

Designing Collaborative Tech-Rich Learning: Building a Multi-Player Game Controller with Makey Makeys



Nate Turcotte, Florida Gulf Coast University

This lesson won the 2023 JTILT Lesson Plan Competition and was peer-reviewed.

LESSON OVERVIEW

This lesson challenges learners to consider the educational benefits of using games to support teaching and learning practices through a Makey Makey design challenge. A Makey Makey is a digital toolkit that creates a closed-loop circuit by connecting alligator clips to conductive materials. I introduce the Makey Makey during a unit exploring the use of gaming technologies in PK-12 classrooms. During this lesson, groups of learners use a Makey Makey to build a multi-player game controller. This article describes a lesson that has been successfully integrated with undergraduate students in an Introduction to Technology in Education course and with middle and high school students.

Topics: Design Challenges, Digital Toolkit, 21st Century Skills, Do It Yourself, and Making

Time: One 75-minute class session.

MATERIALS

- [Makey Makey digital toolkits](#) (1 per group).
- Internet-enabled computer with a USB port.
- USB to USB-C adapter, in the event a student's computer does not have a USB port.
- Conductive materials (e.g., Play-Doh, Banana, Aluminum Foil, and so forth).
- [Makey Makey Introduction Video](#) (Silver, 2012).
- Access to Game websites (e.g., [EdShelf](#), [STEAM](#), [Scratch](#)).
- The [Game Search Template](#).

CONTEXT-AT-A-GLANCE

Setting

An undergraduate Introduction to Technology in Education course at a large university in the United States.

Class Structure

The class met twice a week for 75 minutes per meeting. Students completed the activity in small groups of 3-5.

Organizational Norms

This course prepares future educators to be successful users of technology and is required for all students enrolled in an education major.

Instructor Characteristics

The educator for this course received a Ph.D. in Learning, Design, and Technology and has expertise in educational technology and instructional design.

Development Rationale

Although a significant amount of research indicates the value that video games have for education and teaching and learning practices (e.g., Engerman et al., 2020; Squire, 2003; Turcotte et al., 2018), playing video games is often viewed as an isolated endeavor by students in the course. As such, this lesson introduced Makey Makey as a technology that shifts the act of playing a video game to a more collaborative endeavor.

Design Framework

Active learning strategies were leveraged to provide an environment for students to tinker, experiment, and problem-solve.

STANDARDS

This lesson addresses the following course learning objective: Students will Demonstrate the ability to develop and present educational technology projects using a variety of software programs and platforms. Additionally, the International Society for Technology in Education Educator standards (ISTE, 2017) and the Florida Educator Accomplished Practices standards (Florida Department of Education, 2023) were utilized in this lesson. Specifically:

ISTE STANDARDS FOR EDUCATORS

2.4.b Collaborate and co-learn with students to discover and use digital resources and diagnose and troubleshoot technology issues (ISTE, 2017).

THE FLORIDA EDUCATOR ACCOMPLISHED PRACTICES (FEAPs) STANDARDS:

1.f. The effective educator: develops learning experiences that require students to demonstrate a variety of applicable skills and competencies.

3.a. The effective educator: deliver[s] engaging and challenging lessons (Florida Department of Education, 2023).

CONTEXT AND SETTING

The lesson described in this article targets pre-service educators in an undergraduate Introduction to Technology in Education course. Although students from all majors can enroll in this course, students in the Teacher Education and Child and Youth Studies Programs in the College of Education make up most of the enrolled students. College of Education students typically take this course before being officially accepted into their education major.

To promote active learning, this course is designed and modeled similarly to a flipped classroom approach. As such, course content is distributed and attended to online using the course management system, Canvas, where students are tasked with reviewing content, including course readings and videos, and writing brief reflections on their understanding of weekly content before coming to class. Class time is spent discussing weekly content,

including students' interpretations of concepts and ideas, as well as engaging with relevant technology. The first class of the week is typically spent engaging in small-group and whole-class discussions, while the second class period is spent examining and applying a wide range of technologies in a workshop format. As a result, the nature of the course naturally reflects active learning strategies where learners use existing knowledge to "connect it to new information, and reconstruct that knowledge," a characteristic of flipped classrooms (Mori, 2018, p. 107).

