writing standards-based lesson plans

to *Standards for Technological and Engineering Literacy*

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Introduction

While written lesson plans may seem like a lot of work, with little purpose or benefit to new teachers, a well-written lesson plan is quite valuable for many reasons. The process of writing lesson plans at the beginning of one's teaching career can be very time-consuming (Arnett-Hartwick and Cannon, 2019); however, the development of sequenced lessons that result in effective learning must be organized and articulate, not done haphazardly. Designing a lesson through a written document can help a teacher see the pattern, flow, and implications of a lesson and how it will help all students; this can be especially true when considering the needs of exceptional and English or Exceptional Language Learners. Further, stakeholders within the school system (principal, curriculum director, department head, and district supervisor) may require written units and weekly or even daily lesson plans for the purposes of teacher evaluation, feedback, accountability, or in-service training.

With the release of *Standards for Technological and Engineering Literacy* (*STEL*) by ITEEA in 2020, curriculum developers have new tools to use when developing curriculum and lesson plans in technology and engineering contexts. While there are many different formats of written lesson plans, they all have one purpose: to describe how to get students from point A to point B on the learning curve. The art of writing lessons and curricula has evolved over the years, with many educational theorists impacting the conversation around what, when, how, and why elements should,

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or should not, be included. One theorist, Charlotte Danielson, has contributed significantly and has been widely embraced in the curriculum professional development world of education (King and Watson, 2010). In this article Danielson's *Framework for Teaching* (2007) and the backwards design curriculum development model will provide both the structure and rationale for developing standards-based lesson plans with the newly released *STEL*.

Danielson's *Framework for Teaching*

Used as one of the selected instructional models by the Bill and Melinda Gates Foundation in a large-scale 2011 study (Danielson, 2013), *Framework for Teaching* is utilized by school districts across the country primarily for the purpose of teacher and program evaluation. New York, Pennsylvania, and Florida are just a few of the larger states utilizing Danielson in teacher education and evaluation (Viviano, 2012). The framework is organized into four domains and eight criterion that outline the practices of effective teaching. The four domains, which separate different aspects of a teacher's day-to-day responsibilities, are planning and preparation, the classroom environment, instruction, and professional responsibilities. In addition to these domain categorizers, there are eight criteria provided, which serve as standards for assessing teaching expertise. These include:

1. Centering instruction on high expectations for student achievement.
2. Demonstrating effective teaching practices.
3. Recognizing individual student learning needs and developing strategies to address those needs.
4. Providing clear and intentional focus on subject matter content and curriculum.
5. Fostering and managing a safe, positive learning environment.
6. Using multiple student data and elements to modify instruction and improve student learning.
7. Communicating and collaborating with parents and the school community.
8. Exhibiting collaborative and collegial practices focused on improving instructional practice and student learning.

Each of the eight criterion is also accompanied by several benchmarks that provide an example for teaching evaluation. The rationale for this article is based on developing *STEL*-based curriculum and lesson plans with benchmarks that span three of the four domains and four of the eight criteria in the Danielson Framework (Table 1). These benchmarks were chosen for their connection to standards-based curriculum development through the applications of creating critical-thinking questions, linking course content to content standards, setting appropriate course outcomes through assessments of standards, and forming links in coursework to other academic standards. particularly in the content of STEM. The Danielson *Framework*, based on a constructivist view of education (Viviano, 2012), aligns with development of curriculum for technology and engineering. With both the rationale (Danielson's *Framework for Excellent Teaching*) and tools (*STEL*) for excellence in technology and engineering curricular development, the release of *STEL* represents a prime opportunity for teachers, new and seasoned, to evaluate their curricular planning effectiveness and identify ways to improve their efforts.

