Appendix C
Example Lesson Plans and Reflections
Part 1

Name:	Date: 12/9/19
Lesson Topic: Beach Cleanup DASH	Grade Level: 5th grade

Curriculum Standards
TN Science Content Standards: 5. ETS1: Research, test, re-test, and communicate a design to solve a problem. 5. PS1. 2: Analyze and interpret data to show that the amount of matter is conserved even when it changes form, including transitions where matter seems to vanish. 5. PS2. 2: Make observations and measurements of an object's motion to provide evidence that a pattern can be used to predict future motion. **Component Idea:** Developing Possible Solutions **Tennessee Digital Readiness Standards** 5.CCP.4 Create an algorithm which includes structures to solve a problem using visual block-based and/or text-based programming language both collaboratively and individually. AIT.2 Develop a plan to use technology to find a solution and create projects. CC.3 Contribute, individually or as part of a team, to work to identify and solve authentic problems or produce original works using a variety of digital tools and devices. CC.1 Interact with peers, experts, and others using a variety of digital tools and devices.
Science and Engineering Practices: 1. Analyzing and Interpreting Data: Students should organize data, observations and measurements) in a manner which facilitates further analysis and comparisons. 2. Using mathematics and computational thinking 3. obtaining, evaluation, and communicating information
Crosscutting Concepts: 1. Cause and effect is being used as the students are creating the prototype and the final program for their Dash. They will need to test a command and analyze the outcome in order to make decisions about efficiency. 2. Systems and system model 3. scale, proportion and quantity
Central Focus
Central Focus Statement: Designing and testing using a trash collecting dash bot in order to solve environmental problems that are focused on the idea that we need to recycle, reuse, and improve the way we use our resources.
Real-World Phenomena: Sea turtles and other oceanic animals are dying from eating straws and trash that is left on the beaches.
3-Dimensional Lesson Objectives (or Multi-dimensional)
1. The student will be able to design a solution for the given problem of making the environment more safe and clean. 2. The student will be able to communicate possible solutions by analyzing the results of their designed trash collecting dash bot. 3. The student will be able to organize their data in a manner which facilitates further analysis and comparisons in regards to their prototype.

Language Demands		
	Word(s) or Descriptions	Supports
Language Function	Analyze	CER template Data Sheet Teacher instruction Blockly
Subject-Specific Vocabulary (Tier 3)	Dash, Blockly, coding, prototype, program, recycle, reduce, reuse criteria, grid, constraints, proximity	Slideshow- (programming instructions) teacher instruction
General Academic Vocabulary (Tier 2)	design, function, solution, direction, explain, evaluate, explore, data, seconds	Data sheet Slideshow CER template examples
Syntax	1. Students will be able to refer to the Dash/Blockly slideshow to help them see the steps required to make the dash function for the project given. 2. Students will be able to understand, and use coding and coding language. 3. Documenting efficiency of trash pickup path (quantity/time)	Slideshow (Dash instructions) Slideshow (Makerspace) Teacher model on Ipad and computer.
Discourse	1. Students will be engaging in discourse with team members and teachers to make plans for programming 2. Documenting the results in their CER statement 3. Students will be able to use the Makerspace slideshow to understand the instructions and goal of the activity and verbally talk about what needs to be done with their peers.	Teacher model Peer model Data sheet provided

Assessment/Evaluation			
Formative			
Connected Objective(s)	Name & Description	Evidence Collected of Student Understanding	Location in the Lesson
● The student will be able to organize their data in a manner which facilitates further analysis	**Thumbs Up, Thumbs Down:** After the class has reviewed the instructions for the data table, the teacher will make a quick note of	Based on students showing their thumbs at various positions, the teacher will be able to quickly note if students feel comfortable in their	Instructional Procedures