Further, since students can review and familiarize themselves with course content and concepts prior to class, class time lends itself to more student-centered and student-led learning experiences. Petress (2008) describes active learning as a process that envisions students as partners in the learning process. In turn, I employ pedagogical strategies that provide students with autonomy in the direction of their learning engagement and activities that include group work, collaborative problem-solving, and experiential learning that can support students' active engagement in their learning (Anthony, 1996).

This lesson falls immediately after two, one-week modules where students explore Makerspaces and the DIY movement and the use of video games to support learning. Given the breadth of topics covered in this course, students spend a week exploring general applications of video games for their future classroom. However, throughout the remainder of the semester, students continue to reflect on how a wide range of technologies can support teaching and learning, which includes returning to concepts and games that were initially discussed earlier in the semester. In my experience teaching this course, students frequently mention a concern that gaming can be an isolated learning experience. This concern contradicts the pedagogical approaches that encourage collaborative learning and the philosophies of teaching and learning that students are exposed to in this course. As a result, this lesson leverages both the ethos of "making" and students' interests in video games to have students create a game controller that can support collaborative learning and active engagement.

During the class preceding the described lesson, students explore and discuss the relevance of commercial (e.g., Minecraft) and educational games for use in their future classroom. At the start of the class, students watch Carr-Chellman's (2010) Gaming to Re-engage Boys in Learning TED Talk and

Steinkuehler's (2013) discussion of how games impact students' interest and engagement in formal schooling practices. After watching the videos, students engage in class discussions where they consider how video games could be integrated into their future classroom. Next, students explore popular educational game sites such as Common Sense Media and EdShelf to locate games that could apply to their future classrooms. They also fill out the [Game Search Template](#). This template provides students an opportunity to find a game that they believe to be relevant for their future classroom, but also justify and discuss that relevance, generating a games-resource database that students maintain and add to throughout the semester. Using this document, the class engages in discussions focused on the games that students identify and how these games can support learning. In the class session that follows, students engage in the following activity:

LEARNING REPRESENTATION

ACTIVITY OVERVIEW

PART 1: ACTIVITY INTRODUCTION (5-10 MINUTES)

To begin the activity, I introduce the Makey Makey (see Figure 1) and describe it as a Digital Toolkit that can connect to any conductive material. This discussion is relatively straightforward, and I typically just show the Makey Makey to the class. Next, I show a short YouTube video that introduces the Makey Makey, how it originated, and its creators (Silver, 2012). I then demonstrate how to connect the Makey Makey to a computer and describe how it replaces the keyboard and mouse through a closed-loop circuit system.

Every class that has participated in this lesson is different; however, I often find that I can provide a very short overview, which includes showing students the video above and tasking them with building a game controller that replaces the need for their computer keyboard, with minimal direct instruction. Essentially, what motivates students to engage in this learning experience is the design challenge itself and how it is structured, particularly, the significant agency students have in their attempts to address

the challenge while I facilitate their understanding of how to hook up the toolkit. When I have delivered this lesson to younger students in the past, I have detailed the main parts of the Makey Makey, including its interface, how alligator clips connect to the circuit board, and how to connect the Makey Makey to a computer. However, I have found this information to be unnecessary with older students.

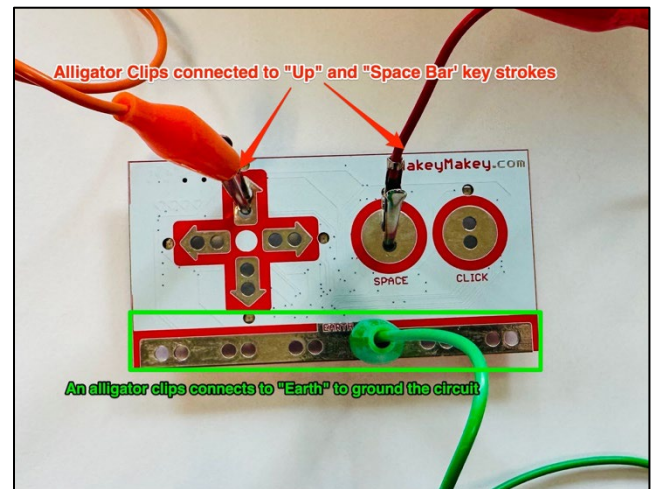


Figure 1. Makey Makey with Alligator Clips

PART 2: LEARNING HOW TO CONNECT A MAKEY MAKEY TO A COMPUTER (5-10 MINUTES)

After Makey Makeys are distributed to each student group and properly connected to their respective computers, students attempt to figure out how to connect the alligator clips and get their Makey Makey to function. If connected correctly, students should notice that a green light will appear above the respective button or arrow indicators that the alligator clip is connected to on the toolkit. Depending on time, class size, and learner ability, this step can also be demonstrated by the teacher.