Table 1. Danielson Benchmarks and Criterion linked to Standards-Based Curriculum Development

Criterion	Domain	Benchmark
2. Demonstrating effective teaching practices	3. Instruction	3b. Using Questioning and Discussion Techniques
4. Providing clear and intentional focus on subject matter content and curriculum	1. Planning and Preparation	1a. Demonstrating Knowledge of Content and Pedagogy
4. Providing clear and intentional focus on subject matter content and curriculum	1. Planning and Preparation	1c. Setting Instructional Outcomes
6. Using multiple student data and elements to modify instruction and improve student learning	1. Planning and Preparation	1f. Designing Student Assessments
8. Exhibiting collaborative and collegial practices focused on improving instructional practice and student learning	4. Professional Responsibilities	4d. Participating in a Professional Community

Backwards Design

Further supporting the emphasis placed on standards-based lesson plan development, teachers and curriculum developers can refer to the backwards-design process published in 1998 by Grant Wiggins and Jay McTighe in *Understanding by Design* (Wiggins, & McTighe, 1998). Prior to this book, curriculum design was largely based on topics to be covered. Once topics were identified, the lesson activities were then planned, and exams written. In this approach, the connection between lessons, activities, exams, and standards was usually less well-defined; in many instances the standards connections may have been added as an afterthought.

Understanding by Design and the standards movement worked together to overturn this approach to curriculum design. Wiggins and McTighe's book did this by making a case for a radical new way of designing curriculum: pick the standards and essential questions first, design the assessment to match those performance objectives and standards, and finally, design the lesson activity—an approach that became known as backwards design. This new process was very different for technology and engineering instructors, who often based curriculum design on the equipment and consumables they had in their lab or what had been taught for the last 30 years. Wiggins and McTighe published a second edition in 2005, along with many additional resources. Utilized widely across the United States and internationally, *Understanding by Design* had been widely used as the framework for in-service training and professional development workshops, making it still as important, current, and viable as when it was first published (Dack, Merlin-Knoblich, 2019).

6E Format

The 6E lesson-planning approach used by ITEEA was derived from the 5E instructional model developed by Biological Sciences Curriculum Study (BSCS) (Bybee et al, 2006). The BSCS approach, which is based on a constructivist paradigm to educational planning, includes the steps: (1) *Engage*, (2) *Explore*, (3) *Explain*, (4) *Elaborate*, and (5) *Evaluate*. This approach places students at the center of the learning experience as they construct meaning from experiences, questions, and opportunities presented to them (Bybee, 1997). In 2014, ITEEA's STEM CTL™ proposed a 6E approach to lesson planning that revolved around the premise of "develop[ing] a student-centered model that would blend design (context and concepts) and inquiry." In a 6E approach to instructional design the steps to learning include: (1) *Engage*, (2) *Explore*, (3) *Explain*, **(4) *eNGINEER***, (5) *Enrich*, and (6) *Evaluate*.

- ***Engage*** marks the beginning of a learning opportunity with the express goal of piquing student interest and evaluating prior/current knowledge. Showing a video of artificial intelligence (AI) machine learning at work or demonstrating a sensor-activated switch may accomplish such a task.
- In the next phase, ***Explore***, the students construct their own understanding of the topic individually or in teams as they prepare to move to the next stage. Providing students with relevant hands-on materials for exploration, brainstorming, and experimentation is key, as students will need access to tools for constructing understanding and meaning of the topic at hand.
- Step three—***Explain***—provides the students and teacher an opportunity to identify what has already been learned, correct any misconceptions, and make plans for learning what still needs to be addressed. This step often signifies a more formal "learning" experience, as traditional lessons, presentations, readings, or other resources are used to ensure that a current comprehension of the required material has been reached.
- In Step four the "***eNGINEER***" is intentionally written as such (lower case "e") to denote actions of engineering and not necessarily the occupation of Engineer. These actions include designing, modeling, building, and testing as part of the overall problem-solving process. In a traditional "design challenge" lesson this is the stage at which students model and build their proposed solution to the problem. An emphasis on modeling, prediction, and analysis—above and beyond a simple "guess and check approach" will improve the experience of students and take this step towards a more robust experience.

