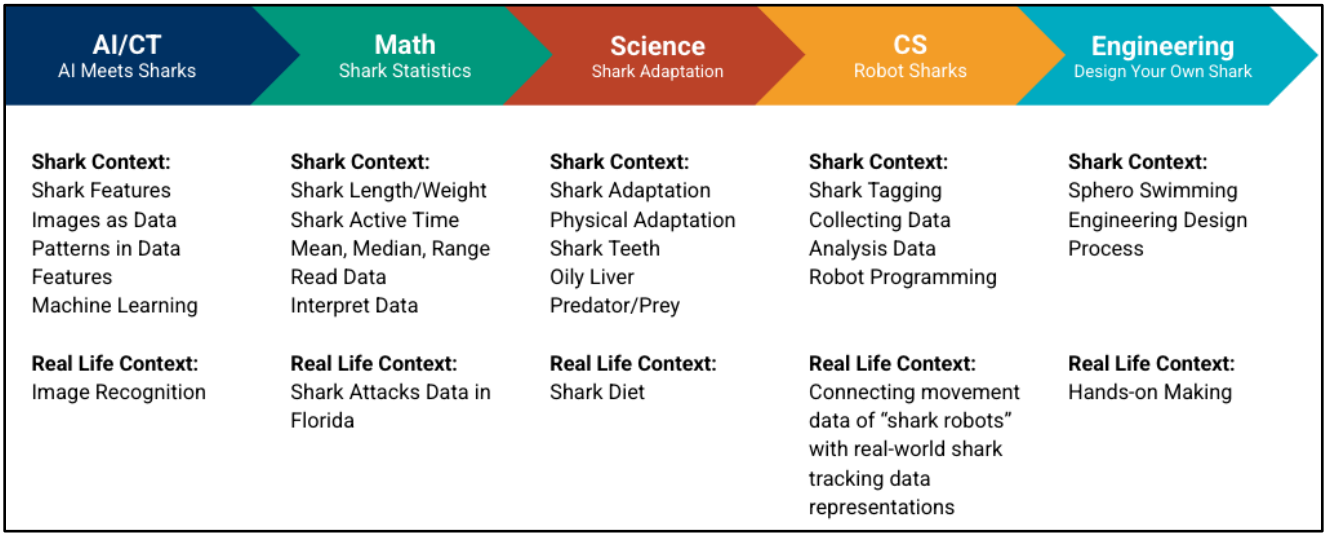

Figure 1. Unit Structure of Robot Sharks: An AI and STEM Adventure.

Materials

- Lesson One Packet (PDF; Guo et al., n.d.-a)
- Printed materials in the lesson plan
- Paper and pencils

5E Lesson One

Engage

To capture students' interest, the teacher begins with an activity called "Circling the Dogs" (Guo et al., n.d.-a), which utilizes a widely recognized internet meme (Shenkman et al., 2021) to illustrate the differences between human and machine learning. In this activity, students observe, analyze, and differentiate between images of Chihuahua dogs and blueberry muffins, which share similar visual features. Following this, the teacher introduces the concept of machine learning, explaining how computers process and classify images based on extracted patterns and features. Next, the teacher introduces the ocean animal scenarios, promoting discussions with questions such as "How can we distinguish shark images from those of other ocean animals?" and "What makes a shark a shark?" Finally, the teacher connects these ideas to real-world applications, such as Australian scientists using AI image recognition to monitor coral reefs (González-Rivero et al., 2020) to spark students' interest in machine learning principles.

Explore

In the explore phase, students randomly draw 12 ocean creature cards in the Lesson One Packet (PDF; Guo et al., n.d.-a) and sort them into 3-5 groups based on common features. They then describe the features they used for classification. This activity serves as a practice of observing and recognizing patterns in images.

To simulate the principle of machine learning, students use the same 12 cards as training data and classify them into the "shark group" and the "non-shark group." They record the features they use to identify sharks. Next, students apply these features to classify the remaining six cards as test data. The class then discusses whether the identified features need to be refined.

Explain

In the explain phase, the teacher further presents machine learning and its process, emphasizing how models identify features in training data and use them to make predictions about new data. However, students may initially rely on their personal experience rather than extracted features when identifying sharks. To address this, the teacher can use the Shark Anatomy poster (Guo et al., n.d.-a) to clarify key shark features. Additionally, to reinforce algorithmic thinking, the teacher can use the Decision Trees worksheet in the Lesson One Packet (PDF; Guo et al., n.d.-a) to guide students through a step-by-step decision-making process based on shark features (Figure 2).

Figure 2. Using decision trees worksheet to guide the step-by-step decision making.

Elaborate

In the elaboration phase, the teacher revisits the students' prior knowledge of the binary system, which computers use to process information. Students then practice converting extracted features into binary questions that can only be answered with

"Yes" or "No." Using the Construct Binary Questions worksheet in the Lesson One Packet (PDF; Guo et al., n.d.-a), the teacher provides images of turtles, dolphins, whales, rays, and sharks. Students write binary questions to describe and differentiate these ocean animal images based on observation features.

Evaluate

Since this lesson takes place in an informal learning setting, the teacher assesses the students' learning through open-ended discussion, collaboration, and active participation in the activities.

Lesson Two: Shark Statistics

Lesson Two, Shark Statistics, focuses on mathematical and statistical concepts, especially mean, median, range, and how to calculate these values within a dataset. Through this lesson, students will be able to develop an understanding of shark size. The guiding question of this lesson is, "How big is a shark?" Prior to teaching, the teacher should review the lesson package (Guo et al., n.d.-b), prepare the worksheets, and, if needed, install the OCEARCH app in advance.

Materials

- Lesson Two Packet (PDF; Guo et al., n.d.-b)
- Printed materials in the lesson plan
- iPads with an internet connection
- Ocearch Tracker Website (OCEARCH, n.d.)
- Tape measures
- Masking tape
- Paper and pencils

5E Lesson Two

Engage

At the beginning of the class, the teacher and the students read a news article about a shark scientists tagged and named "Breton" from USAToday together (Lesson Two Packet PDF; Guo et al., n.d.-b). Following this, students work in groups to measure their heights with tape measures and record the results on Worksheet #1 found in Lesson Two Packet (Guo et al., n.d.-b). They then compare their measurements with Breton. Alternatively, students may use tape measures and masking tape to mark Breton's length on the ground, according to the information in the article. After this, students can attempt to jump the measured distance, incorporating a physical activity component that provides an intuitive grasp of shark size.

Explore

Next, students explore the OCEARCH shark tracker website or app (OCEARCH, n.d.). To familiarize them with the website's interface, the teacher demonstrates how to use the filter in the toolbar to track Breton's movement and guide them in answering the questions in Part A of Worksheet #2 found in the Lesson Two Packet (Guo et al., n.d.-b). Once they become comfortable navigating the website or app, let them complete Part B of worksheet #2, which focuses on data collection and recording. Then, they proceed to Part C of worksheet #2, which involves graphing the collected data.

Explain

Upon completing the worksheet, students pair up with elbow partners to discuss their findings. The teacher then introduces the concepts of mean, median, and range, guiding students through the calculation process using the data from Part A of worksheet #2. Based on their calculations, students respond to questions in Part D of worksheet #3 (Guo et al., n.d.-b). Through these activities, students practice interpreting numerical data and formulating analytical statements. To further develop their data interpretation skills, the teacher may utilize the travel logs of sharks tagged by scientists and called Mary Lee and Luna as additional examples to discuss how data can be analyzed for meaningful insights.

Elaborate

To establish a real-world connection, students visit the Shark Attack Data on the Florida Museum of Natural History Website (University of Florida, n.d.) and discuss the following questions:

- Which county in Florida has the highest number of confirmed unprovoked shark attacks?

- How many fatal attacks have happened in this county since 2012?
- When do shark attacks most commonly occur?

The teacher should emphasize that only about a dozen of 530 known shark species are involved in attacks on humans. The three species most commonly associated with shark attacks, often referred to as "the big three," are the great white shark, the tiger shark, and the bull shark.

Evaluate

Finally, student learning is assessed through students' collaborative discussions, worksheet completion, participation in activities, and open-ended reflections.

Lesson Three: Shark Adaptations

Lesson Three, Shark Adaptation, explores concepts in life sciences, focusing on predators, prey, and animal adaptation. In this lesson, students will be able to explain the shark's adaptations and apply their knowledge by designing their own shark that illustrates these adaptations. The guiding question for this lesson is, "What makes a shark special?" Before the class, the teacher should review the lesson package (Guo et al., n.d.-c) and prepare the necessary teaching materials.

Materials

- Lesson Three Packet (PDF; Guo et al., n.d.-c)
- iPads with an Internet connection
- Shark teeth
- Magnifying glass
- A large bowl of water
- Balloons
- 40ml vegetable oil
- Paper and pencils

5E Lesson Three

Engage

To engage students at the start of the lesson, the teacher guides students to the 27 Animals That Don't Think You Can See Them webpage (Baldwin, 2015) and lets them identify the hidden animals in images. This activity fosters students' curiosity and introduces the concept of camouflage as a physical adaptation. Following this, students use magnifying glasses to observe shark teeth and compare them to human teeth, describing the differences. The teacher introduces the fact that shark teeth are arranged in rows, allowing continuous replacement when a tooth is damaged or lost. When a front tooth is worn down, it falls out and is replaced by a new tooth from the row behind it, with additional teeth forming at the back to maintain this cycle.

Explore

After exploring shark teeth, students engage in another hands-on activity to investigate the buoyancy of sharks. Students place two balloons, one filled with oil and the other with water, in a large bowl of water. Students observe the position of the two balloons. Meanwhile, the teacher explains that sharks do not have swim bladders; instead, they rely on their large, oil-filled livers, which contain substances called squalene, to help them maintain buoyancy.

Explain

Following these observation activities, the teacher introduces the concepts of predators and prey. The discussion extends to shark diets, reinforcing the idea that sharks do not perceive humans as prey. By revisiting the Shark Attack Data from Unit Two, students critically discuss the ecological importance of protecting these apex predators. The teacher can also facilitate an open discussion about how predators can also be prey to other species, highlighting the interconnectedness of marine ecosystems.

Elaborate

Next, students apply what they have learned by designing their own shark on paper. Each student names their shark, specifies its length and weight, and illustrates its color, teeth, fins, and unique adaptations that aid in survival. Additionally, students describe their shark's habitat, diet, and daily behaviors.

Evaluate

The teacher assesses students' learning by participating in activities, engaging in open discussion, and completing their shark design.

Lesson Four: Robot Sharks

Lesson Four, Robot Sharks, provides students with the opportunity to simulate the data collection process in shark tagging through the use of Sphero, an educational robot. In this lesson, the student will be able to program Sphero to move in water and record the data collected by the robots. The guiding question for this lesson is, "How does shark tagging work?" The teacher should review the Lesson Four Packet and data examples (Guo et al., n.d.-d), pre-charge the Sphero robots, prepare materials for students to construct their own sharks, and set up a water pool for testing the robots' movement.

Materials

- Lesson Four Packet (PDF; Guo et al., n.d.-d)
- Printed materials in the lesson plan
- iPads with an Internet connection
- Sphero robots with Nubby covers
- Storage bins/baby pool with water
- Rubber bands
- Plastic folders
- Aluminum foil
- Gaff tape
- EVA foam sheets
- Bubble wrappers
- Paper and pencils

5E Lesson Four

Engage

To introduce the lesson, students participate in an animal track match game (ESLVault.com, n.d.). The teacher places the cards face down, and students take turns flipping over two cards at a time, attempting to find matching pairs. If a student finds a match, they keep the cards and continue playing until no further matches remain. If working with a large group, the teacher may instead distribute cards randomly and have students search for peers with matching cards.

Explore

Following this activity, the teacher prompts students to consider how scientists observe ocean creatures that live beyond the range of human vision. This discussion leads to an introduction to shark tagging, where scientists collect and record data on sharks' location, size, sex, growth, and movement patterns to track their behavior over time.

Explain

Building on this concept, the teacher introduces Sphero as a model for a tagged shark in this lesson. The teacher showcases how to drive the Sphero robot in water and then explains how to program it for data collection. This lesson connects to Lesson Two, reinforcing how the data collected through shark tagging contributes to the OCEARCH (n.d.) track website and app. Additionally, the instructor explains the real-world process of shark tagging, detailing how scientists attach tracking devices to sharks and utilize the collected data for research.

Elaborate

Students then start hands-on exploration by driving and programming the Sphero robots. The teacher facilitates discussions by allowing students to compare Sphero's movement with and without Nubby covers, which leads to an optional extension on shark skin adaptations (Figure 3). To further encourage creativity and problem-solving, students are given various craft materials and challenged to design different "swimsuits" for their Sphero robots, optimizing their movement in the water.

Evaluate

Lesson Four serves to deepen students' understanding of data collection, which was introduced in Lesson Two, expand their knowledge of shark tagging and skin adaptations in Lesson Three, and enhance their programming skills through hands-on application. The teacher can assess students' learning via collaborative activities, participation, and open-ended discussions.

Figure 3. Preservice teachers introducing Sphero's movement with and without Nubby Cover.

Lesson Five: Design Your Own Shark

Lesson Five, Design Your Own Shark, offers students an opportunity to review and apply the knowledge acquired in the previous four lessons. This lesson is designed to give students hands-on experience in designing and constructing their own sharks using limited craft materials. The guiding question for this lesson is, "Who will win the Shark Olympics Game?" As this lesson builds upon Lesson Four, the preparation process and required craft materials remain the same. However, the teacher still needs to review the Lesson Five Packet and prepare the engineering design process poster before the class (Guo et al., n.d.-e).

Materials

- Lesson Five Packet (PDF; Guo et al., n.d.-e)
- The rest of the materials are the same as those in Lesson Four

5E Lesson Five

Engage

The class begins with a headband game to review the key concepts in previous lessons. The teacher prepares cards featuring terms students have learned in prior lessons. Each student randomly draws a card, holds it in front of their forehead, and takes turns asking binary (yes/no) questions (as introduced in Lesson One) to peers to determine the words on their card (Figure 4).

Figure 4. Preservice teachers play the headband game with students.

Explore

After the activity, the teacher introduces the rules of the Shark Olympics Game and divides students into pairs. Each group is given 5-8 minutes to design a prototype of their robot shark and 8-10 minutes to construct their design using the provided craft materials. Next, groups test their prototypes in a water pool, adjusting and revising their prototypes as needed.

Explain

Throughout the design process, the teacher actively engages with students, encouraging them to verbalize their thought processes, explain their design choices, and describe the debugging and revision process (Figure 5).

Elaborate

Once all groups have completed their design, the teacher gets them together to participate in the Shark Olympics Games. Each group places its robot shark at the starting line, and all sharks begin "swimming" simultaneously. The shark that completes the full path in the shortest time is declared the winner. If time allows, the teachers may facilitate multiple rounds of competition.

Evaluate

To conclude the lesson, the teacher refers to the engineering design process poster (PBS LearningMedia, n.d.) and discusses the nine steps. Students then reflect on their design strategies, problem-solving techniques, and iterative improvement. Although this final lesson does not include a formal assessment, students' learning can be evaluated based on their improvement in collaboration, active participation, and engagement in discussions.

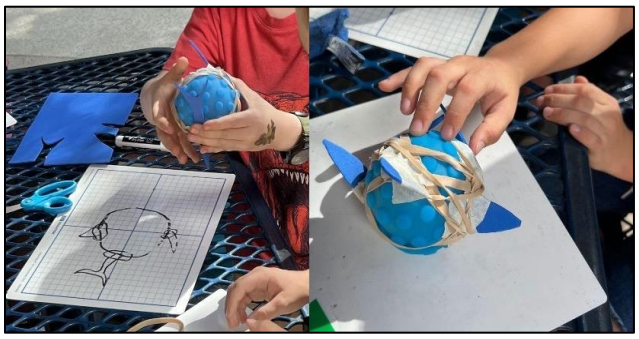

Figure 5. Student's design and prototype.