Students' ability to self-regulate their learning along with their technology confidence ultimately affects how much autonomy I provide in these first two steps. However, I consistently find that my undergraduate students (and even high school students) can connect the Makey Makey to their computers and alligator clips with relatively little intervention. In most cases, the only intervention I need to do is to show students how to "ground" their Makey Makey so that it functions properly.

Additionally, due to our recent exploration of the Maker Movement, I position myself as a facilitator during this class session by encouraging students to “tinker” with the Makey Makey, using the resources they have on hand, including their personal internet-connected devices, to figure out how to operate the technology. At times, this includes encouraging students to search for “how-to” videos, resources, and troubleshooting guides. By default, the nature of this experience encourages students to be problem-solvers, especially when figuring out how to “close the circuit.” During this process, I provide students with a significant amount of autonomy, while also monitoring their progress and serving as a guide (if needed), since this lesson is not focused on the science involved with circuits and circuitry and is more interested in positioning students as problem-solvers, designers, and collaborators.

TEACHER CHECKPOINTS

- With younger students, it is recommended to provide a tutorial to students about connecting the alligator clips and ensuring that the connections function properly or work directly with the students to help them get connected.
- With more advanced students, the educator can be available for help if needed, but can also provide the learners with the agency and space to tinker with the toolkit.
- Students should notice that they need to be “grounded” to complete the closed loop circuit. This requires one end of an alligator clip to be connected to the bottom of the Makey Makey where it is labeled “earth” and the other end of the alligator clip to either be held by the student or connected to a conductive object (e.g., Play-Doh) that a student can either hold or touch.
- Students can check to see if their Makey Makey is set up properly by using their free hand (not connected to the grounded alligator clip) to touch the directional arrows on the Makey Makey. If connected properly, the arrows will light up green.

PART 3: DESIGN CHALLENGE: CREATING A GAME CONTROLLER (15-20 MINUTES)

Once the Makey Makey is connected correctly, I prompt student teams to build a game controller. More specifically, I ask students to build a game controller that can be used to replace their keyboard. Students can use the websites listed in the Materials

section to locate a game, but I initially prompt them to find a game that only requires the use of directional arrows or mouse clicks to play. However, I do not limit students to games labeled as “educational.” For example, Super Mario Bros., Pacman, and Flappy Bird are good games to start with because they require directional arrows or mouse clicks and are easy to figure out how to play.

To create their game controller, student teams are encouraged to bring items to class that they believe are conductive, including jewelry, food, and other “everyday” objects, like pencils. Students are also provided with Play-Doh, Conductive Tape (Aluminum Foil can also be used), and Conductive Thread. Through a process of trial and error, students determine which items are conductive by whether they get the corresponding green lights to show on the toolkit as they engage with an object that is connected to the opposite end of the alligator clip.

While students determine what objects they will use, I prompt them to consider the functionality of their designs. For example, if using Play-Doh, and playing a game that requires directional arrows, I encourage students to layout the Play-Doh and connect to it in a manner that resembles the typical D-pad direction control design found on popular game controllers.

TEACHER CHECKPOINTS

- Once “grounded” a student can connect one end of another alligator clip to any of the directional keys or mouse buttons and the other end to a conductive item. While grounded, the student can then use their other hand to make the keystrokes or mouse clicks function.
- A controller can be as simple as physically touching the opposite ends of the alligator clips connected to the Makey Makey. However, students should be encouraged to connect these ends to the conductive materials provided.