- Step five—*Enrich*—is an opportunity for students to transfer what they learned to new situations, scenarios, and applications. For example, concepts touched upon during the *Explore* and *Explain* stages could be applied to the task at hand or other similar scenarios during which students must transfer their understanding of one idea to another setting.
- Step six is ***Evaluate***. This step, although located at the conclusion of the process, should really occur throughout. Formative assessment, evaluation, and learning must happen all along the learning journey as students self-evaluate, perform peer evaluations, and submit work for formal assessment and evaluation by teachers.

The 6E approach to lesson planning is not designed to be rigid or prescriptive; rather, this systematic approach to instructional design represents one method with proven success among teachers and students. Teachers may find it useful to use this approach, in tandem with *STEL*, to ensure that students are engaged, standards are met, objectives accomplished, and classroom experiences are positive and truly integrated.

Standards

Since the publishing of *A Nation at Risk* (1983), the U.S. has been focused on creating and disseminating national content standards to accomplish the goal of making schools and teachers accountable for student learning. In reading *A Nation at Risk*, one sees the imprint of the business community, as the initial push for standards and competencies in high school graduates was focused on employability and helping the U.S. stay economically strong. Over time, the business focus shifted to a push to make all high school graduates ready for college through academic preparation. This goal evolved more recently to accommodate both perspectives through college and career readiness. The content areas of mathematics, science, English, and social studies were the first to develop national content standards, some of which were controversial when developed. The field of technology education began developing its own national content standards with the Technology for All Americans Project in 1996.

Standards for Technological and Engineering Literacy

Table 2. *Standards for Technological and Engineering Literacy*

Core Disciplinary Standards	1.	Nature and Characteristics of Technology and Engineering
	2.	Core Concepts of Technology and Engineering
	3.	Integration of Knowledge, Technologies, and Practices
	4.	Impacts of Technology
	5.	Influence of Society on Technological Development
	6.	History of Technology
	7.	Design in Technology and Engineering Education
	8.	Applying, Maintaining, and Assessing Technological Products and Systems
Practices	1.	Systems Thinking
	2.	Creativity
	3.	Making and Doing
	4.	Critical Thinking
	5.	Optimism
	6.	Collaboration
	7.	Communication
	8.	Attention to Ethics
Contexts	1.	Computation, Automation, Artificial Intelligence, and Robotics
	2.	Material Conversion and Processing
	3.	Transportation and Logistics
	4.	Energy and Power
	5.	Information and Communication
	6.	The Built Environment
	7.	Medical and Health-Related Technologies
	8.	Agricultural and Biological Technologies

The International Technology Education Association (ITEA/ITEEA) released *Standards for Technological Literacy* in 2000 as the first set of national content standards for the field of technology education. Nearly two decades later, leaders within ITEEA and its Council on Technology and Engineering Teacher Education convened 38 educators and industry representatives to develop a completely revised set of content standards, which resulted in the publishing of *Standards for Technological and Engineering Literacy: The Role of Technology and Engineering in STEM Education* (ITEEA, 2020). Key highlights of the revision include a reduction in the number of core disciplinary standards from 20 down to eight and benchmarks from 288 down to 142. These changes intended to change the standards from being "a mile wide and an inch deep" towards a set of core disciplinary standards and benchmarks that clearly define technology and engineering education and provide a useful resource to classroom teachers and curriculum developers (Loveland, Love, Wilkerson and Simmons, 2020; Reed, 2018).

In addition to the core standards, eight sets of practices and eight sets of contexts were identified (Table 2). According to ITEEA (2020), practices are "a student-centered set of practices that reflect the knowledge, skills, and dispositions students need in order to successfully apply the core disciplinary standards in the different context areas" (p. 11). The eight contexts reflect the eight major settings where the *STEL* benchmarks can be taught, but this does not always imply a specific technology and engineering course. The *STEL* standards, practices, and contexts should be identified in the development of standards-based lesson plans.