Critical Reflection

Robot Shark: An AI & STEM Adventure was an AI and STEM disciplines integrated unit implemented by 23 preservice teachers (in 12 teaching groups) for 53 elementary students across grades K to 5 during an afterschool STEM club in the fall semester of 2024. The preservice teachers were enrolled in an undergraduate level teacher preparation program and participated in their first teaching exploration course. In this course, the preservice teachers were divided into teaching groups based on their preferred grade levels, prepared the lessons together, and practiced teaching once a week. To prepare each lesson of this unit, the preservice teachers spent 60 minutes studying the weekly lesson packages, selecting suitable activities for their students from the package, and developing their customized lesson plans. Next, each group spent 30 minutes preparing their weekly teaching materials, sharing effective teaching strategies they utilized in the last week, and did a last-minute check-in before their practice. The preservice teachers then moved to a local elementary school together and prepared their teaching before the students arrived. The preservice teachers conducted the teaching practice with their students for 45-50 minutes. Finally, all preservice teachers individually completed a teaching reflection before the subsequent lesson preparation.

The unit consists of two distinct versions: one for K-2nd graders and another for 3rd-5th graders. Both versions focus on the topic of AI and sharks but utilize different academic standards, teaching activities, and robotic devices in each lesson. Each version is tailored with suitable activities for students' grade levels. This article uses the 5th-grade lesson package and authorized teaching images as examples to illustrate how to teach these five lessons of the unit.

The course designers aligned each lesson with the K12 AI guideline (AI4K12.org, n.d.) and the state's academic standards in Math, Science, and Computer Science (CPalms.org, n.d.) for 5th grade. For example, Lesson One, AI Meets Sharks, focused on the K12 AI Guideline Big Idea #3 (the definition of machine learning, the role of training data, and the learning phase vs the application phase in machine learning). Lesson Two, Shark Statistics, targeted the Math standards MA.5.DP.1.1 and MA.5.DP.1.2. Lesson Three, Shark Adaptations, aims at the Science standards SC.5.N.2.1 and SC.5.L.17.7, and Lesson Four, Robot Sharks, employed the CS standards SC.5.PE.2.3 and SC.5.PE.1.3.

The overall design of this unit utilized a multidisciplinary integration approach (Vasquez et al., 2013), allowing students to acquire shark-related knowledge from various disciplines. However, the final design challenge did not necessarily rely on the information provided in former lessons. For example, in the final engineering design lesson, the students could review and discuss the shark's features and adaptations, such as length, weight, color, fins, teeth, buoyancy, and skin. However, using this information to design their robot sharks with Sphero was unnecessary. Nonetheless, the last lesson of the unit

emphasized the engineering design process, along with three disciplinary core ideas: defining an engineering problem, developing possible solutions, and iterating design solutions (Roehrig et al., 2021).

This AI and STEM integrated unit engaged elementary students in learning about sharks, a real-world and locally relevant topic, via lenses from multiple disciplines. It highlighted the hands-on experiences in each lesson and emphasized students' creativity in the final engineering design challenge. The students showed apparent engagement and excitement across the five lessons, especially in Lessons Four and Five. On the other side, the preservice teachers also reflected on building connections across various disciplines in the AI, CT, CS, and STEM concepts.

One limitation of this AI and STEM integrated unit was time. Due to the course structure and unexpected weather impacts, it eventually lasted six weeks. The preservice teachers worked very hard to complete all lesson plan activities each week, but they had less time to expand or build the across-lesson connections. Another limitation was the Sphero Bolt robots. We encountered situations where robots were not completely charged or lost battery power quickly. In these cases, some students completed their prototype shark designs but were unable to fully test them due to technological limitations. Therefore, it is suggested that robots be tested in advance of the lesson, and if possible, additional backup robots be provided.

Teachers can customize the lesson to meet their students' prior knowledge and backgrounds. If Sphero is unavailable, the teacher can also employ other robots to do "land sharks." Lessons One to Four can be used separately to address the academic standards, and the last engineering design lesson can be used in informal CS learning scenarios (e.g., STEM Night, Robot Days) at a higher elementary level. For future lesson implementation, we recommend that teachers employ effective strategies while using robots. For example, assigning each student in one group a role (e.g., a coder and a robot manager) and switching the role when it is necessary. Also, adjusting the activities flexibly and leaving the robot activity at the end of the class was one option because once the robots were introduced, it was challenging to redirect student focus to other types of activities. Additionally, we suggested teachers involve more helpers in Lesson Four and Lesson Five to support all students evenly.

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Youth-Led Experiential Research by First-Year Undergraduates: Investigations into Youth, Technology, and Society

Joan E. Hughes[1], Anna R. Oliveri[2], and Michelle Read[3], [1]The University of Texas at Austin, [2]Salve Regina University, [3]Southern California University of Health Sciences

Overview

This unit positions first-year undergraduates as youth researchers who investigate technology in youth society. The learners are guided through five phases of research inquiry: ideation, focusing in, planning, doing, and sharing. Throughout the process, learners develop presentation, library research, data collection and analysis, and writing skills through digital scaffolds (see Materials). Students share their results orally and within an APA-style research report.

Topics: Youth-Led Research, Information and Media Literacy, Academic Writing and Speaking

Time: 16, 75-minute classes

Materials

- Ripped from headlines presentation template
- Research project pitch template
- Research project description
- Assessment rubrics
- Asset, skills, and values handout
- Team contract handout
- NoodleTools setup and citations
- What to pay attention to and write about handout
- Developing research questions handout
- Research project focus handout
- Research plan template
- Research and ethics handout
- Consent form template
- Writing at university presentation
- Summarized writing guide
- Data analysis preparation template
- Team research report template
- Academic library databases
- Learning management system
- Word processing, presentation, and survey apps

Context-at-a-Glance

Setting
First-year undergraduate seminar at a large, urban, public, research 1 university in the United States.

Modality
Face-to-face class sessions.

Class Structure
14-week course meeting twice per week (75 minutes each). Mobile tables and chairs, 3 whiteboards, and Canvas LMS. Instructor lectern with computer, display, document camera, room audio and projector.

Organizational Norms
In this required first-year seminar, students develop college-level skills in research, writing, speaking, and discussion through interdisciplinary, collaborative, experiential, and contemporary experiences.

Learner Characteristics
Students enroll by interest, requirement, or schedule.

Instructor Characteristics
Joan Hughes holds a Ph.D. in Educational Psychology: Cognition and Technology and has taught 30 years collegiately and 3 years in K-12. Anna Oliveri holds a Ph.D. in Curriculum and Instruction: Learning Technologies and has taught 6 years collegiately and 3 years in K-12.

Development Rationale
The instructors shifted from leading students to read and write *about* others' research to guiding students in *doing their own* research with youth peers.

Design Framework
Youth Participatory Action Research; Backward Design

Setup

This 8-week unit occurs within a technology-rich, face-to-face course. Instructors should review the supplemental materials, adopt or revise, and sequence them in alignment with instructor goals.

Context and Setting

This university is a mixed undergraduate/graduate-doctorate large, research 1 institution (Carnegie Foundation, 2025). An Office of Undergraduate Research facilitates student engagement in research and creative activity by helping students find independent research opportunities and sponsoring several support initiatives (e.g., information sessions, database of research opportunities, poster design workshops, and competitions).

Youth-Led Research

The first author teaches one section of a required undergraduate course for first-year students. Each section is a small seminar in which the topic of the course is defined by the professor, but the structure must include several requirements set by the Undergraduate College, including:

- The course is writing intensive in which students must write, receive feedback, and have chances for revision.
- Students must have chances to present orally.
- The course should highlight university "gems," such as unique resources, places, or experiences.
- Students must attend a university lecture.

The first author's in-person course is entitled "The role of technology among youth in society and education" and has been offered for more than ten years. While course topics and readings have changed across time, the course always included two large units of study and assessment:

1. A self-study of digital technology use yielding an essay comparing the self to national and international use trends
2. A research-based synthesis regarding a course topic yielding a scholarly-literature-rich essay

In 2023, the first and second author redesigned the second unit to be more collaborative and experiential and were inspired by youth participatory action research (YPAR). Participatory action research involves people affected by a problem working with researchers to understand and address it. YPAR positions youth as the researchers working with other youth affected by a problem or issue. Students engage in collaborative learning experiences that are youth-driven, participatory, democratizing, systematic, critical, action-oriented, and empowering (Ozer, 2016). We reconceptualized the latter unit so these new undergraduate students might experience research rather than merely read about it. We felt this research experience at the outset of their undergraduate experience might dovetail with other university efforts to support undergraduate participation in research and creative endeavors.

This redesigned curriculum unit enables undergraduate students (a) to become active, empowered learners (b) who share greater responsibility for their learning through a shift in typical teacher-student hierarchy and power (c) when students lead, co-plan, and co-research with their peers (d) as authentic youth researchers.

The timeframe of eight weeks prevents a close implementation of YPAR methodologies especially related to (a) *action* in which findings yield practical changes that can be followed in subsequent cycles of research and (b) *social justice/critical perspectives* in which inquiries center issues of power. While we are inspired by YPAR, our implementation did not explicitly center social justice nor facilitate ongoing action on the explored issues; thus, we refer to it as youth-led research. Nonetheless, the YPAR methodologies (Community Futures, Community Lore, n.d.; University of California, n.d.) are used as a guide for this youth-led research unit.

Throughout the unit, students are guided in doing their own research with other youth affected by an issue/problem. Students generate community-based issues of concern for youth (ages 5-22) related to our technological society, form a research team, choose an issue of focus, learn a range of research skills, conduct a study, create and share results in multiple formats (text, multimodal) to multiple audiences (academic, community), and outline future actions and advocate for change. The broad learning goals for this innovation in teaching included:

- Increased educational empowerment
- Increased research knowledge and skills

- Broadened use of educational technology resources
- Expanded views of themselves as technological users, as researchers, and as creators

Reflecting these goals and the YPAR methodology, we designed intended learning outcomes, identified the evidence and assessment approaches to measure the outcomes, and planned learning activities to match (Wiggins and McTighe, 2011).

Learner Characteristics

First-year students at this university typically rank in the top 6% of their high school class (Dey, 2024). In 2023, 42,444 undergraduates enrolled: 56.3% women, 43.6% men, 23% first-generation (University of Texas, 2023). Figure 1 shows the racial/ethnicity demographics of these undergraduate students.

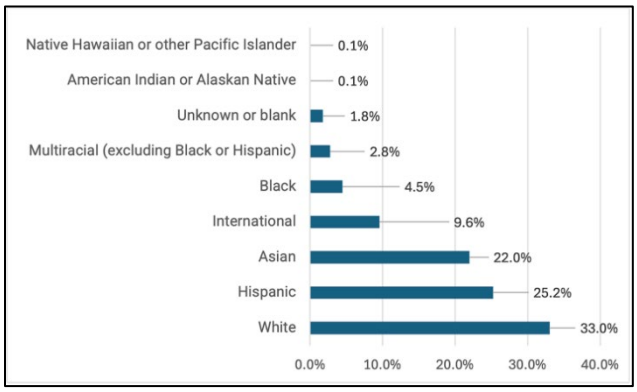


Figure 1: Race/ethnicity of 2023 undergraduate students

We have additional information about the specific students enrolled in our course during the three semesters in which we taught the redesigned unit (Fall 2023 and Spring and Fall 2024). Figure 2 shows the enrolled students' declared majors.

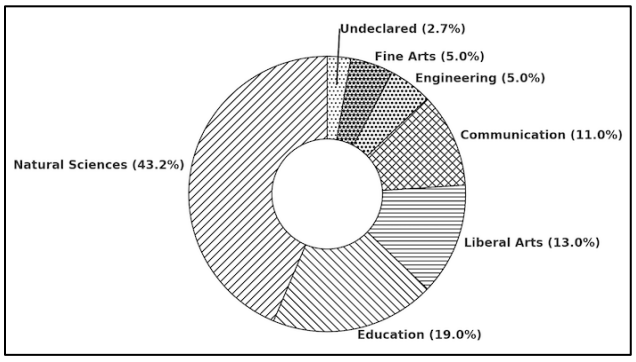


Figure 2: Distribution of major/field of study for students

An early assignment in this course asked students to reflect on their research experience. Their definitions of research often focused on fact-finding—searching the internet, reading books, or asking knowledgeable people. A student wrote, "research requires the participant to open up textbooks, search the internet, and read articles, papers, and biographies authors have written to inform readers about their field of knowledge" (Participant#2024-01-23, 2024). The students showed a basic understanding of research as fact-finding, including online databases such as JSTOR, Gale, or EBSCO, but only a few understood or had conducted research as active, disciplined investigations yielding novel discoveries.

Most students reported that digital technology was central to their high school learning, especially during the COVID-19 shift to online classes. Many were issued Chromebooks and used tools like Canvas, Schoology, Google Docs, and Zoom. Very few took computer science or statistics, using tools like Python, R Studio, or Excel.

Based on a self-assessment and reflection of digital competency (Vuorikari, Kluzer, & Punie, 2022) that students conducted at the beginning of the semester, Figure 3 shows the weighted mentions of various technology tools they used.

Figure 3: Reported technologies used by students

More specifically, students used tools like DuckDuckGo, Google Scholar, and Boolean search techniques. Some identified credible sources by checking dates, authors, and domain types. Emergency Remote Teaching (ERT) boosted their use of tools like Canvas, Teams, and Google Docs for group work. Some produced school projects like videos, infographics, and memes, and used social media personally. Knowledge and experience gaps involved spotting bias and AI-generated content, managing their online presence and privacy, being data insecure, and solving technical problems.

	Ideation (Weeks 1-3)	Focusing In (Week 4)	Planning (Week 5)	Doing (Weeks 6-7)	Sharing (Week 8)	Final Paper Submission
Main Goals & Activities	Building Background Knowledge Identifying Questions	Team Formation Introduction to Research Design	Literature Search Understanding Research Ethics and Methods	Conducting Research Preparing for Data Analysis Writing	Analyzing Data Presenting Findings Writing	Sharing Findings
Assignments	"Ripped From the Headlines" Presentation Research Pitches	Team Contract Research Project Focus	Literature Summaries Research Plan	Literature Review Draft Data Analysis Plan Data Collection	Methods Section Draft Research Presentation	Team Research Report

Table 1: Overview of the unit

Learning Representation

This unit is broken down into five phases: ideation, focusing in, planning, doing, and sharing (see Table 1). Students move through the phases across the eight weeks that are dedicated to the youth-led research projects. Below we describe the activities completed in each of the phases that lead to the culminating research presentations and papers.

Ideation

Ideation spans the first three weeks. This phase guides students to generate and acknowledge societal issues involving youth and technology and transform these issues into curiosities and wonderings, phrased as questions. Student outcomes include two oral presentations: Ripped from the Headlines and Research Project Pitch.

Week One (Ripped From The Headlines)

At the beginning of this project, each student develops a "Ripped from the Headlines" presentation in which they identify, read, and summarize a contemporary issue related to technology and youth currently explored in a general news media resource (e.g., newspaper article, blog post, magazine, television, etc.).

Learning Objectives

After this week students will be able to:

- Create and execute a research strategy to find a headline source from mass media.
- Effectively develop and express ideas through oral and visual communication modes via a presentation.

This presentation assignment provides a gentle entry to identifying research topics or issues by situating students to consider and read general mass media sources. It also contributes to information literacy by helping students eventually discern the difference between mass media and peer-reviewed research resources.