and comparisons in regards to their prototype.	student understanding/ comfort level in regards to how to complete and fill out the data table by students thumb positions. Thumbs up = Good understanding in regards to how to complete the data table. Thumbs down = Lacking good understanding in regards to how to complete the data table. Horizontal thumbs = Partial understanding in regards to how to complete the data table.	understanding in regards to how to complete the data table.	
● The student will be able to design a solution for the given problem of making the environment more safe and clean.	**Fist to Five:** Fist to Five asks students to indicate the extent of their understanding of a concept, or directions for an activity by holding up a closed fist (no understanding), one finger (very little understanding), and a range up to five fingers (I understand and I can explain it to someone else.	Based on students showing their fingers at various positions, the teacher will be able to quickly note if students understand their given task: "There is a beach that is in desperate need of trash pick-up. We need to help make this beach clean again by using art and technology to tackle the challenge. Your task is to design and build trash collecting robots."	Set
● The student will be able to design a solution for the given problem of making the environment more safe and clean.	**Data Table:** The students will fill-out a data table throughout the completion of creating prototype #1 and prototype #2. The data table will have students explain their design (What materials they used and how they	While students are completing the design and documentation process for each prototype, the teacher will circulate amongst each group. The teacher will make mental notes in regards to how students are	Instructional Procedures

● The student will be able to communicate possible solutions by analyzing the results of their designed trash collecting dash bot. ● The student will be able to organize their data in a manner which facilitates further analysis and comparisons in regards to their prototype.	went about building each prototype). The data table will also have students document the success of each prototype (Dash bot collected a substantial amount of trash = 3. Average amount of trash = 2. Only a few pieces of tash =1)	present the results of their designed trash collecting dash bot and documenting the description of their designs.	
Summative			
Connected Objective(s)	Name & Description	Evidence Collected of Student Understanding	Evaluation Criteria
● The student will be able to communicate possible solutions as well as present the results of their designed trash collecting dash bot. ● The student will be able to organize their data in a manner which facilitates further analysis and comparisons in regards to their prototype.	**CER Template:** CER (Claim, Evidence, Reasoning) is a format for writing about science. It allows you to think about your data in an organized, thorough manner.	● The CER template will serve as a measurement in which student understanding can be evaluated. ● By completing the CER template, students will have the opportunity to demonstrate the results of their design, and their understanding as to why prototype #1 or prototype #2 was more successful.	● Students will be graded on the CER scoring rubric. ● The claim, evidence, and reasoning can be scored on a scale from 1 to 4. ● 12 points possible can be awarded.

Instruction Total Length of Lesson: 50 minutes	
Instructional Procedures	Questions
Set/Introduction Total Time: 5 minutes	

ENGAGE ● When the students enter the class and are seated, the teacher will go over the informational text articles, " so the students have an idea of the purpose for the activity. ● Presenting the Problem through Google Slides ○ Present the "Makerspace Presentation" slideshow to the whole class. ○ Explain that our environment is in a great need for us to start reducing waste, reusing materials, and recycling. ○ Explain to the whole class why we must start taking better care of our environment. ○ The teacher should review personal connections for the students to relate to such as how litter and waste have negative effects on our environment. (Straws and sea turtles, and TVA Kingston ash spill). ○ Present the scenario/ inquiry task: "There is a beach that is in desperate need of trash pick-up. We need to help make this beach clean again by using art and technology to tackle the challenge. Your task is to design and build trash collecting robots."	How much waste do you produce in a week? month? year? Can you tell us about a local environmental problem? What is one thing you can use less of or eliminate completely do to reduce waste? Using the fist to five scale, who understands the task?
Instructional Procedures Total Time: 35 minutes	
Use Headings for each subsection of your procedures and provide a time for each. Add or delete rows as necessary.	
● The teacher will sit out materials prior to class. ● Using the Dash bots and Blocky App ○ The students will view a presentation in which they will learn how to use and code dash bots. ○ Further instructions as to how to use and code the dash bots will be given verbally to the whole class if there is any confusion.	Are there any questions about what you just saw? Who is familiar with the Dash? Blockly program?
EXPLAIN (Will be completed later on throughout the lesson) ● Data Tables ○ The teacher will pass out the data tables. ○ The teacher will go over what is to be recorded in the data tables. ■ Quick Sketch of Design ■ Success of Prototype ○ The teacher will explain that the students are to create two different prototypes of trash collecting robots.	Using thumb positions, how comfortable do you feel completing the data tables?
● Assign Students into Teams ○ Students will work in groups of 5 to 6 in order to solve this task.	