Using *STEL* to Develop Lesson Plans

Based on the backwards-design model, a technology education teacher would first consider the big idea and enduring understandings the lesson should provide. They would then identify which *STEL* standards and benchmarks they need to teach in their course. By directly referring to *STEL* (ITEEA, 2020) or viewing the ITEEA *STEL* website (www.iteea.org/STEL.aspx), they would select the core standards and then look to the grade band benchmarks to find the age- and content-specific benchmarks to choose from. For example, a high school technology and engineering teacher may want to teach about the history of technology. They would have a choice within *STEL* 6, History of Technology, of five benchmarks (#6F-6J). In this case, the teacher chose 6F: *Relate how technological development has been evolutionary, often the result of a series of refinements to basic inventions or technological knowledge.*

The next strategy of backwards design would be to identify or develop an assessment strategy for the standard being taught. ITEEA has made this step easier through the publication of a matrix indicating the domain, T & E dimension, and Bloom level of the verb used in each benchmark. With this information, the appropriate assessment strategy can be easily identified. In the Benchmark #6F example above, "Relate" is linked to "Apply" in the cognitive domain and "Receiving" in the affective domain. The type of knowledge would be conceptual. An appropriate formative assessment would be a critical-thinking discussion, and the summative assessment would be a student-produced timeline of an invention.

At this point, the teacher could still be on the ITEEA *STEL* Resources page, so this is an excellent point to identify other matched academic benchmarks to their *STEL* benchmark. Accordingly, the teacher should open the folder "*STEL* Benchmark Crosswalk to Other Standards." Provided in Microsoft Word for easy copying, the teacher would see that in *STEL* #6F, benchmarks from *Next Generation Science Standards* (HS-ETS1-1.), Common Core State Standards-Mathematics (6.SP.1) and Common Core State Standards-English Language Arts (ELA-Literacy.RST.9-10.2) are validly linked.

The next step would be to think about how the *STEL* practices could be taught in the lesson plan envisioned. Learning performance objectives would be identified, likely matched to state or district curriculum frameworks. The teacher would then begin to add rich detail to the 6E lesson plan. Practical preparation tasks related to teacher prep, required tools and equipment, lab safety, student resources, educational technologies, and vocabulary would all have to be spelled out. Enrichment activities to extend the lesson or strategies to differentiate it will need to be written. Finally, the teacher is ready to write out a design brief that students will use in their engineering project or activity.

Conclusion

Writing lesson plans can be initially difficult. With the resources provided by ITEEA and *STEL*-based professional development over the next few years, this activity could become an easier and more effective tool for teachers to use—an intended goal of the *STEL* Revision leaders and writers in 2019-2020. Utilizing the knowledge and skills of backwards design, Danielson's *Framework for Teaching*, *STEL* resources, and the 6E model, technology and engineering teachers should be able to write standards-based lesson plans and curriculum that clearly align to the new ITEEA national *STEL* standards.

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Best Practice Example

Below is a full lesson plan developed using this method. It is based on the 6E Lesson plan template that has been adapted for *STEL.*

Teacher: ________________________________

Name of School: _____________________________

District __________________________ City ________________________ State ___

Context(s): Select from *STEL* Contexts (Ch 5):
TEC-1: Computation, Automation, Artificial Intelligence, and Robotics

Name of Course: __STEM Academy__ ***Grade Level:*** 5th Grade

Lesson Title: Automated Structures

Overview:
In this project-based unit, students will incorporate foundational construction concepts and computational thinking skills as they design (using scaled figures), build (using proper wall-framing techniques) and automate (using a variety of sensors, including thermal, light, and touch) a model clubhouse. Students will relate their work to a multitude of engineering and technical concepts in order to learn about automation, construction, and electronic systems.