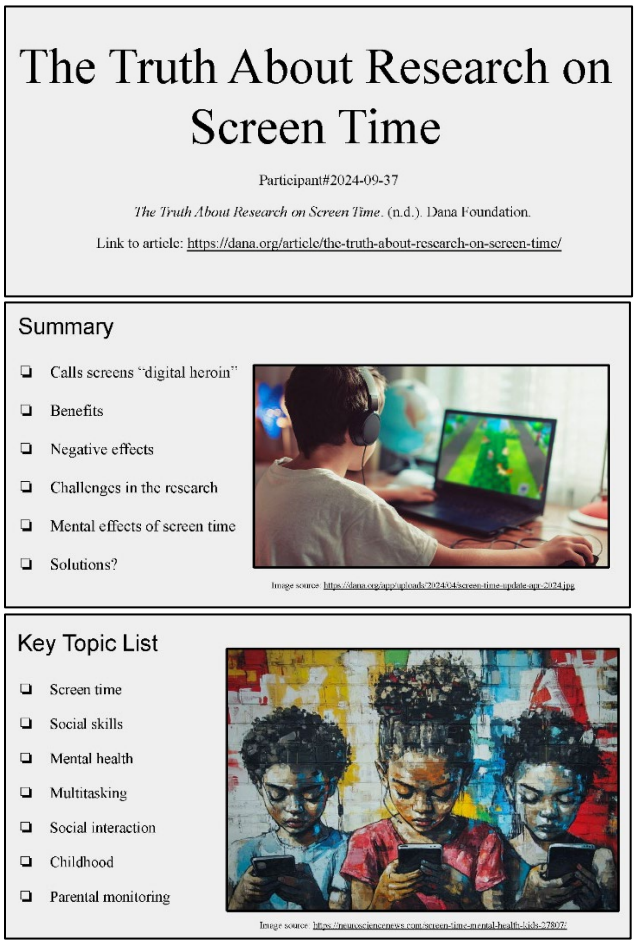
Resources and Activities

In a prior class session, the instructors orally present several examples of the "Ripped from Headlines" Presentation to serve as a guide and familiarize students with this assignment. The students then prepare their presentations ahead of class.

We provide a "Ripped from Headlines" Presentation Template from which students create four slides:

1. Title Slide: Your title with APA formatted reference and a hotlink to the news source.
2. Summary Slide: Add pictures, text, tables graphics to illustrate/highlight important aspects of the story in the news media source as they orally summarize.
3. Key Topic List: Summarize the article by listing the topics that are linked to this news media source. These could be simply key words or short phrases (akin to what you might use as search terms if conducting searches for more information).
4. Questions This Spurs: List questions that the article investigated AND list new questions that you have about this topic that relate but might be slightly different or a new avenue of inquiry.

Students' presentation headline topics have included issues such as "social media literacy is the key to adolescent online safety, not bans," "teens are finding sneaky and clever ways to outsmart their parents' location tracking apps," and "baby's first social media handle" (see Figure 4).



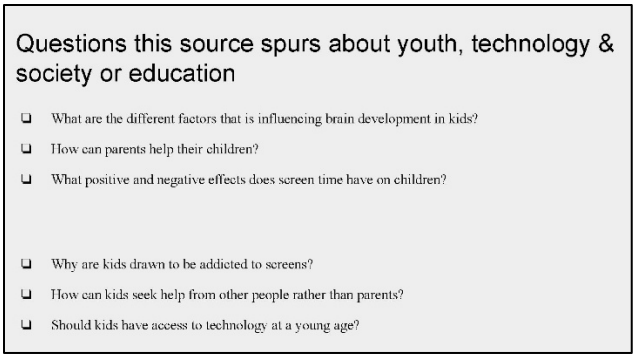


Figure 4: A Ripped from the Headlines presentation

Presentations occur over the course of two class sessions. While their classmates present, the rest of the class is responsible for generating questions that each presentation spurs for them, submitting them using a Google Form. Students are provided with the following guiding questions to support their submissions:

- What questions does this news story raise?
- What connections do you have to this topic?
- What is something you learned?

This allows the audience to engage with each presentation and expand upon the initial ideas expressed by each presenter. After the presentations, the instructors amass The Key Topics (#3 slide from template) and Questions This Spurs (#4 slide from template) and Audience Questions and Comments (bullet above) into a *Compilation Spreadsheet* (see Table 2) from which students can consult for the next activities in Weeks Two and Three.

Assessment

After each student presents, instructors use an assessment rubric to provide feedback in terms of topic fluency (high fluency with topic, explicitly connected to mass media, maximizes content coverage) and presentation fluency (well-practiced, eye contact, polished supporting materials).

Week Two (Building Background)

After presenting their headlines, students spend the next week building their background knowledge on youth-led research and how to use the university's library resources to gather relevant literature to build their research pitches that occur in Week Three.

Title/ Presenter	Presenter's Topic Keywords	Presenter's Questions This Spurs	Audience Questions & Connections
Navigating Childhood Friendships in a Digital World. Participant#2023-09-08	• Mental health • Smartphones • Social Media impacts • Parenting • Socialization • Youth Friendships • Negative and dangerous content • Media restrictions • Online vs. in person communication	• How can parents help their children navigate their friendships in the digital world? • What developing factors are harmed by social media. Use? • How do kids feel FOMO in online settings? • What types of systems are implemented by tech companies specifically for youth? • How does online popularity affect these friendships? • How greatly have social skills been impacted? • How specifically is physical health impacted from media use in friendships?	• Why do teens feel the need to share their friendships online? • Do most teens feel anxious about their friendship with a certain person when they are posted less on social media by that certain person? Or are they confident in the friendship they have because of the in-person interactions they have? • How can friendships being posted on social media have a positive or negative effect on mental health? • Is there a way for parents to help their children navigate their first phones? Are parents willing to set aside time for introducing kids to their first phones? • Is cyberbullying easily traceable back to anonymous accounts?
How Artificial Intelligence Affects Media Consumption Participant#2024-09-30	• TikTok AI Transparency • Content Credentials • Digital Watermarking • Deepfakes • AI misinformation • 2024 U.S. Election • Meta Data • TikTok U.S. Ban Threat • Social Media misinformation	• How does TikTok's platform influence consumption of AI-generated content among its younger use bases? • What are the potential risks of AI-generated misinformation on platforms heavily used by. Youth, such as TikTok? • How does the increasingly prevalence of AI-generated content affect critical thinking skills among youth, especially regarding media literacy and the ability to discern fact from fiction? • What are the long-term societal consequences of growing up in a media environment where AI-generated content is pervasive, and how should education systems adapt to these challenges?	• How are kids able to distinguish that some of this content isn't real? • Can AI recognition technology help protect the population from harmful AI replications? • I have seen a lot of AI content on social media, especially. AI art and video. How can this be protected against on social media? Should social media ban all AI generated content? • Questions that this topic raised for me are what can users do to ensure if what they are seeing is real and why do people want to spread false information? • An additional question I have is how will they limit this use of AI and how will they be held accountable?

Table 2: Excerpt from a compilation spreadsheet

Learning Objectives

After this week students will be able to:

- Critically evaluate information shared in example youth-led research studies.
- Create an initial research strategy.
- Develop approaches to searching the academic databases at the library.
- Conduct library research in databases on an individual topic.
- Clarify the differences between popular literature and research literature.

Resources and Activities: Youth-Led Research

To build a background understanding on youth-led research, students read about examples of youth-led research projects ahead of class, including "St. Thomas and Cristo Rey work to improve experience of first-generation students" (The Newsroom, 2016), two short synopses of projects in California: "Hmong youth for education" (2003) and "New side generation" (2009). Students also respond to a discussion forum ahead of class answering the question: What surprises or inspires you in these shared stories?

In class, students discuss the example research project from Minnesota, given its greater depth of content, including what was investigated, how they investigated, and what their recommendations and actions were based on what they discovered.

Students also explore and share their experiences with research through an interactive Agree/Disagree activity that we adapted from a lesson within YPAR Basics (Getting started, n.d.). Students are invited to stand up in the center of the classroom, with tables moved to edges. The instructor shows and reads one statement after which students physically move to an AGREE or DISAGREE side of the room based on their response. Then, instructors offer a question to discuss with those 'on your side' of the room for one to three minutes, ending with a student orally sharing out the pulse of discussion. The instructor asks each student to share out at least once during this activity. Students are provided with the following statements and discussion prompts in a projected slide deck:

- I have done research before.
  - Agree: What kinds of "research" have you done?
  - Disagree: What contexts might have prevented you, so far, from engaging in "research"?
- I like research.
  - Agree: Why?
  - Disagree: Why not?
- Talking to people is research.
  - Agree: How and why is it research?
  - Disagree: How, where, why doesn't it count?
- I have strong feelings after reading about topics that relate to me and my life experiences.
  - Agree: What types of feelings do you have? Why do you react (even if it's just in your head)?
  - Disagree: What are you thinking during/after reading?
- Researchers and academics (like professors) have the best insights about issues that face our society.
  - Agree: Why?
  - Disagree: Why?
- I am curious about how and why the world works in the way it does.
  - Agree: What drives your curiosity?
  - Disagree: What contexts or presumptions might reduce your curiosity?
- People who conduct research should have no personal connection to the issue that's being studied.
  - Agree: Why? What are some personal connections that might exist? How might that impact the research?
  - Disagree: Why? What are some personal connections that could exist? How might that connection impact the research?
- Research findings can lead to calls for change in local and/or societal contexts.
  - Agree: Why or how does this happen? What are examples?
  - Disagree: What prevents this from happening?

These questions allow students to reflect on their own perspectives and experiences with research and learn from one another. They also allow instructors to learn more about the experiences that students bring to their projects.

Resources and Activities: Library Research

The next class occurs at the university library with a university librarian. In advance of the session, students are asked to review the youth-led research project assignment description; review the Compilation Spreadsheet instructors prepared that includes the Ripped Headline topics, keywords,

resource questions, and audience questions; and identify and submit two preliminary Research Topic Ideas. The research topic submission requires the following elements:

- Either state the research/inquiry topic or write a question that captures the essence of what you'd like to investigate about youth, technology, and society or education?
- List several keywords that may relate to this topic.

The instructors provide a Research Topic submission example in the assignment:

- How do university students and university faculty use ChatGPT?
- Keywords: AI, artificial intelligence, higher education, technology use, coursework, instruction

The university librarian teaches the difference between popular and scholarly literature resources. The librarian then teaches students how to develop search strategies for university library databases, to execute a search, and to review and interpret results from searches. Students practice searching by using one of their submitted project ideas to find articles in support of their "Research Pitch" that they will prepare for the next week. The university librarian works closely with the course and is available to students for individual meetings. The librarian also creates a course-specific webpage with videos, links, and reminders of shared activities and content.

Assessment

The instructors provide written feedback on the Research Topic Submission regarding its completion, its alignment with the course topic (technology, youth, society, education), and occasionally offer ways to narrow or broaden the topic, if desired. This submission has no point/grade value.

Week Three (Research Pitches)

After learning about how to conduct searches within university library databases, students develop an oral "Research Pitch" presentation during week Three.

Learning Objectives

After this week, the students will be able to:

- Engage in creative and innovative thinking to generate potential areas of study.
- Practice effective communication (written and oral) at the college level.
- Identify a creative, focused, and manageable research question or topic for inquiry.

Resources and Activities

Using the "Ripped from the Headlines" Compilation Spreadsheet and their Research Topic ideas from the library session, students identify an issue or topic to pitch to the class as a possible research avenue for a team project. They are also encouraged to find one or more peer-reviewed resources to inform their pitch.

Once ready, students develop an oral pitch using a one-slide Research Pitch Template that must include the research question (item #2 below) and anything else they would like (see Supplemental Files). Their presentation should do the following:

1. Explain the problem or gap that drives their proposed inquiry. What is known? What is still unknown? What do you want to understand? Why do you want to know more about this topic?
2. What is your research question? This should be written as a question.
3. Who is involved in your research inquiry? What types of people need to be involved to help you answer your question?
   a. For example, would you need to involve parents of young children; 7th graders; high school seniors; college students; people with specific characteristics; those who use this or that technology?
4. So what? Why is it important to know the answer to this question? How could your proposed study lead to change in the world - anywhere from the smallest to the largest impact? Who might be interested in hearing what you learn?

All students orally pitch their research idea for two minutes in front of the class. After everyone has presented their pitch, printed posters of each pitch slide are taped on the walls. Students engage in a voting process to narrow down the topics to approximately six (for groups of three students). At the beginning of this voting process, highly similar topics are merged. Students put their names on two sticky notes and physically place them near the posters/topics of most interest to them. Students are given control of the process. Therefore, students are

asked to discuss with one another and decide if/when to remove topics, such as those that have no sticky notes (i.e., no interest). In our class case, students voted once, withdrew their stickies, and revoted with one sticky to further narrow groups. Topics with three stickies become a group. Other topics with more or fewer stickies involved students negotiating with each other, recruiting, or moving topics until six teams of three students were formed.

Assessment

After each student pitches their idea, instructors use an assessment rubric to provide feedback in terms of topic fluency (e.g., high fluency with topic, explicitly connected to mass media, maximized content coverage) and presentation fluency (e.g., well-practiced, eye contact, polished supporting materials).

Focusing In

Week Four (Team Formation and Identification of Research Focus)

Week Four prepares students to work together in a small group; begin finding, reading, and interpreting scholarly resources; and honing research questions to guide the group inquiry.

Learning Objectives

After this week, the students will be able to:

- Engage in inquiry, analysis, evaluation, and synthesis of information.
- Create and begin a research strategy and critically evaluate information.
- Identify a creative, focused, and manageable research question or topic for inquiry.
- Work with small groups to find solutions to ill-defined inquiries.

Resources and Activities: Team Formation

To build a productive research team, students first identify their personal assets, skills, and values. Before class, students consult an Asset, Skills, and Values handout. Then, they create an asset map that represents the strengths they bring to the group, such as a) academic skills, b) values, c) team and people skills, and d) personal and other skills. Instructors encourage creative asset representations, such as mind maps, drawings, images, word clouds, or tables and words. Students also review a Team Contract handout.

Building on their library research session in Week Three, students follow detailed pre-class instructions to set up individual NoodleTools accounts. One team member creates a team NoodleTools project folder and shares the folder with team members and the instructors. NoodleTools is provided for free by the university libraries. It is a citation tool where students can track sources, take notes, create outlines, collaborate with classmates, and format bibliographies. Students can add sources to their accounts for initial review and share vetted sources to the team project. Before class, students use their library search skills to locate and read at least two relevant sources and add them in NoodleTools.

During the class session, research teams meet to share their asset maps. They also discuss and begin the Team Contract, due at the end of the week.

Instructors review a pre-class handout: What to Pay Attention to and Write about from Research Resources. This handout offers questions to guide students' reading. The functions for scholarly literature that the librarian introduced are reiterated. In this class session, emphasis is placed on how literature can assist students in developing a research focus for their project by reading into what others have done *or not done*. In working towards a review of applicable literature (see Week Six), each student will find, read, review, and summarize at least four scholarly resources. When completed, notes are added to NoodleTools, linked to each source item.

Then, the teams discuss and fill out the Developing Research Questions handout. Students identify their interest, commitments, and background knowledge related to their research topic, including any ideas from the two initial library resources they identified. Questions in the handout scaffold the team toward identifying an important, actionable, and researchable issue and writing that issue as a research question.

Class ends with the instructors fielding questions about NoodleTools functions and/or searching academic library databases.

Resources and Activities: Research Focus

The next class focuses on crafting answerable research questions through focused research design. In preparation for class, students watch a 10-minute Introduction to Research Design video (Jensen & Laurie, 2017), accessible through the university library subscriptions and embedded in Canvas. Instructors ask students to pay close attention to the role of research questions in the process of doing research. Students also watch a five-minute Overview of Data Collection Methods video (Scribbr, 2021), embedded in Canvas. Finally, they reflect in a class discussion board on the question "What are one or two important strategies you want to remember from these videos on research design and data collection approaches as you focus on your research inquiry?"