○ The teacher will explain, “Work with one other person in your table group in order to complete this task.”	
● Pass out the Paper ○ Pass out the paper to each group. ○ Explain to the students that they will be using their bots to collect trash (tiny, crumpled up pieces of paper and foil) and deposit it in a designated recycling center (a square draw on paper). ○ Explain to the students that they most create a code in which the trash bot moves from each indicated trash spot marked on the beach. ○ Explain to the students that they must	
EXPLORE ● Prototype #1 (15 minutes) ○ Have students use materials and collaborate with their group in order to create prototype #1. ○ Explain to the students that they will have 15 minutes to create, program, and record their results for prototype #1. ○ The teacher will set a timer for 15 minutes. ○ On each paper, with the recycling center drawn on it, the teacher will layout pieces of trash, so that the students are able to create their code. ○ As the students are working, the teacher should be walking around giving suggestions, guiding collaboration, and reminding students to document their work in their data tables. ○ Encourage students that they need to be testing out and revising their programming to see if they can pick up more with changing the direction of the bot to pick up materials. ○ At the 5 minute mark, the teacher will encourage students to record their results for prototype #1 in their data tables if they have not already done so. ○ At the end of the 15 minutes, students will start working on prototype #2.	
ELABORATE ● Protype #2 (10 minutes) ○ Have students collaborate with their group in order to revise prototype #1. ○ Explain to the students that they will have 10 minutes to revise, re-program, and record their results for prototype #2. ○ The teacher should convey that they are not to create a whole new trash bot, just revise prototype #1, such as altering the first code that was made.	

○ NOTE: If the students are struggling to create a successful code, show them the premade code after a few minutes has elapsed. ○ The teacher will set a timer for 10 minutes. ○ As the students are working, the teacher should be walking around giving suggestions, guiding collaboration, and reminding students to document their work in their data tables. ○ At the 5 minute mark, the teacher will encourage students to record their results for prototype #2 in their data tables if they have not already done so.	
Closure Total Time: 10 minutes	
<u>EVALUATE</u> ● CER Template ○ The teacher will first review how the CER template should be completed. ■ Writing in complete sentences, provide your claim, reasoning, and evidence within the boxes. ■ NOTE: If time is limited, the teacher can help the students complete this CER template step by step. ■ Claim: This section should describe <u>which</u> prototype was the most successful **in** helping make the environment a more safe and clean place. ■ Evidence: This section should describe <u>why you determined</u> the particular prototype prototype was the most successful in helping make the environment a more safe and clean place. ■ Reasoning: This section should describe <u>why the particular prototype was the most successful</u> (Modifications, programming, etc.) ■ The teacher should mention to the students that examples are noted on their "CER Template" hand-out. ○ The teacher will pass out CER templates to all of the students. ○ Individually, the students will complete the "CER Template" hand-out. ○ The students will fully complete this CER template before leaving class.	What design was most effective for your trash bot?
● "Scientists say more sea turtles are eating plastic and dying" AND Writing Reflection Prompt ○ The teacher will pass-out the article, "Scientists say more sea turtles are eating plastic and	

dying" and a Writing Reflection prompt to the students at the end of class. ○ The student must first fully read "Scientists say more sea turtles are eating plastic and dying" as well as complete all the reflection questions for homework.	

Adaptations to Meet Individual Needs:

- During the design and redesign process, students will be placed in groups comprised of higher level learners and lower level learners.
- Throughout this process, the higher level learners will serve as a guide and example for the lower level learners.
- The teacher will give clear, repeated, and precise instructions both verbally and posted on the Projector throughout the entirety of the lesson.
- Throughout the entire lesson, the teacher will be circulating.
    - Throughout the design and redesign process, the teacher will make an effort to address each group in order to identify their needs or to be able to expand on instruction.