Big Idea:
Computer science and technology play a critical role in our everyday lives.

Enduring Understandings:
- Scaled models can be created using a specific scale and an object's dimensions.
- Proper wall-framing techniques are used throughout the construction of a building's framework.
- There is specific terminology used to identify framing and structural members within a building's framework.
- A variety of sensors (including touch, thermal, and light) can be used to automate systems and programmed using block coding.
- Nested loops can be used to develop a program in order to solve programming problems.

Purpose of Lesson:
In the lesson, students are engaged in designing, representing, building, and automating a model clubhouse. This lesson provides students with an opportunity to relate the world around them to a multitude of engineering and technical concepts. Students begin to learn firsthand how automated systems and structures are developed in order to create technologies that make up the world around us, including our homes.

Instructional Time: 14 weeks

Standards/Benchmarks (Danielson Criterion 4, Domain 1A, Criterion 8 Domain 4d)
The standards and benchmarks for this unit are outlined below.

***Standards for Technological and Engineering Literacy (STEL)* Benchmarks**	
STEL-7N.	Practice successful design skills.
STEL-7O.	Apply tools, techniques, and materials in a safe manner as part of the design process.
STEL-8F.	Identify why a product or system is not working properly.
***Next Generation Science Standards (NGSS)* Benchmarks**	
3-5-ETS1-1	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
Common Core Mathematics Standards (CCSS Math) Benchmarks	
CCSS.MATH.CONTENT.5.NF.B.5	Interpret multiplication as scaling (resizing).
CCSS.MATH.CONTENT. 5.NF.B.5.A	Interpret multiplication as scaling (resizing), Comparing the size of a product to the size of one factor on the basis of the size of the other factor, without performing the indicated multiplication.
MP.2	Reason abstractly and quantitatively. (3-5-ETS1-3).
Common Core English Language Arts Standards (CCSS-ELA) Benchmarks	
CCSS.ELA-LITERACY.W.5.2.D	Use precise language and domain-specific vocabulary to inform about or explain the topic.

***STEL* Practices (selected from *STEL* Chapter 4)** (Danielson Domain 2B)

***STEL* Practice**	**How you will include this?**
Systems Thinking	Systems Thinking refers to the understanding that all technologies contain interconnected components and that these technologies interact with the environments in which they operate. Students learn about and use their understanding of the universal systems model, consisting of inputs, processes, outputs, and feedback, to program their automated clubhouse using a variety of sensors (thermal, light, and touch).
Making and Doing	Students will design, model, build, and use technological systems (including a Micro:bit). Students learn by the carrying out of physical activities, including the use of computer software, tools, and other technology.
Critical Thinking	Students will use critical thinking skills, involving questioning, logical thinking, reasoning, and elaboration throughout the process of making design decisions. Students will be making design decisions throughout the process of constructing their model clubhouses and the incorporation of automated systems.

Learning Objectives (Danielson Criterion 4, Domain 1c)

- Students will create an accurately scaled model given a specific scale and an object's dimensions.
- Students will apply knowledge of wall-framing techniques through the construction of a model's framework with proper spacing and construction.
- Students automate at least three systems within a model using sensors (including touch, thermal, and light).
- Students will create a working program that uses nested loops in order to solve programming problems.

6E Learning Highlights: (Danielson Criterion 2, Domain 3b, Criterion 4, Domain 1e)
Include critical thinking questions throughout.

Engage
The purpose of the ENGAGE phase is to pique student interest and get them personally involved in the lesson, while pre-assessing prior understanding.

- Set the context: Begin by having students watch a clip from the television show, *The Jetsons*. This show first aired in 1974 (how long ago was that?) and takes place in the year 2062. During this time, it was believed to be somewhat of an unimaginable society with the advanced technology present in the show.
- Have students pay special attention to the technology within the Jetsons' home!
- After the clip, facilitate a discussion with students about the smart and automated technology present in the clip.
  - What are some technologies you saw in the video that could be found in homes today?
  - What are some technologies we don't have now?
  - Do any of you (the students) have smart devices within your home? What do they do?