This class session offers an experiential introduction to data collection methods and resulting data. The instructors provide a short review of six methods to investigate issues: observation, interviews, focus groups, survey, measure or test, and artifacts. Then students experience each approach by cycling through six pre-created activities explained on six Canvas pages:

1. *Experiencing the Interview*: Each student pair take turns interviewing the other person using a provided question "Tell me what it's like at UT Austin" and optional follow up questions.
2. *Experiencing the Focus Group*: A group of four to six students choose one person to be the interviewer. The others are respondents. The interviewer conducts the interview, asking the main question ("Tell me what your favorite study space is like") to the group and using any optional follow up questions. They try to cultivate participation across all respondents.
3. *Experiencing the Observation*: Students observe people in a public student lounge to understand how people use digital technologies or are exposed to digital technologies in a public space. In written notes, they describe through their senses what and how people are using digital technologies and the ambient digital environment within the lounge.
4. *Experiencing a Survey*: Students take a survey about their privacy and personal information in online contexts. The survey questions source from Pew Research Center (2023), an organization from which students have already read reports.
5. *Experiencing a Measure*: Students take a survey that measures Fear of Missing Out (FOMO) (Przybylski et al., 2013), a concept that students already read about.
6. *Experiencing Artifacts*: Students identify three artifacts that represent how they use technology for educational purposes. They screenshot or upload these artifacts to a folder.

The instructors remind students to move to another activity every six minutes. Following the six activities, the class examines what the resulting data looks like using their actual data results or pre-created data for interviews.

The class then shifts into teams to talk through their inquiry topic and any changes they might want to propose based on reviewed literature or ideas regarding research design and data collection. Each group submits a Research Project Focus–a summary of their research question, suggested target participants (subjects), and possible data source(s) they might use. This is a very preliminary set of ideas. The instructors conclude class by sharing the Research Plan Template handout/assignment as an advance guide for Week Five.

Assessment

The instructors provide written feedback on each team's Research Project Focus and their Team Contract in advance of Week Five. At this stage, feedback typically involves suggestions for narrowing the scope of the inquiry and considering access to human participants they might want to involve. Students receive one point for each product submission.

Planning

Week Five (Research Plan Development)

In Week Five, students gather the most applicable perspectives from the literature to guide their research inquiry and collaboratively decide how they will investigate their research issue.

Learning Objectives

After this week, the students will be able to:

- Revise, as necessary, a literature research strategy, critically evaluate information, and track citations and references.
- Identify and synthesize existing knowledge and research relevant to their inquiry topic.
- Draw from one or more disciplinary perspectives to design a methodology for answering their research question or pursue their inquiry.
- Work with small groups to find solutions to ill-defined inquiries.

Resources and Activities

In advance of the first class, students (re)searched, (re)read, and annotated scholarly literature that related to their research inquiry. Students are reminded to use the What to Pay Attention to and Write about from Research Resources handout from Week Four to scaffold their reading and annotation notes that they append to each source in NoodleTools. By class time, each student has:

- Identified four applicable scholarly sources
- Exported/added the citation from the library database to NoodleTools (see NoodleTools Citations Guide)
- Annotated each source by capturing the important concepts in a note appended to the NoodleTool source
- Added each applicable source into the NoodleTools Team Project so all team and instructors can review

In class, the instructors (re)introduce the Research Plan Template, a handout and assignment guide developed by the instructors to align with the Introduction to Research Design video (Jensen & Laurie, 2017) viewed during Week Four. The plan guides teams to develop a research design, including:

- Develop research questions
- Operationalize key ideas
- Select research method(s)
- Choose a framework or key concepts
- Weigh risks and opportunities
- Self-assess research skills and team assets
- Anticipate data analysis

Each plan section includes guiding questions and advice for teams to consider. Teams complete the Research Plan by the end of Week Five.

Since students complete research as a class activity, the university Institutional Review Board (IRB) considers the activity "class research," which allows the instructors to guide ethical research practices. Therefore, the instructors provide a Research and Ethics handout and use it to introduce key research terminology and activities. They also provide a Consent Form template that each team uses for any human participants. While the data and research from these class projects are not usable for publication, instructors guide students in all ethical practices and the consent form clarifies this work as "class research."

Teams then have time to discuss instructor feedback from the Research Project Focus submission from Week Four and the ideas gleaned from the reviewed scholarly literature, with a focus on refining their research focus and question. In particular, instructors draw students' attention to two areas of the Research Plan Template: Develop Research Question(s) and Operationalize Key Ideas. Changes are expected and most groups need narrowing of focus.

In advance of the second class this week, students review a Canvas Module called "Research Methods Resources: Ways of Investigating" to review different strategies and recommendations to build an investigation with specific types of data. Resources in this module are compiled from various university and published resources and align with the data types introduced in Week Four: surveys, interviews, focus groups, artifacts, measures, and observations. The module also includes links to free university tools: Qualtrics, Box, and Zoom. Teams are expected to start building their Research Plan, which includes their research methods, data collection materials, and consent form.

In class, the teams focus their energies on their Research Plan, while instructors cycle through teams to answer questions and provide guidance. Prior to the end of class, each team quickly shares:

- What is your research question?
- Who are your target people?
- What is your method of investigation (data collection tool)?

Assessment

The instructors review the Literature Summaries (i.e., annotations in the team's NoodleTools projects) to ensure there are at least 12 (four from each student); they are applicable to the topic; the notes have identified concepts, methods, and/or findings that are helpful to the team's research inquiry; and notes distinguish verbatim (quoted) versus paraphrased material. Students earn 8 points when all 12 summaries are complete and appropriate; revisions may be requested.

The instructors review the Research Plan and its consent form and data collection materials (e.g., a survey or interview questions). Written feedback may request further narrowing the scope of inquiry, refinement of research questions, and considerable suggestions for data collection methods. Most research plan materials are revised by teams and reviewed by instructors several times, spanning into Week Six. Students earn 4 points when the plan is aligned and doable.

Doing

During the *Doing* phase, students move between writing draft sections of the final research paper and completing data collection and analysis. Therefore, the week-by-week breakdown includes overlapping tasks as students receive feedback, work on revisions, and build upon planned research activities.

Week Six (Writing Literature Review and Data Collection)

In Week Six, teams learn to write a literature review and work towards approval to collect data.

Learning Objectives

After this week, the students will be able to:

- Critically evaluate information from data collection and research articles.
- Identify and synthesize existing knowledge and research relevant to their inquiry topic.
- Gather, evaluate, synthesize, or create relevant evidence, knowledge, or other elements to reveal insights about their topic.
- Respond effectively to the writing of others in the fields and/or professions in which they studied.

Resources and Activities

In advance of the first class in the *Doing* phase, students read the introduction and chapter one from the text *They Say, I Say* (Graff & Birkenstein, 2021). They also view a presentation (University Writing Center, n.d.) about the purpose and approach to writing a literature review; read a handout (The Writing Center, n.d.) explaining what literature reviews are; review the course assignment for the Literature Review draft; and in a Canvas Discussion Board contribute "an example of ONE term (with its definition), prominent theme, debated topic, unexplored question, or method from the literature your team read and reviewed. You likely will need to review your literature notecards in NoodleTools to do this."

The Literature Review Draft assignment asks teams to use the literature they have annotated in Weeks Four and Five to now write a literature review of about 250-500 words to define important terms, synthesize earlier research, and explain prominent themes or issues that are already known. They essentially answer the question, "What do we already know about our topic, based on past research?" We encourage them to think of it as a way into the conversation about the topic because they are conducting research in this topical area. The review is about ideas, themes, or patterns the team notices across what they read. They use the literature review, citing their sources as they write this, to do any of the following:

- Define terms important to the research study,
- Introduce common or prominent themes across the research that has already been conducted,
- Introduce themes or topics where the research diverges/does not agree,
- Identify yet unexplored questions related to your research issue (what we often call "research gaps"),
- Describe methods (ways of investigating) that past researchers have implemented,
- Rationalize your research question, target, or method in relation to past research.

In class, instructors first introduce the Team Research Report, which is an APA-formatted research report template prepared by the instructors, adapted

from University of Wisconsin at Whitewater (n.d.). This document is a guide and a template for students' final report, but through formative assignments, instructors scaffold the teams to focus on one section (i.e., Literature Review) at a time.

Instructors continue in class, presenting Writing at University and a Summarized Writing Guide to help students conceptualize the literature review as entering a conversation with researchers who have come before them and connect the sentence templates to the communication tasks in the review, see bullets above (Graff & Birkenstein, 2021). Each student returns to their pre-class discussion board submission and revises their idea using the introduced sentence templates and verbs. Then, each shares their contribution with their team who consider its applicability for inclusion in their review. With any remaining class time, teams request help finalizing their data collection methods (if not already complete) and discuss writing goals for the literature review draft (due at beginning of Week Seven).

In advance of the second class session, teams revise and seek approval for data collection methods (as needed) and start their data collection processes. They also start writing their Literature Review. The second class meeting is dedicated time for teams to seek help from the instructors and make progress.

Assessment

The Discussion Board posts are reviewed prior to the first Week Six class session, with feedback provided on completion and the applicability of submitted content. Students earn 1 point for an applicable contribution.

The instructors continue to work with any teams that may be revising aspects of their Research Plan (e.g., their data collection processes, consent form etc.) with the aim for teams to begin data collection prior to the week's end.

Week Seven (Data Collection and Analysis; Writing Methods)

In Week Seven, teams submit a draft of their literature review, start or monitor data collection, consider data analysis techniques, and learn to write a Methods section.

Learning Objectives

After this week, the students will be able to:

- Identify and synthesize existing knowledge and research relevant to their inquiry topic.
- Gather, evaluate, synthesize, or create relevant evidence, knowledge, or other elements to reveal insights about their topic.
- Respond effectively to the writing of others in the fields and/or professions in which they studied.

Resources and Activities

In advance of the first class session, teams work on the literature review draft; start or continue to collect data (all teams have chosen to use interview, surveys, or both); and review a Canvas Module Research Methods Resources: Ways of Analyzing Data that contains fundamental analysis information, guides, and skills from the university and YouTube, such as: descriptive statistics, correlation, regression, qualitative thematic analysis (already taught in first half of course) and Qualtrics. We ask them to note techniques they may use to analyze their data to discuss with their teams.

As we gather in the first class session, teams meet to touch base about their literature review draft, due the following day. Then instructors field and answer any questions about their writing, the process, or assignment.

Next, instructors (re)introduce the concept of data analysis. Students already engaged in qualitative thematic analysis for an assignment that preceded this curriculum. In the team's Research Plan (see Week Five), they already considered if their data was qualitative or quantitative and what approaches to analyzing the data they might use, such as calculations or statistics or coding data for significant insights and identifying themes. We review these concepts, homing in on the approaches most likely to be used based on the teams' research questions and our discussions with them. We then introduce a Data Analysis Preparation – Template handout which aims to guide each team to create a data analysis plan by logging collected data (e.g., a survey or interview question), deciding what needs to be done to it (cleaning, analysis), and determining what it will yield (hypothetical finding). The completed analysis log forms a "how to" guide for each team's analysis and ensures they are using all

their data and answering their research questions. The teams then meet to discuss their data analysis.

In advance of the next class, teams submit their literature review draft for review, begin filling out the Data Analysis Preparation handout – with consultation access to the Canvas Module Research Methods Resources: Ways of Analyzing Data, and monitor their continued data collection.

In the second class of Week Seven, we review the Methods section of the Team Research Report and explain how this section describes what they did to conduct their study. The report template includes the following sections: (a) Participants, (b) Design, (c) Materials, (d) Procedures, and (e) Analysis. We show them how content they have already written in the Research Plan and the Data Analysis Preparation handout from the previous class assist in completing the Methods section. We encourage them to copy and revise any of this previous work to satisfy the Methods section. The Methods draft is due in the middle of Week Eight.

We conclude the class by allowing teams to meet. The instructors review each team's Data Analysis Preparation and provide specific suggestions for data analysis to each group based on their inquiry. Common suggestions include descriptive statistics (averages), qualitative coding, correlation, and scoring of a pre-created measure.

All teams end data collection (if not done so already) and begin data analysis.

Assessment

At the close of Week Seven, the instructor reviews each team's Literature Review Draft and provides considerable feedback regarding the content (apt and enough literature), argument (apt use of 'They say, I say' templates), language use, writing style, and correct citations and formatting, referencing applicable areas of the Team Research Report's Assessment Rubric. Students earn four points for the completed draft.

In class, instructors review each team's Data Analysis Preparation Log to ensure they have an adequate plan for analysis once their data collection is complete. If needed, instructors continue to assist teams individually through Canvas messaging. For example, teams who have developed research questions requiring a correlation analysis often need more statistical assistance than others. This is an in-class assignment that does not earn points.

Sharing

Week Eight (Analysis and Sharing Findings)

In Week Eight, teams write and submit a Methods section draft, analyze their data, draw conclusions, and present the findings of their inquiry to peers, instructors, and librarians.

Learning Objectives

After this week, the students will be able to:

- Gather, evaluate, synthesize, or create relevant evidence, knowledge, or other elements to reveal insights about their topic.
- Present a conclusion or creative work that logically follows from the inquiry findings.
- Effectively express ideas through written, oral, and visual communication.

Resources and Activities

In advance of Week Eight, teams continue to write their Methods draft and continue data analysis using their Data Analysis Preparation log as a guide. They also review the Team Research Presentation assignment and have access to a set of guides and suggestions for oral presentations prepared by the university's Public Speaking Center. They are also encouraged to meet with this Center because it offers free consultations and practice.

The teams culminate their inquiry work through a Research Presentation for the class and selected guests (i.e., the librarians). Each team develops an eight-minute oral presentation sharing their research inquiry, with specific focus on the findings from the research. We conceptualize the presentation as a draft submission of the findings, and includes at least the following:

- the research inquiry focus (topic) and any related connections of that topic to youth, society, and/or education (answering: what is this about? and why is it important?)

- your research question (verbatim)
- the method (answering: what did you do in your research?)
- the findings (answering: what did you learn from the data you collected? how did that answer your research question?)
- the future actions (answering: based on your findings, what future actions might this inspire by people, institutions, government, any related entities etc.)

Instructors provide an empty slidedeck for teams to add their slides but unlike earlier presentations, we do not scaffold the slide formats with a template. Instead, teams design their presentation in the way that best fits their project.

The first class session of Week Eight allows the teams to meet in-person to work on any of the following tasks: Methods draft, data analysis, or research presentation. Instructors connect with all teams to answer questions and help with all tasks. Teams submit the Methods draft the day after this session.

The second class session hosts the team research presentations for the class and the university librarians who support these undergraduate courses, Teams orally present for eight minutes and then the audience may ask questions or provide comments for about four minutes.

Assessment

Prior to the last class session of Week Eight, the instructor reviews each team's Methods draft and provides considerable feedback regarding the content (accurate and detailed), language use, writing style, and correct citations and formatting (if any), referencing applicable areas of the Team Research Report's Assessment Rubric. Students earn four points for the completed draft.

Instructors provide ample feedback on the Research Presentation immediately after the second class session. Instructors use a Team Research Presentation Rubric to assess teams' fluency with their topic, content coverage, and presentation fluency. They consider the findings shared in the presentation as formative, so they offer feedback and suggestions, especially if teams could bolster claims with additional analysis.

Submission of Final Paper

Final submission of the Team Research Report is due about five to seven days after the end of Week Eight. Since instructors teach this in the latter half of a semester, the report is due just prior to Finals week.

The Team Research Report is the APA-style research report template provided by the instructors. At this point, teams have received formative feedback on drafts of the Literature Review and the Methods and the oral presentation of Findings. It is expected that the teams will read and consider instructor feedback and revise earlier drafts for inclusion in the final report. Often students do not realize that the formative assignments they have worked on fit into the final report (despite instructor explanations of such in earlier weeks). Remaining writing involves the Discussion, Conclusion, References, and Introduction. The template narrates expectations for these sections, and teams can export an accurate Reference list from the NoodleTools Team Project for inclusion in the report. Students (and instructors) are impressed with the final research reports produced.