Management/Safety Issues:

- Before the lesson is taught, the teacher should prepare all materials and tools ahead of time.
- The teacher should prepare and have a management plan for time and instructions to have posted and to be given verbally throughout the lesson.
- The teacher should ensure respect and positive rapport between teacher and student and between students and their fellow peers throughout the design process completed in groups.
- The teacher should ensure that students are staying on-task, engaged, and focused throughout the design and redesign process of constructing their trash bot.
- The teacher should enforce all classroom rules, including safety, throughout the entirety of the lesson and each group activity.

Materials/Resources

<u>Materials</u>

- Labeled
- Dash bots
- Paper with labeled "recycling center" and stars where the teacher should lay the trash
- Presentation
- Materials to Create Trash Bot
    - Spoons and forks
    - Notecards
    - Tape
    - Pipe Cleaner
    - Scissors
    - Paper Plates
    - Stopwatch/timer or can be done through their phone
    - Aluminum foil
- CER Templates
- CER Scoring Rubric
- Data Tables
- Pencils
- Timers
- iPad

- Blockly App
- Calculator
- Trash to Collect - (Cans

Resources:

- Idea for lesson: https://blog.ozobot.com/ozobot/builtwithozoblockly-bot-beach-cleanup/
- Data Table: Personally Created
- CER Templates: Personally Created
- Presentation: Personally Created
- CER Scoring Rubric: https://www.corelaboratewa.org/blog/teacher-leaders/single/~board/teacher-leaders-archive/post/cera-rubrics
- Information Text
  - https://newsela.com/read/plastic-turtles/id/12011/
    - By Washington Post, adapted by Newsela staff
    - Published:09/25/2015
  - https://www.seeturtles.org/ocean-pollution

Rationale/Theoretical Reasoning
Student Challenges/Misconceptions: (Functional misconceptions) Works with tablets, phones, chromebooks, ios operating system Dash is the bluetooth enabled and does not require an internet connection. Dash has a battery life of 90 minutes (Misconceptions of practice) There is only one right way to program the Dash. In fact, creativity in programming is celebrated. We are JUST playing with robots. In fact, creations that are made in play can have long-term benefits for society and the environment. Students should use safe practices such as; avoiding collision with other dash, students, object, etc avoid dropping devices by holding with two hands at the base NEVER the top of the Dash. Computer or tablets should remain on a base when programming.
Rationale / Theory: **TPACK** According to TPACK.org, “At the heart of the TPACK framework, is the complex interplay of three primary forms of knowledge: Content (CK), Pedagogy (PK), and Technology (TK).” Throughout our lesson, we greatly relied on these primary components of the TPACK model to design the lesson for students. This lesson was designed for the students to use technological knowledge. For instance, the students must demonstrate technological knowledge in understanding how to use Dash and Blockly programming software. The lesson was designed for students to demonstrate technological knowledge by using and running the Dash and Blockly programming in order to create a code for the Dash robot to successfully clean the beach. The TPACK model also encourages the teacher to use pedagogical knowledge. For this particular lesson, we greatly relied on the 5E model. The teachers will engage by explaining the scientific phenomena of the real world pollution problem, as it is affecting our local lakes and sea turtles in the ocean. Furthermore, the teacher will be encouraging the students to participate in the 5E model by explaining how they make their various prototype and codes, exploring how they can make revisions to their prototypes and codes, evaluating which prototype type and code was the most efficient, and evaluating the results from their observations and records formally and precisely through the use of a CER template. Furthermore, this lesson was designed for the students to use and demonstrate content knowledge. For instance, by the end of the lesson, students should be able to demonstrate content knowledge by being able to convey and explain pollution issues and environmental factors in the subject of science. Reference: http://tpack.org/

SAMR
The SAMR model is used throughout our lesson. We mostly use modification and redefinition. Students will use the Dash robot, paired with the Blockly app, as a direct tool for students to demonstrate understanding of coding and pollution problems. They should then be able to explain the reasoning behind their codes and why that is the most efficient way to reduce pollution. Instruction for this lesson allows students to use technology for the delivery and demonstration of content. They can also use the technology to problem solve and implement practices that could be shared on a public/privately shared platform. The use of the dash and the app for programming can give students a real world idea of how to approach a problem that would be inconceivable in the classroom otherwise.
Reference: SAMR Model hand out, page 5 in our technology folder