Prompt students to consider technologies such as an Alexa, Echo, smart refrigerators etc. You can choose to write student responses on the board for them to reference later!

- Transition students to the model clubhouse you have created. Have students gather around, having volunteers come up to try different sensors and features.

- Challenge students to consider:
  - What makes the light turn on?
  - What makes the doorbell ring?
  - What makes the fan turn on?
  - How do we know this?
- Why would we want to have smart devices in our house?

Ultimately you want to pique students' interest in the project and curiosity in automation! Students should realize these technologies are a growing presence in our homes and the world around us.

Explore

The purpose of the EXPLORE phase is to provide students with the opportunity to construct their own understanding of the topic.

Have Micro:bit Smart Home kits out and ready for student use.

- Transition students to the Micro:bit Smart Home kit. Task students with independently exploring the items within the kit, including the sensors, Micro:bit, and booklet. Students should consider how they might turn their clubhouse into a SMART Clubhouse using the SMART Home Kits.
- You can choose to give specific questions for students to answer as they explore the kit if needed.
  Some questions could include:
  - What different sensors are available in your kit?
  - What are some items/systems within our homes that we could automate/make smart systems?
  - If possible, what would you *want* to automate in your home?
  - *Why* would we want to automate our homes?
  - What are some benefits to making these items/systems smart?

Allow students to reference the brainstormed list created in the ENGAGE *activity in order to begin answering these questions. If needed, model an example with the class, or individually with students who may be struggling.*

- After the allotted time, allow students to share responses in a group or with a partner.

Allow students to drive the discussion. Students should learn about and consider other sensors or automated systems they did not explore or know about. Use students' discussion and responses to address misconceptions and assess comprehension of the covered material.

Explain

The purpose of the EXPLAIN phase is to provide students with an opportunity to explain and refine what they have learned so far and determine what it means.

- Explain the purpose of this unit: to provide students with an opportunity to relate the world around them to a multitude of engineering and technical concepts. Students begin to learn firsthand how automated systems and structures are developed in order to create technologies that make up the world around us, including our homes.
- The instructor should provide students with background information by reviewing the following:
  - Unit vocabulary
  - Scaling
  - Proper framework guidelines
- Explain to students that they will be tasked with creating the framework of their model clubhouse, using the provided scale. Students are expected to construct their model clubhouse using proper framing techniques, just as a builder would when constructing a home!

Take time to review directions, address any lingering questions, and clarify any misconceptions students may have.

eNGINEER

The purpose of the eNGINEER phase is to provide students with an opportunity to develop greater depth of understanding about the problem topic by applying concepts, practices, and attitudes. They use concepts learned about the natural world and apply them to the man-made (designed) world.

Be sure to have enough 2 x 4 and 2 x 6 wood pieces cut for the entire class using the laser cutter. You can choose to have all individual pieces cut to size (headers, jack studs, sills etc.) in order to save time and guide students along or have 2 x 4 and 2 x 6 pieces that students will need to cut to size throughout the project.

- In this activity students will use a given scale in order to create a physical prototype of their clubhouse, including the walls and base.
  The physical prototype will need to:
  - Include proper wall construction.
  - Include proper wall-framing techniques.
  - Include a wall with one door.
  - Include a wall with one window.
  - Follow given dimensions.
  - Adhere to the given scale.
- Students will begin by using the "2' x 6' pieces" to construct the base of their clubhouse, and then use the "2' x 4' pieces" to begin constructing the exterior walls.

Remind students of the importance of following the scale throughout this process. As students are working to build their clubhouse, be sure to observe techniques they may be using to construct the walls. Be sure to help students correct any misconceptions or errors they may be committing before they get too far in their framing!

- After completing their framework, students can begin to wire and automate their clubhouse using the Micro:bit, provided sensors, and materials.