Assessment

As a summative evaluation, instructors use an assessment rubric to provide broad feedback since teams do not revise the Team Research Report. Feedback focuses on setting the purpose (well-developed focus with connections to youth and society and establishes the issues at stake), connecting to the past and situating the current inquiry (thoughtful treatment of the literature review, statements are backed by supporting information in the research data and/or appropriate citations from at least 12 sources), communicating the consequences (indications of what could/should change as a result of this research), organization (contains strong topic sentences and builds upon the argument suggested in the introduction and literature review; clear transitions connect ideas both on the paragraph level and the sentence level), and mechanics (mastery over the basics in sentence completeness, structure, variety, word choice, and punctuation; APA format).

Critical Reflection

This youth-led research curriculum has been implemented three times (Fall 2023, Spring 2024, Fall 2024). Institutionally, it fits within the scope of the required undergraduate first-year seminar to develop college-level skills in research, writing, speaking, and discussion through interdisciplinary, collaborative, experiential, and contemporary experiences. It also fits my course theme of exploring youth, technology, and society and also facilitates developing these college students' digital literacies, such as: survey development and administration in Qualtrics, citation management in NoodleTools, data analysis in spreadsheets and documents, team collaboration with Google Drive, content creation in Google Slides and Docs, and asynchronous meetings via video conferencing tools, such as Google Meets and Zoom. Many students specifically reported the value of learning how to do academic library research, the surprising pleasure of learning about other people's experiences through original research, and amazement with their resulting research reports (especially the length and formal writing style). We felt the learning objectives were met week by week, and ultimately the unit drew these undergraduates *into* the research enterprise at the earliest moment in their undergraduate academic career.

In terms of practical implementation, the unit is quite fast-paced. After the first implementation, we added another instructional week after Week Five (for a total of nine weeks), but with no additional content or assignments, to allow more team time and instructor assistance for development of research measures, data collection, and analysis. Since many students have no experience conducting original research, the instructors provide significant scaffolding and support especially in the development of research designs and analysis strategies. Simple descriptive statistics and qualitative coding with themes is completely acceptable. Some teams pursue questions requiring more complex analyses (e.g., correlation) that require more assistance from instructors because this is not a statistical analysis course. To reduce the risk of cognitive overload for the students, the class worked on one component of their project at a time with supportive templates and clear guidance of what was required to simplify the content and expectations. Adding in an additional week allows for more time for this individualized support to occur. To reduce the risk of cognitive overload for the instructors, the instructors closely monitored student projects to ensure that they were not too large of an undertaking for the timeframe (i.e., requiring too much data collection, ambitious statistical analysis, etc.).

While we provide significant guidance, scaffolds, and examples, this unit requires all students in these teams to engage in work outside the class sessions (i.e., homework) that involve novel creative and critical thinking and production. Some students expressed frustration with or dislike of the ill-structured nature of research tasks and preferred a "lecture and test" pedagogy/curriculum. To support this shift to a new course structure, the instructors emphasized that the process of learning about and conducting research can be flexible and multimodal; therefore, each group worked at their own pace throughout the process.

While many students loathe group projects, we have not experienced discontent. We designed several strategies to distinguish individual and team efforts for both the instructors and students. First, instructors watched and worked with teams so deeply during class that they understood in-class and some out-of-class individual efforts. As needed, the instructor would intervene and discuss inequities with individual students or with the whole team. Second, in each submission, team members clarified their roles. For example, "With your submission, each team member should note exactly what and how they contributed to the content of this Literature Review Draft." Third, at the end of the unit, students completed a survey (see Assessment in Supplemental Files) where they clarified their individual contributions and described their team members' contributions. Using this survey information, the assignment submission information, and observations in class, the instructor assigned each person from the team an individual contribution score. This score (20 points) was high enough to impact the overall course grade if a student 'rode the coattails' of their team members' efforts.

While we are inspired by YPAR, our implementation did not explicitly center social justice nor facilitate ongoing action on the explored issue; thus, we refer to it as youth-led research. With more time and/or in another context likely outside a traditional semester format, it would be rewarding for the inquiries to be approved IRB studies that allow the youth teams to present their findings to public audiences that are

impacted by the topics and also to publish their research.

Several institutional changes impact our unit. First, the Public Speaking Center that offered student and team support for oral presentations was shuttered after Fall 2023. In 2024, we directed students to the university's Writing Center that allows consultations on presentations. Second, in 2025, the university removed the explicit requirement for writing and opportunities for peer review, instructor review, and revisions within these courses. The university still expects writing as an element of the course, but the amount of and process of writing is at the discretion of the instructor. Given this change, we are questioning if and how to continue this ambitious research project with significant writing responsibilities given that some students had already felt our course was "more work" comparatively to their friends' sections of the course.

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Modeling Sampling Distributions in an Advanced Placement Statistics Lesson

Colin Ferreira, Dallas Independent School District

Overview

This lesson demonstrates how technology can support teaching and learning in an 11th Grade Advanced Placement (AP) Statistics lesson designed by an empirically tested and effective model (FETL Model; see Ferreira, 2025). Simulation software (including Stapplet) was used to promote conceptual understanding of the abstract concept of sampling distributions and gamification technology (e.g., Wayground) was used for the formative assessment. Students worked in pairs to simulate sampling distributions and then individually to complete a quiz on Wayground. At the conclusion of the lesson, students engaged in reflective practices by anonymously reporting their experiences in Padlet.

Topics: Sampling Distributions, Statistics, High School

Time: 83 minutes

Materials

- Chromebooks or similar device.
- Padlet or sticky notes.
- Anchor Charts (Sampling Methods, Distribution Shapes, Bias Types).
- Mini Flipcharts with: Red (I need help, and I can't Keep working), Yellow (I need help, but I can keep working), and Green (I'm working fine!).
- Assessment entered on Wayground or Khahoot!
- Stapplet Applet (Sampling Distribution for Population Mean Simulator)
- Final Polls in Two Battleground States Video (CNN, 2024)
- Promethean Board or projector and whiteboard.
- Scientific Calculators (e.g., TI-nspire CX II).
- Notebooks and pencils/pens.
- Dry-erase mini whiteboards.
- FETL Model (Ferreira, 2025) or alternative.

Context-at-a-Glance

Setting
An 11th Grade AP Statistics class in an urban public high school located in the South-Central United States.

Modality
Face-to-face

Class Structure
This 83-minute lesson was designed and delivered using the FETL Model which included watching a YouTube video, class discussions, and the integration of technology for simulation (Stapplet Applet), gamification (Wayground), and reflective exercises (Padlet).

Organizational Norms
The district prioritizes high-quality instruction, student achievement, and technology integration. Artificial intelligence (AI) is used for personalized instruction, assessments, intelligent tutoring, natural language processing, and progress monitoring.

Learner Characteristics
Twenty-five 11th Grade students (80% Hispanic and 20% African American) participated in this lesson.

Instructor Characteristics
The instructor is a Distinguished Mathematics Teacher with 30+ years of international teaching experience. He uses technology extensively to build automaticity, fluency, and conceptual understanding.

Development Rationale
This lesson was developed to introduce the FETL Model's effectiveness in fostering conceptual understanding in an AP Statistics lesson using technology and pedagogical best practices.

Design Framework
The FETL Model (Ferreira, 2025)

Setup

Set up your classroom before students enter. As shown in Figure 1, desks were arranged in side-by-side pairs to allow think-pair-share, cooperative, and collaborative learning experiences. This was a simple setup which took about 10 minutes for a class size of 25 students. The spacious classroom was fully equipped with technology including a large Promethean Board, high speed internet, 30 Chromebooks (each student had a computer with reliable and stable Wi-Fi connection), 30 n-spire CX II calculators, anchor charts, collaborative seating, and writing materials. All student materials were placed on desks, including Chromebooks, mini flipcharts, markers, whiteboards, calculators, pencils, and notebooks (see Figure 2).

Figure 1. Seating arrangement for think-pair-share

Figure 2. Learning environment equipped for innovative teaching and learning with Chromebooks, mini flipcharts, notebooks, pencils, whiteboards, markers, and calculators.

Standards

This lesson was designed for Unit 5: Sampling Distributions and Section 5.4: Biased and Unbiased Point Estimates of the College Board's AP Statistics curriculum (College Board, 2019, Unit 5, Section 5.4).

Context and Setting

Learning Objectives

Students will be able to: (1) distinguish between parameter and statistic; (2) distinguish between biased and unbiased estimators; (3) evaluate claims about populations using sampling distributions; (4) describe the relationship between sample size and variability.

Success Criteria: Students I Can Statements:

- I can distinguish between parameter and statistic giving two concrete examples.
- I can distinguish between biased and unbiased estimators using two real-world scenarios.
- I can assess claims about population parameters using simulations of sampling distributions.
- I can explain the relationship between sample size and variability using concrete examples.

Demonstration of Learning

Given a computer-based (Wayground) 10-question quiz on Sampling Distributions, students should be able attain at least 70% accuracy.

The Advanced Placement (AP) Statistics course was launched in 1997. It allows students to gain college credit based on their College Board examination scores (Roberts et al., 1999). The curriculum consists of four main topics including data exploration, study design, probability distributions through simulation, and inference (Roberts et al., 1999). AP Statistics is one of the most challenging high school subjects to teach because the curriculum and examination focus heavily on conceptual understanding and problem solving (Haines, 2015; Roberts et al., 1999).

Technology and pedagogy (e.g., gamification, simulation, and critical reflection) play a critical role in increasing active engagement, motivation, and

conceptual understanding of abstract concepts in AP Statistics. Gamification has revolutionized traditional methods of engagement especially in education (Christopoulos & Mystakidis, 2023). At the secondary school level, gamification fosters critical thinking, strategic planning, and informed decision making (Christopoulos & Mystakidis, 2023). In addition, gamification is an effective tool for stimulating attention, focus, and investment (Arnold, 2014). There has been a growing call for Mathematics teachers to employ computer-based technology in their classrooms (Findley et al., 2019). Computer models and simulations are effective tools for motivational and visual aids (Berkova & Kulicka, 2015).

It is important to note that despite the district prioritizing high-quality instruction, student achievement, and technology integration where Artificial intelligence (AI) is used for personalized instruction, assessments, intelligent tutoring, natural language processing, and progress monitoring, AI was not used in this lesson. However, Wayground was used to foster engagement through gamification, where students completed the assessment in a competitive, virtual game-like environment with badges, music, customized avatars, bonus points, and leaderboard game elements.

Most of the students in this class were considered Hispanic (80%) and the remainder were African American (20%). The face-to-face AP Statistics lesson on Sampling Distributions was designed and delivered in accordance with the FETL Model to a public high school's 11th Grade advanced academic students in an urban city in the South-Central Region of the United States. As it related to prerequisite knowledge and mastery topics, and prior to this lesson, students completed the following concepts: (a) Describing Distributions (Shape, Center, Spread, and Outliers), (b) Normal Distributions, (c) Central Limit Theorem, (d) Law of Large Numbers, (e) Samples and Populations, (f) Sampling and Surveys (Simple Random Sampling, Cluster, Systematic, and Stratified), and (g) Bias (Nonresponse, Response, and Sampling).

The students use whiteboards and mini-flip charts daily in their Mathematics classes to indicate their progress on problems and share their solutions. Students had no prior experience with simulation applets that were used in this lesson. Sentence stems were used to differentiate the reflective exercises for the emergent bilingual students.

The instructor is a highly qualified and experienced teacher with more than 30 years of teaching experience in high school mathematics courses including Algebra, Geometry, Pre-Calculus, AP Statistics, and AP Calculus. The FETL Model is a framework that was developed and empirically tested to respond to the demand for modern and effective teaching methods for 21st Century classrooms. See Ferreira (2025) for a detailed explanation of the components of the FETL Model.

AP Statistics is a challenging course to teach because the examinations and content are primarily based on conceptual understanding and problem solving which requires innovative teaching methods and technology integration for simulating complex and abstract concepts, increasing active engagement, reflective practices, and providing opportunities for the 4C's (communication, critical thinking, creativity, and collaboration). Education for Sustainable Development (ESD) demands pedagogical best practices that engender transformative learning, which include reflective and active learning, experiential, collaborative, and learner-centered activities (Howell, 2021).

Learning Representation

Summary of Items Used: FETL Model Components

The FETL Model works in a cyclical way with the teacher serving as a facilitator of the learning process. It starts with the teacher using the five drivers to inform the lesson planning process. Appropriate instructional and assessment best practices are selected from instructional and assessment toolkits. The introduction is stimulating, and four modes of instruction are employed (whole class, small groups, one-to-one, and AI stations for personalized learning). Lesson evaluations are done at the end of instruction, guided practice, and independent exercises. Both teacher and student engage in reflective practices about the learning experiences. The cyclical process will begin again with the assessment data, student reflections, and the five drivers being used to inform the subsequent lesson planning process. The following list summarizes the processes used in this lesson:

- External Environments: Politics (2024 Presidential Elections).
- Technology (Simulation, Gamification, and communication software).
- Internal Environments (ESL and Special Education Teachers and Supports).
- Assessment Data (data from previous lessons' formative assessments informed this lesson).
- Student Profiles (All necessary supports were incorporated for varying academic abilities, ESL and Special Needs students, and cultural backgrounds).
- Curricula and Standards (College Board Advanced Placement Statistics curriculum and syllabus).
- Introduction Strategies (One minute viewing time for a CNN YouTube video on the population of likely voters in North Carolina and Georgia that have Kamala Harris and Donald Trump as Choice for President (CNN, 2024) to stimulate interests and engagement for the new lesson objectives).
- Development and Execution Stage (uses several pedagogical best practices taken from the Instructional and Assessment Toolkits including scaffolding, differentiation, inquiry-based learning, Blooms Taxonomy, simulation using Stapplet applet for conceptual understanding, writing in the content area, gamification using Wayground, experiential learning, quantitative and qualitative assessments, and the 4Cs. Teacher will incorporate the four instructional strategies: whole class, small group, one-to-one, and ICT and AI stations.
- Conclusion and Reflection Stage (both teacher and students will engage in reflective practices at the end of the lesson using Padlet or stick notes to reflect on their learning experiences.

Do Now Activity (5 Minutes)

Teacher Actions

Prior to students entering the classroom, the teacher arranged the desks for collaboration and placed all resources on the desk. To activate prior knowledge, the teacher posted one question on the Promethean board as the Do Now Activity and set a timer for five minutes on the board:

- *Write one example each for when a simple random sample (SRS), stratified, and cluster sample are most suitable.*

As the facilitator of the lesson, the teacher circulated the classroom to observe students' responses, clarified misconceptions, and provided feedback as students worked in their groups and independently.

Student Actions

Students wrote their responses on dry-erase whiteboards and referenced the anchor charts when needed to review the definitions for the types of sampling methods. Students displayed their mini flipcharts to indicate their progress on the assigned task and raised their dry-erase whiteboards at the end of the five minutes.

Introduction (10 Minutes)

Teacher Actions

The Teacher ensured that all 540 Plans, individualized education programs (IEPs), and English as a Second Language (ESL) supports were incorporated into the lesson plan, learning activities, and assessments. The teacher introduced the lesson with a short CNN YouTube video titled "See results of CNN's final polls in two key battleground states" (CNN, 2024).

Using the think-pair-share questioning strategy, the teacher posted the following questions on the board and set a timer for nine minutes:

- *Identify the type of sampling method (s) used in the exit polls.*
- *Identify the type (s) of bias that may exist in exit poll samples.*
- *What percentage of the population of likely voters in North Carolina have Kamala Harris and Donald Trump as Choice for President?*
- *Can we trust the results of the exit polls or are the results reliable? Justify your answers using Statistical reasoning and theorems. We will revisit this question after the guided and independent practice segments.*

As the facilitator of the lesson, the teacher circulated the classroom to observe students' responses and discussions, clarified misconceptions, and provided feedback as students worked in their groups and independently. Groups of students were randomly selected to share their answers with the class. The

teacher commented accordingly on students' answers to clarify misconceptions and explanations.