PART 4: DESIGN CHALLENGE : DESIGN A COLLABORATIVE CONTROLLER (20-25 MINUTES)

Once students have developed a controller and have successfully used it to play a game, I prompt them to design a controller that allows each one of their group members to play the game simultaneously. Depending on the complexity of the game, this



Figure 2. Examples of student-created collaborative game controllers for Temple Run, Dance Dance Revolution, and Frogger.

typically results in individual learners taking responsibility of specific controller functions or keystrokes, such as the “right-arrow” or mouse click. This part of the learning experience, in particular, is what makes this learning representation unique. For instance, there are online resources that show students designing and developing controllers from their Makey Makeys. However, there are few examples of users creating joint controllers that involve three to five people to play a game.

During this part of the process, the learners must expand on their initial designs to include each group member at their table. As a result, the “scale” of their controller typically grows. Students should have enough alligator clips to accommodate this increase in scale and the ability to move around their tables. To facilitate this, I encourage learners to use multiple alligator clips connected together. I also prompt them to consider how they might arrange their bodies (and controller parts) so they can simultaneously view and play the game (see Figure 2).

Depending on the confidence and skill level of the group, I encourage students to find a game that requires significant communication and teamwork (e.g., Temple Run, Pac-Man, or Minecraft). A frequent challenge that arises during this step is ensuring that all group members are part of the closed circuit. Students might use one hand for their respective keystroke, while their other hand touches a conductive object shared among group members. Note: a long piece of conductive tape connected to the grounded wire can accomplish this task.

TEACHER CHECKPOINTS

- Students should be reminded that they all need to become part of the closed circuit for their design to be considered a success.
- Students should be encouraged to experiment with materials to find a conductive resource to close their circuit (e.g., jewelry, watches, food, pencil lead, water, etc.).
- If a game requires more keystrokes, turn the Makey Makey over and connect to the ports on the back.

PART 5: GAME CONTROLLER PRESENTATION (15+ MINS, BASED ON GROUP NUMBERS)

After students have had sufficient time to test their collaborative controller, they share their controller designs and discuss their development process with the class. During their share-out, students are prompted to discuss their design choices, including their process for designing the controller, the inspiration for their design, and the skills they found necessary to build and test their controller.

Depending on class size, while student groups are presenting, other groups can visit the presenters’ table and see the controller they built in a “gallery-walk” format.

CRITICAL REFLECTION

I developed this learning representation over five years ago when I was invited to provide a workshop for high school students about emerging technologies and how they can support unique forms of learning. Since then, I have provided similar workshops and lessons for elementary students, teachers, higher education faculty, and college-aged students. Moreover, I have used this learning representation for the last two years in my residential *Introduction to Technology in Education* course.

Although *the course* is designed around several learning objectives and student outcomes, one of my personal goals for students is for them to become more confident and comfortable with technology while considering how it can support collaborative learning. When entering my course, many students conceptualize teaching and learning as a teacher directed and controlled endeavor. This conceptualization may be based on their personal experiences and lack of familiarity with more progressive educational philosophies and teaching methods. So, throughout the semester, I model and teach students about learner-centered forms of pedagogy and design, often relying on constructivist methods. As a result, I often find that when students reflect on this activity (both during their “presentation” and on more formal reflections throughout the semester), they look back positively on the experience and find it as one where they had significant agency and control. In turn, this frequently led students to consider how they can provide similar active learning experiences for their future students.

I have found that parts 1-3 of the activity can be adjusted depending on students’ age, needs, and experience levels. With older students, once they understand how to connect the alligator clips to make the toolkit functional, brainstorming to design their game controller quickly follows. However, helping students understand how they can all be part of the closed-loop circuit often takes guidance and experimentation (e.g., students will hold hands and have one group member operate the controller). As a result, I prompt students to not only address this challenge, but also to share materials they know to be conductive among group members. Moreover, I have found this lesson to be widely applicable to a range of content areas and age levels and can be scaled accordingly to the needs of the students.

Significantly, I find that the most beneficial aspect of this lesson is its ability to position learners as collaborators, leaders, problem-solvers, and critical thinkers. Additionally, this lesson provides an opportunity for pre-service educators to reflect on how they can adopt technology in their classroom to support their students’ active learning and development of 21st-century skills.