Defining Computational Thinking for Mathematics and Science Classroom tells us that computational programming and problem solving allows students to explore scientific and mathematical phenomena using computational abstractions. This helps learners develop deep understanding through the building of an algorithm for problem solving with a focus on efficiency. Students will be able to practice decomposing problems into subproblems so that the problems can be reframed as solvable or at least progressable toward solution with the use of the computational tool.

CT in Math and Science Taxonomy lists *troubleshooting and debugging* in the "Computational Problem Solving Practices Category" and this will be observed as students make revisions for their final program. Without this step, there will be no progress toward efficiency.
Modeling and Simulation Practices are being used here to help students gain access to concepts that are large in scale. The concept of environmental remediation is a daunting task for experienced engineers and oceanographers but with the use of programming, students can design, assess and build *models* that could possibly be used for the phenomena. Students will need to *collect and analyze data* that is gathered from blockly program. This analyzation will be done by *visualizing information* about the route to efficient beach clean up.
Reference:
(Journal of Science Education and Technology. October 2015. David Weintrop)

Maker Lesson Summary

Lesson Title	Beach Cleanup DASH
Primary Maker Lesson Tool Used	Dash
Names of collaborators	
Subject(s) and grade level	Science - 5th grade

Lesson Description: (*Give a brief synopsis of what took place in your lesson*)

The Beach Cleanup Dash lesson was used to incorporate STEM, robotics and coding to solve real-world issues. The students reviewed pollution in our surrounding areas (Kingston ash spill, sea turtles and plastic straws), and were given the task to sketch and make a prototype to efficiently collect trash on the "beach" and deliver it to the recycling bin. The students not only had to sketch and build, they then had to program their dash bots to successfully go from the starting line to the two required destinations (trash pick up and recycling bin). After they ran their first code with their first prototype, they had a chance to make modifications and compare how many pieces of trash they collected with each prototype.

Lesson Implementation: (*Where did you teach your lesson, description of class, students, etc.***)**

The lesson was taught at __ Middle School in 5th grade science classes. This lesson was carried out for a total of 3 class periods. The class sizes ranged from around 23 to 28 students per class. The students within all three of these classes were not separated by ability level. For instance, within each class, we were teaching to groups of students who had multiple ability levels.

Connection to important concepts and skills within the discipline and/or across subject areas: (*Describe the main content that you were teaching for all that apply. Refer to your selected standards in your plan and the theory/rationale of your plan as needed.)*

Science:5. ETS1: Research, test, re-test, and communicate a design to solve a problem.

5. PS1. 2: Analyze and interpret data to show that the amount of matter is conserved even when it changes form, including transitions where matter seems to vanish.

5. PS2. 2: Make observations and measurements of an object's *motion* to provide evidence that a pattern can be used to predict future motion.

Math: measurement, multiplication, addition,

Computational Thinking Skills: Modeling and simulation skills were the focus of this lesson.
Students had the opportunity to think about how they might help to remediate environmental problems.
Students used debugging and troubleshooting throughout their programming with Blockly. They needed to do this to be efficient. Students who did not use a ruler to measure distance did more troubleshooting than others. Those students relied on visualizing rather than close analyzation

Other: Social studies concepts were mentioned briefly when we used a current or near historical event to make pollution problems more relevant and personal (Kingston Coal Ash Spill).

Connecting to the SAMR Model

Explanation: https://www.schoology.com/blog/samr-model-practical-guideedtech-integration

What level of the SAMR model do you feel your enacted lesson reached? Why? (*Refer back to what you included on your lesson plan as needed)*

The SAMR model is used throughout our lesson. We mostly use modification and redefinition. Students will use the Dash robot, paired with the Blockly app, as a direct tool for students to demonstrate understanding of coding and pollution problems. They should then be able to explain the reasoning behind their codes and why that is the most efficient way to reduce pollution. Instruction for this lesson allows students to use technology for the delivery and demonstration of content. They can also use the technology to problem solve and implement practices that could be shared on a public/privately shared platform. The use of the dash and the app for programming can give students a real world idea of how to approach a problem that would be inconceivable in the classroom otherwise.