Student Actions

Students watched one minute of the CNN YouTube video, answered each question independently on their whiteboards, and shared answers with their partners. They displayed their mini flipcharts to indicate their progress on the assigned task. Afterwards, they shared their answers with the class by raising their whiteboards once selected by the teacher.

Development and Execution Stage (48 Minutes)

Teacher Actions

The teacher introduced new concepts with definitions and led discussions on real-world examples (see question posted below by the teacher on the survey of 670 students:

- Parameter – a calculated value that describes a characteristic of the population such as the mean (μ) or proportion (ρ).
- Statistic – a calculated value that describes a characteristic of the sample such as the mean ($\bar{x}$) or proportion ($\hat{p}$).
- Sampling Distribution – a probability distribution of a statistic consisting of all samples of the same size taken from the same population.
- Unbiased Estimator $(\mu_{\hat{p}} = \rho, \mu_{\bar{x}} = \mu)$– a statistic is unbiased if the mean of its sampling distribution is equal to the population mean, where $\hat{p}$ (sample proportion) is the population proportion (parameter) estimator and $\bar{x}$ (sample mean) is the population mean (parameter) estimator.
- Sampling variability – the sample statistic will vary from sample to sample when samples of the same size are taken from the sample population.

The teacher provided scenarios for students to identify the population, parameters, sample, and statistics including:

- From the 670 students in the school, the principal conducted a survey with a random sample of 120 students and found that 80 (66.7%) of the sampled students are in favor of school dances once per month. Identify the population, sample, parameter, and statistic.

The teacher set the timer on the Promethean board for 3 minutes. As the facilitator of the lesson, the teacher circulated the classroom to observe students' responses, clarified misconceptions, and provided feedback as students worked in their groups and independently.

To acquire a concrete definition of Sampling Distributions and foster a conceptual understanding of this abstract concept, students completed a Guided Practice (15 minutes). The teacher posted the activity instructions on the Promethean board and set the timer to 15 minutes:

- There are 25 pieces of paper in the bag which are fictitious weights (in pounds) of 25 high school student: 120, 145, 148, 150, 158, 160, 166, 169, 170, 172, 175, 175, 178, 180, 183, 185, 195, 199, 200, 201, 205, 210, 220, 220, 230. Each student will randomly select three pieces of paper, write down the weights in notebooks, calculate the mean, and then record the mean on the dot plot displaced on the Promethean board.
- Students then return the pieces of paper to the bag. The next student thoroughly shakes the bag before selecting three pieces of paper. This continues until all students have randomly selected three weights, calculated the mean, and recorded the mean weight in their notebooks and on the dot plot.
- Each calculated mean must be rounded to the nearest pound. For example, (120 + 170 + 180) / 3 = 157.
- All students will calculate the mean of sample means and the population mean.

The following questions were posted on the board:

- *Is the mean of the sample means a biased or unbiased estimate of the population? Justify your answer using Statistical reasoning and theorems.*
- *Do you think increasing the sample size and repeating the process for 100, 1000, or 100000 samples would result in an unbiased estimator?*
- *How is the Central Limit Theorem and the Law of Large Numbers relevant to this activity?*

The teacher simulated this process for a population with a mean of 10 and standard deviation of 2. The teacher demonstrated using 100 simple random

samples (SRSs) of sizes 10, 20, 30 and asked students to describe the relationship between sample size and variability of a statistic. Students also explained whether the statistic is an unbiased estimator of the population parameter (See Figures 3-5; Simulating Sampling Distributions, n.d.).

A timer on the Promethean board was set for 15 minutes. Students worked in pairs to select the number of their SRSs and sample size (n) to simulate, record the statistic, and write their observations.

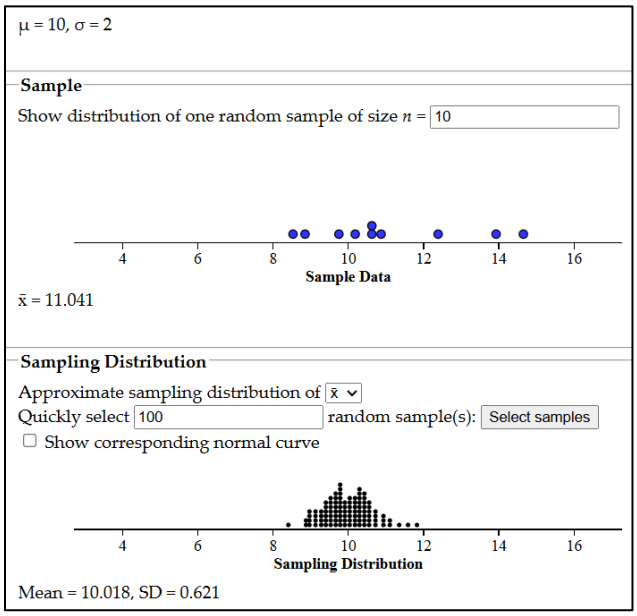

Figure 3. Simulation with 100 SRSs of size 10

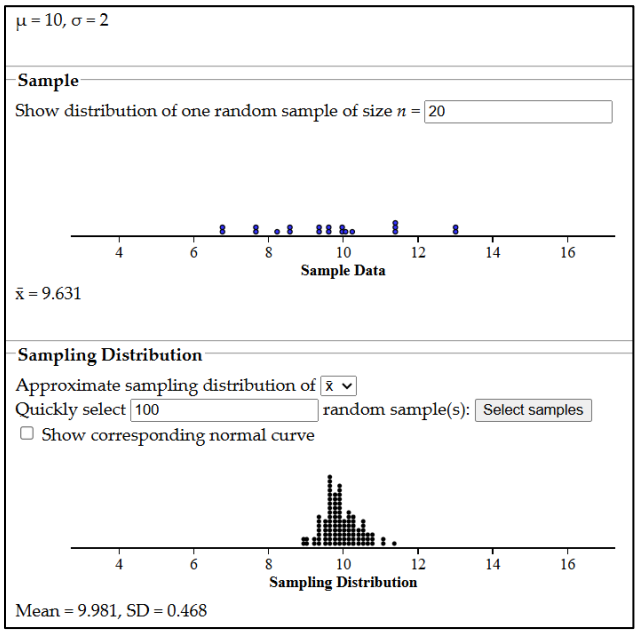

Figure 4. Simulation with 100 SRSs of size 20

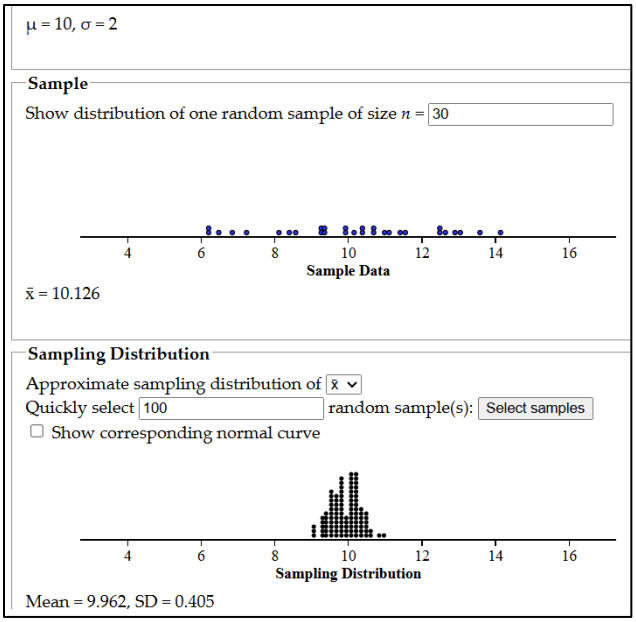

Figure 5. Simulation with 100 SRSs of size 30

Student Actions

Students used think-pair-share and answered the questions shown on the Promethean board using their dry-erase whiteboards. Students randomly selected three pieces of paper, wrote down the three weights in their notebooks, and placed the three pieces of paper back into the bag.

As shown in Figure 6, students calculated the mean of their three selected weights and recorded it on the dot plot shown on the Promethean board. The 25 calculated means were: 143, 156, 181, 182, 159, 177, 198, 153, 173, 200, 188, 158, 149, 181, 163, 196, 201, 178, 179, 189, 186, 146, 162, 190, and 203.

Students calculated the mean of the sample means and the population mean. The mean of the sample means was 176 and the population mean was 181. Working in pairs, students described the shape, spread, and center of each of the distributions with size of 10, 20, and 30 (See Figures 3-6). Working on Chromebooks, student pairs analyzed each dot plot and then described what happened to the variability in the dot plots as the samples increased in size.

Students displayed their mini flipcharts to indicate their progress on the assigned task. For assessment or lesson evaluation, students individually completed a ten-question quiz on Wayground (15 minutes).

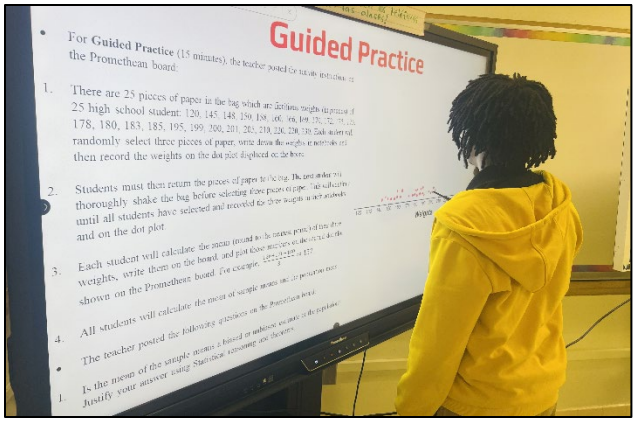

Figure 6. Students acquire a concrete and conceptual understanding of sampling distribution by randomly selecting three weights and calculating and recording their means on the dot plot displayed on the promethean board.

Conclusion and Reflection Stage (20 Minutes)

Teacher Actions

The teacher set the timer on the Promethean board for 20 minutes and randomly asked five students (and allowed three volunteers) to restate the lesson's learning objectives and important discoveries (including the relationship between sample size and variability and why sample size matters in estimating parameters of populations). Three minutes were allocated for this phase.

Students were then informed to return to Question 3 from the introduction section (*Can we trust the results of the exit polls or are the results reliable? Justify your answers using Statistical reasoning and theorems*) and share with the class whether their initial thoughts changed or remained the same. Three minutes were allocated for this phase.

Afterwards, the teacher instructed students to confirm their responses with a simulation of 100 SRSs of sizes 20, 30, and 100 using the applet called Proportion Sampling Distribution Simulator (2025) to simulate Kamala Harris' 48% likely voters Choice of President.

The teacher then instructed students to compare the proportions with sample sizes of 20, 30, and 100 and asked:

- *What sample size is large enough?*

Ten minutes was allocated to this phase.

The teacher then instructed students to write a summary of the lesson using Padlet (Four minutes were allocated for this phase.). The teacher provided sentence stems for students, especially the emergent bilingual students:

1. I understood ….
2. I did not understand ….
3. I need more examples, explanations, and practice on ….

The teacher engaged in reflective practices on the lesson delivery, student engagement, checks for understanding responses, and areas for improvement.

Student Actions

Students simulated the scenario using the applet before attempting to answer Question 3 from the Introduction video on the CNN Presidential Election poll. More specifically, students simulated Kamala Harris' 48% likely voters for Choice for President using 100 SRSs of sizes 20, 30, and 100 (see Figure 7). Students compared the proportions with sample sizes of 20, 30, and 100 and then answered the question "What sample size is large enough?" on their whiteboards.

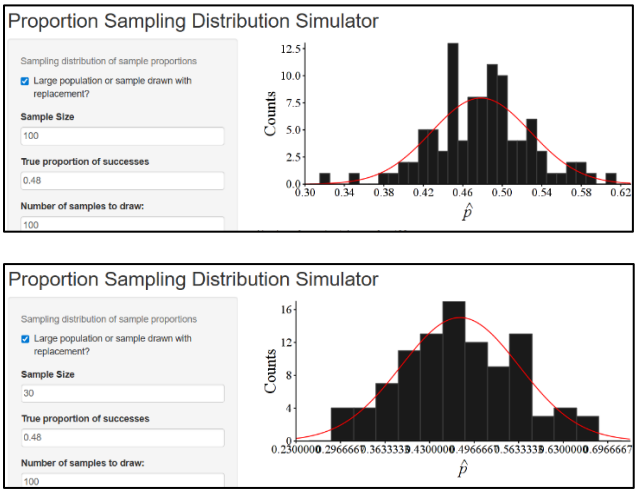

Figure 7. The simulation of the population proportion for the CNN Presidential Elections Exit Poll with sample sizes of 100 and 100 SRSs and 30 and 100 SRSs for Kamala Harris 48% likely voters Choice of President.

Eight students verbally restated the learning objectives and important discoveries (e.g., the relationship between sample size and variability and why sample size matters in calculating statistics of populations). Students reflected on their learning by anonymously stating what they understood well, what they did not understand, and what they needed further practice and explanations on using Padlet.

Critical Reflection

Based on lesson observations, assessment data, and student reflections, the four learning goals of the lesson on Sampling Distribution were met. Most (approximately 80%) of the students understood the relationship among sample size, number of samples taken, variability, Central Limit Theorem (CLT), and Law of Large Numbers in their solutions and reflections. The technology integration and hands-on simulations led to conceptual understanding of the power of random samples in accurately predicting population parameters. Students were able to confirm that the CNN Poll on likely voters for Kamala Harris in North Carolina was accurate based on the simulations. The students concluded that a sample size of at least 30 is sufficient and connected it to the CLT and Law of Large Numbers. The reflections provided rich data that helped explain the quantitative data (assessment scores), which informed targeted instruction for students who scored less than 70%.

The areas of the lesson that went well included sustained active engagement in the learning activities, enthusiastic participation in cooperative and collaborative tasks, students' positive attitudes towards the integration of technology for the simulation exercises, reflective exercises, gamification with Wayground, and the hands-on approach used. To address the 20% of students who got Question 9 incorrectly (misconceptions), higher-order questions would have enhanced students' conceptual understanding on the relationship among sample size, number of samples taken, variability, Central Limit Theorem (CLT), and Law of Large Numbers in their solutions and reflections.

The whiteboards and mini flipcharts were effective tools for gauging students' understanding and identifying misconceptions in the moment so corrective actions could be taken, including. small group, one-on-one, and whole class reteach. A small group reteach was done for five students who were unable to correctly identify the sampling method used in the CNN Poll and the population, parameters, sample, and statistics in the Introduction and Development and Execution stages, respectively. Further, using a timer for each activity kept students on task and maximized instructional and learning time.

The areas of the lesson that can improve include adding higher-order questions (I added Question 11 to the revised DOL Assessment which is a higher-order question that falls into Applying and Analyzing) because most of the questions seem to fall in the Remembering and Understanding stages of Bloom's Taxonomy. Another area for improvement could be strategic pairing of students (high with low performing students) instead of random assignments into groups. This pairing would have allowed opportunities for peer teaching. Research has shown that peer teaching is an effective method to foster student engagement and academic success (Oloo et al., 2016). In addition, based on the time students spent on each question, more time should have been allotted for the assessment so students could carefully read and solve the problems. It was clear that some students rushed through the assessment.

Notwithstanding that fictitious weights were used in the lesson; body weights remain a sensitive issue for teenagers and students might be unwilling or embarrassed to measure and record their actual body weights or even talk about their body weights for fear of being teased or told they are obese or overweight. Therefore, teachers can use height instead to replicate this lesson.