Furthermore, my pedagogical approach and philosophy provide students with significant autonomy and voice in their learning experience. As such, there is no formal assessment given to students at the end of this activity. Instead, the act of completing the design challenge is the assessment. Yet, the lack of formal assessment does not imply a lack of student expectations. I expect students to engage with their group members and the design challenge, experiment with the Makey Makey, and provide a working solution to the design challenges. After design challenge completion, students are prompted to reflect on their experience (e.g., How would you describe your learning in this experience? What problems did you encounter? How would you describe the nature of your group engagement?) and share what they learned. In general, I have not found a need to set strict expectations or guidelines for this activity; students are intrinsically motivated to actively engage in the experience. However, if needed, a teacher could adapt this learning representation to include formal expectations (e.g., engaging respectfully with group members, actively contributing to the design of the controller, using at least 3 different conductive materials in a design). They might also develop a formal assessment and rubric associated with student effort, quality of design, and depth of reflection through a variety of modes (e.g., essay, video, podcast).

Setting this experience up as a design challenge, where I act as a facilitator, positions students as active learners in this technology-rich experience. It also fosters forms of reflection that encourage pre-service educators to consider how they can design technology-rich classroom activities for their future students and encourage collaborative forms of learning. As a result, students recognize how the collaborative nature of this challenge engaged their interests and motivated their learning. This experience may also encourage pre-service educators to reflect on previous technology-based activities that they have completed and consider how they might redesign them to encourage more collaborative elements.

REFERENCES

- Anthony, G. (1996). Active learning in a constructivist framework. *Educational Studies in Mathematics*, 31(4), 349–369.
<https://doi.org/10.1007/BF00369153>
- Carr-Chellman, A. A. (2010, October). *Gaming to re-engage boys in learning* [Video]. TED.
https://www.ted.com/talks/ali_carr_chellman_gaming_to_re_engage_boys_in_learning
- Engerman, J. A., Hein, R., Turcotte, N., & Carr-Chellman, A. (2020). Digital literacy practices for a gaming generation: “COTS lessons from adolescent gamers. In S. Witte, A. Garcia & J. N. Wyld (Eds), *Playing in the classroom: Games, literacies, and youth culture in the 21st Century*. Sense Publishing.
- Florida Department of Education. (2023). *The Florida Educator Accomplished Practices (FEAPS)*. Retrieved January 18, 2024 from <https://www.fldoe.org/teaching/professional-dev/the-fl-educator-accomplished-practices.shtml>
- International Society for Technology in Education. (2017). *ISTE Standards: For Educators*. Retrieved January 18, 2024 from <https://iste.org/standards/educators>
- Mori, T. (2018). The flipped classroom: An instructional framework for promotion of active learning. In K. Matsushita (Ed.), *Deep active learning: Toward greater depth in university education* (pp. 95-109). Springer Nature Singapore.
- Petress, K. (2008). What Is meant by “active learning?” *Education (Chula Vista)*, 128(4), 566-569.
- Silver, J. (2012, May 14). *Makey Makey – An invention kit for everyone* [Video]. Youtube.
<https://youtu.be/rfQqh7iCcOU?feature=shared>
- Squire, K. (2003). Video games in education. *International Journal of Intelligent Games & Simulation*, 2(1), 49–62.
- Steinkuehler, C. (2013, April 16). *Constance Steinkuehler on interest-driven learning (Big Thinkers series)*. Edutopia. Retrieved January 18, 2024 from <https://www.edutopia.org/video/constance-steinkuehler-interest-driven-learning-big-thinkers-series>
- Turcotte, N., Hein, R., & Engerman, J. A. (2018). Strategies for adopting games-based lessons in the K-12 classroom. *PAECT Technology Education Research Journal*, 1(1), 324-341.

ABOUT THE AUTHOR

Nate Turcotte (He/Him) is an Assistant Professor in the College of Education at Florida Gulf Coast University. He studies technology-rich forms of teaching and learning across formal and informal learning settings. He teaches undergraduate pre-service educators how to examine and evaluate technology for educational purposes. He also teaches graduate courses in educational technology and design.

SHARING & MODIFICATION PERMISSIONS

Unless otherwise noted, this article and its resources are published under a [Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International license](https://creativecommons.org/licenses/by-nc-sa/4.0/):



You can freely share the article and its resources if you indicate the original authors, identify the Creative Commons license, and use them non-commercially.

You may also make and share modifications by:

- [Identifying the original authors](#).
- Using the resources non-commercially.
- Licensing modifications under the CC BY-NC-SA 4.0 license (and including a link to it).
- Indicating what modifications were made.