Reflection:

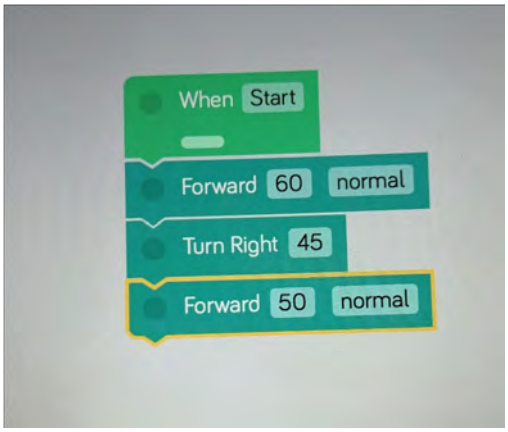
What Went Well? (*Be thorough - give specific examples)*

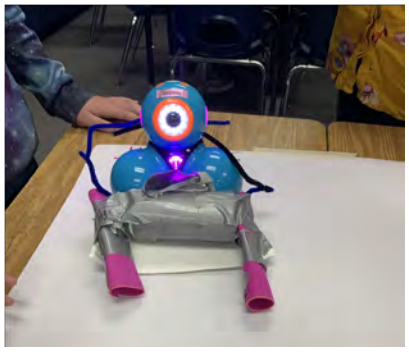
Throughout the lesson, we can reflect on several things that went well. For instance, we were successful in the way in which we were prepared and organized to carry out the lesson with each group. We had several materials and tools that we were responsible for using and setting-up before each lesson for each class to use. Furthermore, we were successful in the way in which we were able to explain the real world phenomena to each class. By successfully describing pollution issues such as sea turtles and how they are in danger due to pollution, as well as the TVA ash spill, we were able to successfully engage students to want to solve the task at hand. Additionally, we had several instances in which we had to handle disagreements and communication issues, as the students struggled to come agree upon group designs for their trash bots. We were successful in the way in which we were able to handle these disagreements and communication issues.

What would you change? (*Be thorough - give specific examples & explain why.)*

There should be smaller groups with defined roles. The groups were large and some were not engaged. Some others were adamant that a specific task should be relegated to them. This caused students to distract other team members. With smaller group sizes, the roles would be spread out more evenly, and there would be less down time for each student. The only other change I would make is class time provided. This needs to be done with a school that is on block schedule so there is at least 90 minutes for the class.

Pictures of students working, student artifacts and/or links to video:


When Start
Forward 60 normal
Turn Right 45
Forward 50 normal



Part 2

Name:	Date: 12/09/19
Lesson Topic: Building Animal Habitats	Grade Level:4th

Curriculum Standards
TN Science Content Standard: **4.ETS2 1.** Use appropriate tools and measurements to build a model. 2. Determine the effectiveness of multiple solutions to a design problem given the criteria and constraints. **4.ETS1: 1.** Categorize the effectiveness of design solutions by comparing them to specified criteria for constraints. **2.LS2: 1.** Develop and use models to compare how animals depend on their surroundings and other living things to meet their needs in the places they live. 2. Predict what happens to animals when the environment changes (temperature, cutting down trees, wildfires, pollution, salinity, drought, land preservation). **Component Idea(s):** ● A. Interdependent Relationships in Ecosystems ● A. Interdependence of Science, Engineering, and Technology ● C. Optimizing the Design Solution **Math** ● **4.MD.A.1** Measure and estimate to determine the relative sizes of measurement units within a single system of measurement involving length, liquid volume, and mass/weight of objects using customary and metric units. ● **4.MD.A.3** Know and apply the area and perimeter formulas for rectangles in real world and mathematical problems. For example, find the width of a rectangular room given the area of the flooring and the length, by viewing the area formula as a multiplication equation with an unknown factor. **TN Digital Readiness Standards** ● **CC.3** Contribute, individually or as part of a team, to work to identify and solve authentic problems or produce original works using a variety of digital tools and devices. ● **4.CCP.1** Recognize the input and output devices along with the components that form an interdependent system with a common purpose.
Science and Engineering Practices: ● Developing and Using Models ● Constructing explanations and designing solutions ● Using Mathematical and Computational Thinking ● Obtaining, evaluating, and communicating information
Crosscutting Concepts: ● System and System Models ● Structure and Function ● Scale, Proportion, and Quantity
Central Focus: Habitats
Central Focus Statement: What animals need to survive in their habitats. Designing and constructing models of those needs in TinkerCAD, and staying within the limits of the 3D printing bed.
Real-World Phenomena: ● Flat grasslands are habitats for rabbits, elephants, lions, zebra, etc. ● Cold, Arctic environments are habitats for polar bears, penguins, and seals ● Trees with lots of shade are habitats for birds, squirrels, monkeys, etc.
3-Dimensional Lesson Objectives (or Multi-dimensional)
The learner will..

- Describe and reflect on the environment and the basic needs of plants and animals, and what elements are needed to survive in their habitat.
- Design and construct a model of a habitat suitable for an assigned animal within the measurement constraints in TinkerCAD
- Solve basic measurement and metric conversions to better understand assignment constraints

Language Demands		
	Word(s) or Descriptions	Supports
Language Function	• Students will be able to **describe** what elements of a habitat an animal needs to survive • Students will **justify** why their habitats are suitable for their assigned animals	• Teacher modeling (guiding questions) • Class discussion • Think-Pair-Share
Subject-Specific Vocabulary (Tier 3)	Criteria, Constraints, Print bed, Filament TinkerCAD 3D Printer	• Teacher modeling (introduction) • Powerpoint Introduction • Class discussion • Exit Ticket
General Academic Vocabulary (Tier 2)	Measurement Centimeter Millimeter Habitat Shelter Food Source	• Teacher modeling • Powerpoint introduction • Class discussion • Tinkering with Habitats Handout • Exit Ticket
Syntax	• Students will use their design to measure each part of their habitat model not exceeding the TinkerCAD limits. • Students will document their measurements on their design model for each side to help them prepare for designing in TinkerCAD.	• Students will be able to use the powerpoint presentation to help them understand how to design and use TinkerCAD for their assignment given. • Teacher modeling
Discourse	• Students will engage in discourse by working in teams and planning their habitat models.	• Students can use the powerpoint slides to help them understand the instructions of TinkerCAD and design their models. • Teacher modeling

Assessment/Evaluation
Formative

Connected Objective(s)	Name & Description	Evidence Collected of Student Understanding	Location in the Lesson
● Describe and reflect on the environment and the basic needs of plants and animals, and what elements are needed to survive in their habitat. ● Design and construct a model of a habitat suitable for an assigned animal within the measurement constraints in TinkerCAD ● Solve basic measurement and metric conversions to better understand assignment constraints	**Thumbs up and thumbs down**. After the powerpoint and handout is completed the students will respond with a thumbs up meaning they fully understand, a thumbs down meaning they do not understand and a thumbs in the middle meaning they partially understand.	The teacher will be able to see the students understanding by them giving a thumbs up or down when prompted during the review/ presentation.	During the presentation slides and handout review
	Observation: Teacher will observe students responding to questions in class as well as observing their group discussions on what part of their habitat they are creating in TinkerCAD	The teacher will be able to see the students understanding by observing their responses to any questions given in the class as well as the group discussion on designing and creating their models to use in the 3D printer.	During the presentation as well as the designing and constructing the student habitat models.
	Informal Questioning: Teacher will observe students responding to questions during the question/answer discussion prior to designing and constructing their habitat models.	The teacher will be able to see the students understanding by observing their responses to any questions given during the informal questioning.	Questions and discussions before designing models
Summative			
Connected Objective(s)	Name & Description	Evidence Collected of Student Understanding	Evaluation Criteria
● TLW solve basic measurement and metric conversions to	**4.ETS2 1. Exit Ticket** Students will reflect on TinkerCAD and their experience with working	Evidence of student understanding will be collected during the time allotted for exit ticket	Student understanding will be revealed through correctly answering the