Setting up the classroom with all required materials before students enter the classroom will prevent loss of instructional time because students will be actively engaged from the time they enter classroom. Since not all schools have fully equipped classrooms with the technology and other resources used in this lesson, teachers are encouraged to use the substitutes and alternative materials listed in the material sections. The FETL Model implementation fostered inclusive instruction, meaningful and relevant learning activities, conceptual understanding, reflective practices, and active engagement.

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Building Vocabulary with Canva: Digital Storytelling for 3rd and 4th Grade English Language Learners

JTILT Lesson Competition Winner

Claire Sanderlin, Auburn University at Montgomery

This lesson won the 2025 JTILT Technology-Rich Lesson Plan Competition. It was not peer reviewed.

Overview

This lesson helps 3rd–4th grade English Language Learners (ELLs) build academic vocabulary through digital storytelling using Canva. Students create digital books that integrate visuals, text, and narration, providing authentic contexts for language use. The lesson engages students by allowing them to work collaboratively, create stories, and receive feedback. Canva's multimodal features uniquely support academic vocabulary. Students search images to represent words, type sentences with differentiated frames, and record oral narrations with opportunities for re-recording. This process deepens semantic understanding, builds syntax, and develops oral fluency in academic register, offering support beyond traditional instruction. Assessments like rubrics and peer feedback track progress and improve language skills and digital communication.

Topics: Story Telling, Vocabulary Development, Communication

Time: Three 30-minute in-class sessions.

MATERIALS

- Laptops or tablets with internet access
- Free Canva accounts (instructor sets up class "team" for students)
- Sample Canva Slides
- Projector/interactive whiteboard for modeling
- Headphones with microphones for recording
- Instructor-prepared vocabulary slides/word wall cards
- Assignment rubric

Context-at-a-Glance

Setting
In-person English Language Learner (ELL) pull-out group with 4-6 students in the United States

Modality
Face-to-face

Class Structure
The lesson used a small-group setting with 30-minute sessions. The classroom was arranged for flexible grouping, allowing pairs of students to collaborate on digital storytelling projects.

Organizational Norms
The school emphasizes equitable access to technology and language development, providing laptops, internet access, and professional support for instructors.

Learner Characteristics
Learners included 3rd and 4th grade ELLs with diverse cultural and linguistic backgrounds, with similar WIDA proficiency levels (2.0 - 3.0).

Instructor Characteristics
The instructor, an ELA instructor, was experienced in sheltered instruction and comfortable integrating digital tools into language lessons.

Development Rationale
The lesson was designed to improve vocabulary development, oral fluency, and collaboration through Canva. Backward design (Wiggins & McTighe, 2005) informed its development, ensuring that technology was meaningfully aligned with pedagogy and content.

Setup

To prepare for this lesson, the instructor created a Canva template with 3–5 blank slides, each containing placeholders for an image, sentence frame, and expectation for an audio recording. Figure 1 shows an example of the template students used to complete this project. Providing a template for students reflects principles of cognitive load theory in multimedia learning (Mayer, 2009), reducing cognitive processing so students can focus on vocabulary without being distracted by layout or navigation. Vocabulary visuals and sentence frames were displayed on the classroom word wall and projected at the front, providing extra scaffolding for students.

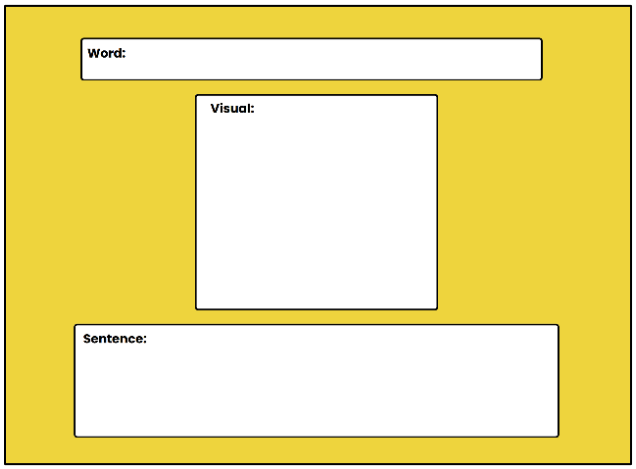

Figure 1. Canva template.

The design also aligns with Backward Design (Wiggins & McTighe, 2005), ensuring that supports and tools directly scaffold the targeted vocabulary objectives. Before the lesson, all devices were charged and connected to the internet in advance. Students were previously taught how to log into a shared Canva classroom space to minimize technical delays, reflecting the importance of advance organizers in instructional planning (Ausubel, 1960). Headphones with microphones were distributed to each pair.

The instructor modeled expectations by presenting a sample Canva mini-book that demonstrated how to insert an image, type a sentence, and record narration, which is an application of the gradual release of responsibility model (Pearson & Gallagher, 1983). The classroom was arranged with flexible seating to support collaboration, emphasizing the social construction of knowledge in line with sociocultural theory (Vygotsky, 1978).

Finally, digital safety and responsible use were discussed to ensure a safe learning environment. These preparations created a structured yet supportive environment, ensuring that learners could engage productively with technology while focusing on their language objectives.

Standards

WIDA ELD Standards (2020)

Language for Social and Instructional Purposes; Language for Language Arts; Key Uses—narrate, inform, explain.

ISTE Standards for Students (2016)

6. Creative Communicator – Students create original works or responsibly repurpose digital resources to express ideas.

CCSS.ELA-Literacy

The following Common Core State Standard also aligns to this lesson: “Vocabulary Acquisition and Use; Speaking and Listening Standards” (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010).

Context and Setting

This learning representation was implemented in a suburban public elementary school in Alabama, where the ELL program serves a growing population of English Language Learners from diverse cultural and linguistic backgrounds. The lesson took place in a small-group pull-out classroom setting, which allowed the instructor to work closely with four to six students in grades 3 and 4. This setting was significant because the smaller class size made it possible to provide differentiated scaffolds and direct support for learners at WIDA levels 2.0 - 3.0. Instruction was conducted face-to-face in 30-minute sessions, with flexible seating arranged for pairs to collaborate on digital projects.

The school context strongly influenced design decisions. The district has invested in equitable technology access, supplying devices and reliable internet connectivity, which made the use of Canva feasible. The district also purchased educational licenses for instructor and student Canva use and collaboration. Organizational norms emphasized both language development and technology integration, aligning with broader district goals of preparing all students for digital literacy. These priorities encouraged the instructor to integrate a creative technology platform that would promote vocabulary development and oral fluency while also building 21st-century communication skills.

The instructor's background also shaped the design. As an experienced ESL instructor with training in sheltered instruction and comfort with digital tools, the instructor was able to scaffold language objectives through visual and audio supports while guiding students in using Canva to represent their learning. Backward design was applied to ensure that technology use was purposeful, aligned with content and language standards, and responsive to the learners' needs. Ultimately, the combination of a supportive organizational culture, diverse learner needs, and available technological resources made Canva a strategic choice for engaging students in multimodal vocabulary practice.

LEARNING REPRESENTATION

DAY 1

INTRODUCTION

The instructor began by introducing 6 target vocabulary words connected to a thematic unit (character traits and emotions). Visuals, realia, and gestures were used to support comprehension. Words were displayed on a word wall and projected for whole-group reference. Students chorally repeated the words and then identified them in pictures, building oral confidence and recognition.

CONTENT PRESENTATION

The instructor modeled the use of Canva by displaying a pre-prepared sample project on the projector. As shown in Figure 2, the demonstration included inserting an image, typing a sentence using a sentence frame, and recording an audio narration of the sentence. The instructor completed this with the students. The instructor highlighted the multimodal supports (text, image, and voice) that helped communicate meaning. This illustrated for students how technology uniquely integrates multimodal vocabulary practice: visuals reinforced meaning, typed text provided written context, and audio recordings built oral fluency. Digital safety expectations were also reviewed, including avoiding personal photos.

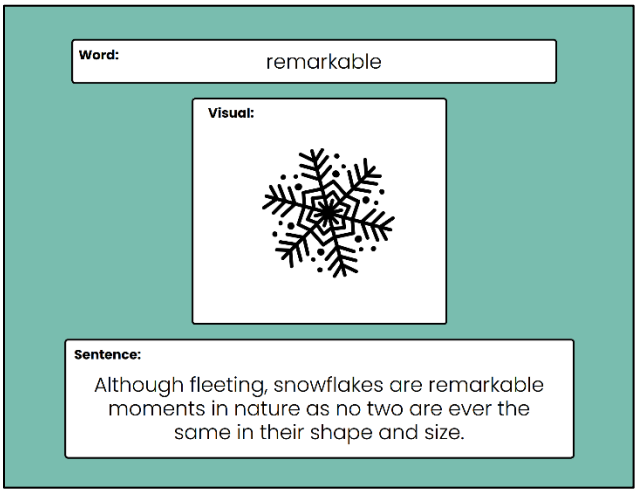

Figure 2. Instructor guided example.

GUIDED PRACTICE

The instructor modeled the Canva project by inserting an image, writing a sentence with a scaffolded frame, and recording narration. This phase reflected *gradual release of responsibility* (Pearson & Gallagher, 1983).

DAYS 2-3

COLLABORATIVE PRACTICE

Students were placed in pairs, combining different proficiency levels for peer support. Pairs created 3–5 Canva slides for target vocabulary words. For each word, students selected or searched for an image within Canva's library that best illustrated the term, typed a sentence using a differentiated frame, and recorded an oral narration. The design process required them to discuss and justify which image

best represented the vocabulary word, encouraging semantic precision. Audio features allowed multiple re-recordings, giving students repeated oral practice with immediate feedback from peers and the instructor. This process leveraged Canva's multimodal features to support vocabulary depth. For example, image selection reinforced conceptual understanding, text production built syntax, and audio recording strengthened oral language. Figure 3 shows how students searched and selected an image to represent the term.

Figure 3. Students selecting an image on Canva.

The instructor circulated, provided individualized support, offered additional sentence starters, assisted with spelling, and encouraged multiple recordings for pronunciation practice. Headphones with microphones allowed ELLs to rehearse without distraction and prepare for ACCESS testing.

DAY 3

ASSESSMENT

Formative assessment occurred as the instructor observed student participation, accuracy of vocabulary use, and oral production during guided and collaborative practice. Each pair's Canva project was reviewed against a rubric/checklist evaluating correct vocabulary usage, completion of slides, and oral narration. Peer assessment was incorporated during sharing, with students identifying vocabulary words they heard in classmates' projects.

EXAMPLES

- Student Example 1
- Student Example 2
- Student Example 3
- Student Example 4

CLOSURE

The class came together, and pairs shared their Canva projects either on the projector or in small groups. Students reflected orally by answering: "What is one new word you learned today?" The instructor recorded responses as anecdotal evidence of learning and uses them to inform future vocabulary instruction.

CRITICAL REFLECTION

This learning representation was implemented twice with small groups of elementary ELL students during pull-out sessions. Each session included 4–6 learners ranging from WIDA Levels 2.0 - 3.0. The lesson was able to meet its intended goals: students successfully used target vocabulary in context, created multimodal slides that paired images with text, and recorded oral narrations. Peer collaboration supported language development, as more proficient students modeled sentence frames and pronunciation for newcomers. The activity also aligned well with the larger instructional context of the ELL program, which emphasizes building academic vocabulary and oral fluency through interactive, student-centered activities.

Several important lessons emerged. First, the Canva template with placeholders was critical. Without it, some students would have struggled with layout and navigation. Second, typing was a barrier for some students, and providing sentence starters along with dictation features reduced frustration. Time management was also a challenge; while most pairs completed three slides, very few finished five, and even fewer had time for narration. In future implementations, I would extend the activity into four

or five sessions or reduce the required number of slides.

Overall, Canva proved to be an engaging tool that supported language objectives and lowered affective barriers by allowing students to re-record their voices. Future modifications could include providing differentiated sentence frames based on proficiency levels, pre-assigning collaborative roles (designer/speaker), and integrating student reflection into the final share-out. This lesson demonstrated high student engagement and oral practice but could benefit from better pacing and typing scaffolds. These reflections will guide improvements to strengthen the activity in future lessons and ensure technology use remains a meaningful support rather than an obstacle.

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About the Author

Claire Sanderlin is an ELL teacher with seven years of experience supporting elementary English Language Learners. Her work focuses on academic vocabulary development, oral fluency, and equitable access to learning through technology integration. Skilled in sheltered instruction and data-informed practice, she designs lessons that embed digital tools to create multimodal pathways for language growth. Claire's professional interests center on advancing ELL achievement through innovative instructional design, Universal Design for Learning, and technology-enhanced collaboration. She may be contacted at csanderl@aum.edu.

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Digital Fingerprints: A Technology-Enhanced Forensic Investigation

JTILT Lesson Competition Winner

Rocky Elmore, Auburn University at Montgomery

This lesson won the 2025 JTILT Technology-Rich Lesson Plan Competition. It was not peer reviewed.

Overview

This forensic science lesson engages 11th – 12th grade students in authentic fingerprint analysis using technology-enhanced collaborative data collection. Students use iPads to capture and analyze fingerprint patterns, first sampling their classroom, then expanding across multiple classrooms to explore how sample size affects data reliability. Through real time collaboration using shared Excel spreadsheets, students aggregate fingerprint pattern distributions, calculate percentages, and evaluate the validity of their findings. This technology-rich experience transforms traditional fingerprinting labs by enabling large-scale data collection and analysis that would be impossible with paper-based methods. Students apply scientific methodology to forensic evidence, assess how sample size impacts conclusions, and develop data literacy skills that are essential for criminal investigations.

Topics: fingerprints, reliability, validity, sample size, percentages, forensic science

Time: Two 86-minute Block Periods

Materials

The following are materials needed for this lesson:

- Fingerprint analysis student handout
- Pencils
- Ink pads
- Hand sanitizer
- Calculators
- Student iPads (with camera access)
- Reference slide presentation
- Student generated shared Excel spreadsheet

Context-at-a-Glance

Setting
Suburban public high school in Alabama, USA.

Modality
Face-to-face

Class Structure
Part 1: single 86-minute block in home classroom.
Part 2: single 86-minute block across eight classrooms for expanded, diverse data collection

Organizational Norms
Students have 1:1 district issued iPads and experience with collaborative learning. Phones and personal devices were recently banned.

Learner Characteristics
Across all sections, approximately 15% were English Language Learners (primarily Spanish), 4 students had 504 plans, and 5 had Individual education plans.

Instructor Characteristics
The instructor is in their tenth year of education, with a background in Physics and Biology. This is their fourth consecutive year teaching all Forensic Science courses. They are comfortable with technology integration and cross-curricular collaboration.

Development Rationale
This activity demonstrates how sample size impacts data reliability and validity. By expanding data collection schoolwide, students experience how larger samples yield more representative results.

Design Framework
Backwards design (Wiggins & McTighe, 2005) integrated with the science and language framework (Lee et al., 2019) based on Next Generation Science standards and constructivist approaches.

Setup

Prior to the lesson, create a shared Excel spreadsheet with columns for finger pattern data (arch, whorl, loop) and share the link with all students through the learning management system, ensuring edit permissions are enabled. An example of how to set up a data table within the shared Excel spreadsheet is provided in Figure 1. Prepare the classroom by setting up three distinct work areas: A fingerprinting station with handouts and pencils, a data entry station with 3-4 iPads logged into the shared spreadsheet, and a reference station where the fingerprint pattern examples are displayed on the main screen. Schedule and confirm classroom visits with participating teachers at least one day in advance, noting available times on the classroom visit checklist. Test all iPads to verify they can access the shared spreadsheet and that cameras function properly for capturing fingerprint images. Place hand sanitizer at the fingerprint station for hygiene between samples. The complete setup takes approximately 30 minutes the day before implementation and 5 minutes the day of the activity to display materials and distribute handouts.