  Students will be required to include and individually code the following for their clubhouse:
  - Light sensor
    - Interior lights should turn on when it becomes dark out.
  - Temperature sensor
    - Fan should turn on when it reaches a specific temperature indoors.
  - Touch sensor
    - Sound should be heard when the doorbell is rung.

If needed, take time to review coding basics with the class. If students are unfamiliar with makecode.org, take time to show them how to navigate the site and set up an account in order to save their programs for later reference.

- Students should save each program with an appropriate convention for later use.

Enrich

The purpose for the ENRICH phase is to provide students with an opportunity to explore in more depth what they have learned and to transfer concepts to more complex problems.

Be sure students' laptops are charged and ready for use. Students should have saved and have access to all of their individual programs (for the light, touch, and thermal sensors).

- In this portion of the lesson students have an opportunity to develop greater depth of understanding of if/then, loops, and if/then/else statements.
- Students will be tasked with nesting all of their code in order to fully automate their clubhouse within the Makecode editor.
- Give students a brief lesson on nesting. Explain that nesting is a term used to describe a particular function or functions contained within another function in a program.
- Model an example of a nested code with the class. You can choose to help students begin their program by modeling the first few lines of code.

If needed, you can create a colored template for students who may be struggling in order to guide them through this portion of the lesson.

- Challenge students to consider whether it would matter which function was contained within another function in their program. Would the clubhouse still work?

Ultimately, you want students to recognize that it would not matter which function was nested within another function, as you can program the entire clubhouse using different nested programs. There are, however, approaches that would result in simpler/shorter programs. It is up to the instructor to decide whether they would want students to use a specific function within a function in their program.

- Students' nested code should include:
  - Thermal sensor
  - Light sensor
  - Touch sensor
  - OLED screen

As students work through this part of the lesson, observe techniques they may be using. Be sure to be especially vigilant as students begin to construct the walls in order to correct any misconceptions or errors they may be committing before they get too far in their framing!

Evaluate

The purpose of the EVALUATION phase is for both students and teachers to determine how much learning and understanding have taken place.

Have students gather their clubhouses in order to showcase them to the rest of the class, school, or even parents.

- Students should have their program downloaded onto their Micro:bit and have their clubhouse ready to present!
- Students will be evaluated on their working clubhouse model and presentation.
- Students should demonstrate the following within their presentation:
  - Framed structure, using learned terminology
  - Use of sensors (thermal, light, and touch)
  - Working nested code

Students should document all work throughout the lesson within their Design Portfolio. The Portfolio should be completed and submitted for evaluation by the determined due date. Portfolios allow students of a wide range of abilities to showcase the performance criteria for a standard, but also show the depth beyond the minimum that they are capable of producing. Students can build skills for real-world applications through the practice provided by these tasks, as they often require critical thinking, creativity, reasoning, and reflection.

Lab/Classroom Prep: (Danielson Domain 2c)

Review materials prior to lesson in order to determine any additional needs of individual students, time allocation, and acquisition of needed materials. The classroom space should be adaptable for the needs of each student. This space should allow students to work collaboratively, brainstorm, and prototype. Additionally, if needed, plastic tablecloths or covers of some sort should be used to protect student work areas from superglue.

Instructors should ensure that students have resources necessary for the duration of the lesson and appropriate online resources. Computers in the classroom should have internet access. Students can register for a free account on makecode.org. After students create an account, they will be able to save all their individual programs throughout the project.

Required Tools/Materials/Equipment: (Danielson Domain 1d)

The following is a list of supplies and equipment needed to teach this lesson.