	A	B	C	D
1	Teacher Name:	Loop	Whorl	Arch
2	Number of Students			
3	Total Students in Class			
4	Student Percentage			
5	National Percentage			

Figure 1. Data Table from the Shared Excel Spreadsheet

Standards

Alabama CTE Law, Public Safety, Corrections, and Security (2020)

- CTE20.LPS.FSCS.26 Develop fingerprints and classify characteristics for identification by using distinguishing features.

Context and Setting

This lesson was implemented in a Forensic Science and Criminal Investigation course at a suburban public high school in West Alabama. Students within this school have access to a district issued iPad to complete schoolwork and conduct activities during the school day. A significant portion of the student population is classified as ELL students with Spanish language backgrounds. While these students may have deficiencies in spoken or written English, they demonstrate basic digital literacy skills and are proficient with district-issued iPads used throughout the school day.

The lesson framework adapts the conceptual work of Lee et al., (2019), which synthesized ideas from the Next Generation Science Standards (NGSS) and *A Framework for K-12 Science Education*. This framework argues that both science and language learning have shifted from discrete skill acquisition towards constructivist approaches emphasizing authentic practice and social collaboration. Scientists develop understanding through collaborative efforts; similarly, language learners acquire proficiency through authentic social engagement with peers rather than text-based study alone.

This lesson employs backwards design (Wiggins & McTighe, 2005), beginning with the desired understanding that sample size affects data reliability and validity. Rather than starting with an activity idea, I identified what students should understand, designed assessments to measure that understanding, then created learning experiences to reach those goals. The authentic scientific methodology – where students encounter real investigative challenges – proved central to this idea.

In Part 1, students independently recognized limitations in their classroom only sample. In Part 2, they discovered a critical validity flaw: self-reported fingerprint identifications may be inaccurate. This student-driven problem discovery, emerging from genuine data analysis rather than teacher direction, exemplifies backwards design's power. Students reached the desired understanding through intellectual need, not compliance. This approach served both the forensic science content objectives and the ELL language development goals, as students used scientific terminology to describe problems they had authentically encountered.

The framework informed two critical design decisions. First, ELL students conduct scientific experiments rather than simply reading about them. Secondly, students communicate scientific ideas with peers to learn scientific language within

practical contexts. Both ELL and native English-speaking students practice scientific experimentation and communication – first qualitatively with peers, then quantitatively through data collection and analysis.

The lesson occurs after students complete notes for the fingerprinting analysis unit. Students have been introduced to basic fingerprint pattern terminology but have not yet applied this knowledge through hands-on investigation. The classroom emphasizes collaborative learning and student autonomy, with students accustomed to working in groups and using technology for data collection. Strategic grouping supports ELL students by pairing them with peers who can assist with language needs while maintaining their active participation.

Learning Representation

Learning Objectives

By the end of this lesson, students will:

1. Identify and classify the three basic human fingerprint patterns using proper scientific terminology
2. Conduct a complete scientific investigation including forming questions, following procedures, collecting data, analyzing results, and drawing evidence-based conclusions
3. Explain how sample size affects data reliability and validity
4. Communicate scientific findings both qualitatively and quantitatively
5. Compare experimental results to national averages and explain sources of variation

Part 1: Classroom Data Collection

Fingerprint Collection (40 minutes)

Distribute pages 1-2 of handouts and fingerprint ink pads. The instructor demonstrates proper fingerprinting technique using his own right thumb, circulating to show quality examples. Students create their right thumbprint in the designated box (See Figure 1). Then, they assist each student in identifying their pattern type (loop, whorl, or arch) and have them record it. Once all students are correctly identified, students clean up and return materials.

Data Collection (20 minutes)

The instructor explains that multiple strategies exist for collecting class data and allows student autonomy in determining their method. Students typically progress through individual polling (walking around asking peers), an emergent whole-class strategy (one student leads counting by having peers raise hands for each pattern), and refinement (conducting 2-3 counting cycles for accuracy). Students record class data in their tables.

Analysis & Discussion (26 minutes)

Students calculate class percentages for each fingerprint pattern as a group. The instructor displays national average percentages for comparison. Students complete analysis questions addressing most/least common patterns in class data, comparison between class and national data, and potential explanations for differences. The instructor facilitates a discussion: "How could we improve our data?" Then, the instructor introduces the concept of sample size, explaining that the class represents a small sample compared to national data. Use this discussion to transition to Part 2.

Part 2: Schoolwide Data Collection

Group Formation and Role Assignment (10 minutes)

The instructor divides students into groups of six and distributes handout pages 3-4 to groups. The six roles for data collection are explained: Data Recorder 1 enters data into the shared Excel spreadsheet, Data Recorder 2 assists with data verification, Reference Guides use the presentation for print identification, Pollster 1 asks students to identify their patterns, Pollster 2 assists with counting and verification, and Timekeeper/Navigator manages time and tracks classroom visits.

After discussing objectives and behavioral expectations, groups determine role assignments. The instructor ensures Data Recorders can access the spreadsheet and Reference Guides can access

the presentation. Groups then discuss who will visit each classrooms before hall passes are distributed.

School-Wide Data Collection (60 minutes)

The instructor accompanies groups needing additional support while other groups work independently. Groups visit their assigned classrooms, introduce themselves and the activity, then systematically collect fingerprint pattern data using their designated roles. Students enter teacher names and data into the shared Excel spreadsheet and check which classrooms other groups already visited to avoid duplication. Groups continue visiting classrooms until they complete their assigned list. Figures 2, 3, and 4 depict students going to classrooms to poll their peers and identify their fingerprints.

Figure 2. A group of Chemistry students being counted.

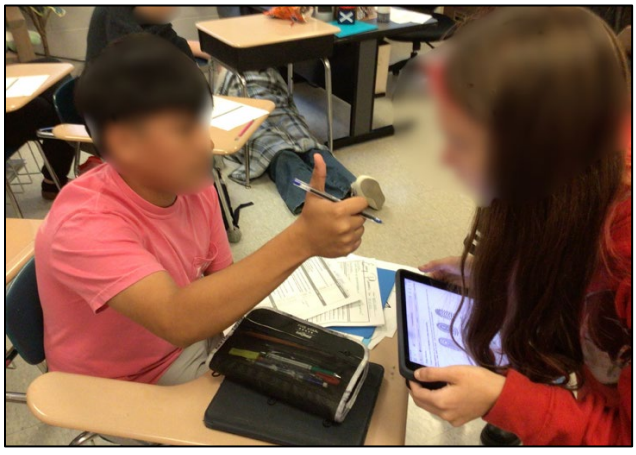

Figure 3. A student inspects the thumb print of another student.

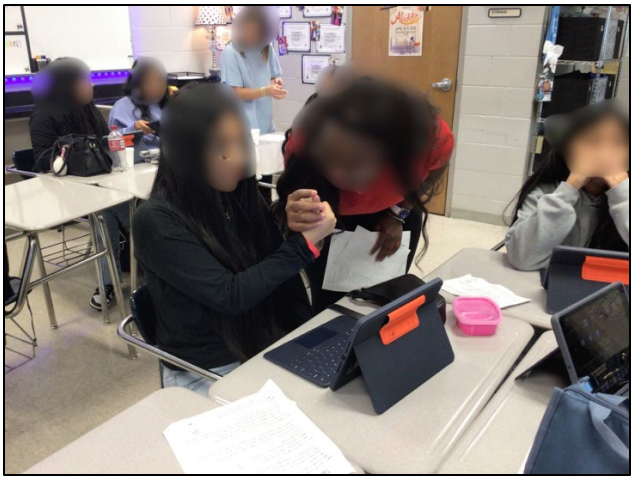

Figure 4. A student inspects the thumbprint of another student.

Analysis and Final Discussion (21 minutes)

All students then return to the forensic science classroom. Working in their groups, students combine individual datasets to calculate new sample totals representing the school-wide data. The instructor reviews the sample size concept (introduced in Part 1) and facilitates discussion about how the expanded sample improved data reliability. Students calculate new percentages and record them on the board for comparison.

The final discussion addresses several key points:

- How Part 1 classroom data compared to Part 2 school-wide data
- How their combined data compared to national averages
- Potential sources of error in their collection methods
- Procedural improvements for future implementations

Students reflect on how increasing sample size affects their results and conclusions.

Assessment

The following endeavors are useful for capturing assessment data:

Formative Assessment

- Observations during fingerprint identification
- Monitoring of data collection strategies and collaboration
- Analysis question responses on handouts
- Participation in discussions about sample size

Summative Assessment

- Data table completion with accurate calculations
- Written responses comparing class, school-wide, and national data
- Evidence-based conclusions about fingerprint pattern distribution
- Demonstration of understanding regarding sample size and reliability

Adaptations

For ELL Students: Strategic grouping with native speakers for language support; visual reference guides (presentation) available throughout; hands-on experiential learning to reduce language barriers; teacher proximity during Part 2 for groups with multiple ELL students; collaborative roles that allow contributions based on strengths.

For Students with Academic/Behavioral Concerns: Teacher accompanies specific groups during Part 2; clear role definitions to provide structure; visual models and demonstrations; multiple opportunities for clarification.

Critical Reflection

This lesson was implemented three times across three different Forensic Science courses. Each implementation revealed insights about student learning, technology integration, and lesson design.

Successes

ELL Student Engagement: Strategic grouping proved highly effective. ELL students successfully communicated scientific concepts with peers and demonstrated understanding through hands-on activities, achieving the Lee et al. (2019) framework goals. Pairing ELL students with supportive peers while maintaining active participation created authentic language learning opportunities.

Experiential Learning: Students authentically experienced how sample size affects data reliability. The transition from classroom-only to school-wide data provided concrete evidence that larger samples produce results closer to national averages—more impactful than lecture-based instruction.

Student Autonomy: Allowing students to determine data collection strategies in Part 1 resulted in creative problem-solving. Students independently discovered that whole-class counting was more efficient than individual polling, demonstrating metacognitive awareness.

Backward Design in Practice

The lesson was structured around the backward design principle of beginning with the end goal: students should understand how sample size influences validity. Every instructional choice, from whole-class data collection to school-wide polling, was intended to make this concept visible. Assessment data, including class discussions and student-generated graphs, confirmed this outcome: students not only articulated why larger samples improve reliability but also critiqued flaws in their own methodology. When students identified inaccuracies in peer self-reporting, they engaged in authentic scientific reasoning, demonstrating that even unexpected challenges reinforced the targeted learning objective.

Challenges and Solutions

Technology Failures (Implementation 2): The shared Excel spreadsheet failed to update in real-time, preventing live coordination. Lesson learned: maintain paper-based backup systems.

Data Validity Concerns: Students noted that self-identified thumbprint patterns could be inaccurate, revealing a fundamental methodological flaw. While problematic, this demonstrated critical scientific thinking.

Network Limitations: Older iPads and high traffic in afternoon classes caused delays. Identifying school-wide device capacity as a constraint emphasized the need for contingency planning.

Future Implementation

Based on student identified concerns, future implementations will shift from self-reporting to iPad photography of thumbprints during classroom visits. Prints will then be classified back in the Forensic Science classroom, improving accuracy while retaining collaborative data collection. Pre-assigned classroom lists, trial runs, and paper backups will mitigate coordination issues, while timing the activity during low-traffic blocks will reduce network strain.

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TechQuest Classroom

TED Design Competition Winner

Crisianee Berry, East Carolina University

This lesson won the 2025 AECT Teacher Education Division PK-12 Lesson Design Competition. It was not peer-reviewed.

Overview

Learners read through a classroom scenario and try to align technology choices with learning theories. Behaviorism, Cognitivism, and Constructivism are the foundational learning theories introduced to preservice educators as they begin exploring learning theory. Using a narrative-based story line, learners test their understanding of how these basic learning theories can use technology tools to support students and learning.

Topics: Technology in Education, Learning Theory

Time: 20 minutes

Materials

- Computer or tablet with internet access
- TechQuest Classroom Genially link

Setup

Classroom setup should only take a few minutes. Students need a device connected to the internet to access the material with a link. Students can interact with the material in groups to discuss choices if desired.

Genially includes a simplified template of the branching scenario. Project development moves quickly if the learner pathways are mapped out before working within the tool. Genially has a free plan available. Paid versions of Genially allow teachers to require a login for students to access the resource and collect data about student use of the resource.

Context-at-a-Glance

Setting
An undergraduate course on technology in education for pre-service PreK-12 teachers at a public university in the Southeastern United States.

Modality
In-person or synchronous

Class Structure
This activity is a 20-minute review. Students meet once a week for 15 weeks. Each class is one hour and forty minutes.

Learner Characteristics
Students in the course represent a range of experience from those who are in their first semester of courses in the college of education to those who are about to graduate to the classroom. Although the culminating project for the course requires basic knowledge of learning theory, not all students have completed courses that cover the topic.

Lesson Rationale
Approaching learning theory and technology integration simultaneously allows preservice teachers to think critically about what applied theory can look like while also developing a better understanding of their own knowledge base.

Technology Rationale
The assessment was created using Genially. The tool allows the use of narrative-based storylines to engage students with real world scenarios that allow students to test their understanding and receive immediate feedback. Genially is a presentation tool that has enhanced interactivity features, such as assessment and gamification tools, which are built into the tool (allowing speedy development of material that is accessible via a shared link). Learners can access the tool and review the material as often as they feel necessary.

Standards and Outcomes

The following International Society for Technology in Education (ISTE) Standards for Students (ISTE, 2016) and for Educators (ISTE, 2017) align with this activity:

ISTE Student

Empowered Learner
1.1.c Feedback to Improve Practice
Students use technology to seek feedback that informs their practice and to demonstrate their learning in a variety of ways.

ISTE Educator

Citizen
2.3.a Create Positive Experiences
Educators create experiences for learners to make positive, socially responsible contributions and build inclusive communities online.

Designer
2.5.b Design Authentic Learning Activities
Educators design authentic learning activities that incorporate technology to advance student outcomes and develop opportunities for students to apply their knowledge.

Analyst
2.7.b Use Tech to Create Assessments
Educators use technology to design and implement a variety of formative and summative assessments that accommodate learner needs, provide timely feedback to students and inform instruction.

Course Learning Outcomes

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

- Identify the three learning theories covered: Behaviorism, Cognitivism, and Constructivism.
- List characteristics of the three learning theories.
- Provide examples of activities supported by each learning theory.
- Select technology tools that support the characteristics and goals of each learning theory.

Learning Representation

The culminating project for preservice teachers in the Technology for Education course is the creation of a video that describes their process for creating a technology-integrated lesson plan. In the video, they introduce the lesson standard and objectives covered, demonstrate the material they have developed for the lesson, and discuss the theoretical foundations that support their choices throughout the lesson. This includes describing the learning theory or theories that are evident throughout the lesson. However, the course focus is on technological aspects and there is little room in the curriculum for teaching learning theory. For this reason, it was critical to design a learning experience that would facilitate student engagement with the material. It was also important that the assessment do more than assess basic declarative knowledge for a grade. The assessment needed to help the students better understand their own knowledge about the topic.

For this reason, a choice-based assessment that positioned basic learning theories within real world technology integration scenarios was created. The use of narratives that describe realistic events provides students with the opportunity to test their ability to apply what they have learned in class. Scenario-based practice promotes critical and higher order thinking skills (Agarwal & Joshi, 2025; Temiz, 2020), the application of existing knowledge to new situations (Temiz, 2020; Wong et al., 2017), and knowledge retention over time (Agarwal & Joshi, 2025; Campanaro et al., 2022), especially when compared to studying traditional education materials (Wong et al., 2017).

The ‘Choose Your Own Adventure’ style question and answer design allows the creation of an assessment that both tests student knowledge and provides opportunity for knowledge improvement. This assessment specifically encourages learners to make multiple attempts while providing guidance for decision making.

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Crisianee Berry is an Assistant Professor in Instructional Technology Education at East Carolina University. Her background includes K-12 classrooms, instructional design in industry, and medical curriculum development. Her research areas include emerging educational technologies, currently practical application of AI in teaching and learning, educational gaming, and professional development.

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