- Laptops/Computers with internet access (1 per student)
- 1/8" Baltic birch plywood
- Super glue
- Activator
- Laser cutter
- Rulers
- Protractors
- Pencils
- Sandpaper
- Micro:Bit Smart Home kits
- Micro:bits
- Student resources
- Teacher resources

Lab/Classroom Safety and Conduct: (Danielson Domain 2d)
Clear safety and conduct guidelines are a crucial component within every classroom. While this contains some general safety guidelines, it does not address the specific tools, equipment, and working spaces found in any specific classroom. Teachers must provide comprehensive safety guidelines to students based upon individual classrooms.

- Students should use tools and equipment safely, maintaining a safety level for themselves and others in the laboratory or classroom.
- Students should wear gloves when handling super glue.
- Safety glasses are required at all times while in the lab.
- Students should demonstrate respect and courtesy for the ideas expressed by others in the class.

Student Resources: (Danielson Domain 1d)

- Design brief
- Makecode.org

Technologies and Other Material Resources:

- Laser cutter
- Laptops/Computers with internet access
- Makecode.org
- Micro:Bit Smart Home kits
- Micro:bits
- 1/8" Baltic birch plywood

Vocabulary:

- **Loop**: A piece of code that runs itself repeatedly.
- **Sensor**: Instruments used as input devices for robots, which enable it to determine aspects regarding the robot's environment, as well as the robot's own positioning. Sensors respond to physical stimuli (such as heat, light, sound, pressure, magnetism, and motion), and they transmit the resulting signal or data for providing a measurement, operating a control, or both.
- **Nested**: Contained within something like itself. E.g., a nested array is an array that is inside another array, and a nested class is a class defined inside the definition of another class.
- **Block-based programming language**: Any programming language that lets users create programs by manipulating "blocks" or graphical programing elements, rather than writing code using text.
- **Program**: An algorithm that has been coded into something that can be run by a machine.
- **Automation**: Making a task, workflow, or process happen automatically, so routine tasks are completed in an efficient way, without human intervention.
- **Inputs**: A way to give information to a computer.
- **Outputs**: A way to get information out of a computer.
- **Feedback**: The return of information from a manipulator or sensor to the processor of the robot to provide self-correcting control of the manipulator.
- **Building code**: A collection of rules and regulations for construction established by organizations based on experience and experiment, and enacted and enforced by local municipalities.
- **Framing**: (1). The act of building the house frame. (2). Lumber used for the structural members of a building, such as studs, joists, rafters, and trusses.
- **Spacing**: The distance between individual members in building construction.
- **Top plate**: Top horizontal member of a frame wall supporting ceiling joists, rafters, or other members.
- **Header**: The horizontal structural member over an opening (e.g., over a door or window).
- **Cripple stud**: Short vertical framing member installed above or below an opening.
- **King stud**: The vertical, full-height framing member that runs continuously from the bottom plate to the top plate.
- **Trimmer (jack stud)**: The vertical stud that supports a header at a door, window, or other opening.

Standards-Based Assessment: (Danielson Criterion 6, Domain 1F, Domains 3d & 4b)

- Formative assessment:
  Addressed through student responses to the critical thinking questions within discussions.
- Summative assessment:
  Addressed through clubhouse project rubric.

Enrichment: (Danielson Criterion 3 Domains 1b and 3e)
In order to accommodate for a wide variety of learners within your class, you can choose to modify the activities as needed. Below are some suggestions.
For struggling learners:

- Assign students a partner who would be able to provide assistance as needed throughout the project. This will provide the student with a peer of whom they can ask questions when they are struggling. Additionally, you can choose to provide the student with a nested code template in order to help them as they combine the programs from the four sensors.

For advanced learners:

- Allow students to add an additional sensor within their clubhouses (moisture, sound, etc.). Students can begin by creating a code solely for the new sensor and then integrating it within their nested code. This will provide stu"?dents a chance to be creative as they personalize their clubhouse while also providing them a chance to explore and learn about inputs, processes, outputs, and feedback of another sensor.

Supporting Files
Include attachments as both Word and PDF files.
(For example design briefs/lesson plans, go to www.iteea.org/STELLessonPlans.aspx).