better understand assignment constraints ● TLW construct a system and system model using TinkerCAD that will be suitable for assigned animal with a team	with it. Students will describe the process of working together as a team and their role in that team. Students will be asked to reflect on, when working with TinkerCAD, what was easy for them to grasp and what was more difficult. Students will also show further understanding of basic metric conversions.	completion. The teacher will walk around and observe how students respond to exit ticket questions. Evidence will also be collected through the collection of the exit ticket and reading over student's responses of understanding.	metric conversion questions. Most of the questions on the exit ticket are opinion-based and opportunity for student reflection.

Instruction Total Length of Lesson: 90 minutes	
Instructional Procedures	Questions and Actions
Set/Introduction Total Time:10 minutes	
Discuss habitat Project (2 minutes) (h) ● The teacher will connect and introduce habitat project and emphasize that students should already be assigned an animal. **Review of centimeters and millimeters (5 minutes) (s)** ***Slides 1 - 4 *** ● After distributing Tinkering with Habitats Handout, the teacher will go over the measurement review questions at the beginning. ● The teacher will orally go over the answers to the review measurement conversions with students while students fill in the answers on their sheet. ● The teacher will emphasize that the TinkerCAD design needs to be *smaller* than 10x10x10cm, which is why review is necessary **Briefly Introduce 3D Printing and TinkerCAD (3 minutes) (h)** ● The teacher will quickly introduce TinkerCAD by telling them they will use an online program to design 3D printable objects and pass around different examples of 3D printed objects that had been done prior.	1. How many millimeters are in a centimeter? 2. How many millimeters are in 10 centimeters? 3. The design needs to be smaller than what measurements in millimeters? 100 x 100 4. What part of the habitat are you creating?
Instructional Procedures Total Time: 60-65 minutes	
Use Headings for each subsection of your procedures and provide a time for each. Add or delete rows as necessary.	

Designing a habitat for assigned animal (10 minutes) **(s)**
● The students will use this time to come together as a team and begin designing their habitat on paper (Tinkering Handout)
  ○ Each student should select one of the following: Food source, Water Source, structure/shelter, or animal to design. (*If more than 4 students are in a group, additional students can design more food*.)
  ○ Students should use rulers and add dimensions to their sketches. They should plan logically so that no component is larger than 10x10x10cm and the individual components fit within these dimensions.
● The teacher will walk around and monitor the student discussion and designing process. Teachers will approve sketches prior to beginning next step.
	1. What are the parts of your habitat?
	2. What are you responsible for creating?

Powerpoint Presentation (2 minutes) Slide 5 **(h)** ● The teacher will begin by asking guiding questions of past experiences students may have had with 3-D printing, TinkerCAD, or something similar like Minecraft. ● The *students* will raise their hands in response to the guiding questions	1. Has anyone ever 3-D printed anything before? If so, what? 2. Have you ever used Minecraft? 3. Do you guys have questions before we begin with TinkerCAD?

TinkerCAD class house creation (18 minutes) Slide 6-11 **(s)(h)**
● Students will be asked to open their computer and go to TinkerCAD.com
● From there, students will choose "Join Now!" and then "Students, join a class"
● The teacher will display and orally project the class code for everyone to log in and join
● After joining the class, the students should see their open work-plane on TinkerCAD
● **At slide 11 The teacher will begin projecting the example of designing a house with the students on tinkercad.com**
● The students will mimic the teacher's actions of creating and designing a house.
  ○ Pull out a block and model resizing
  ○ How to determine dimensions
  ○ Model making objects hollow and adding a hole
  ○ Model scribble feature
  ○ grouping and ungrouping
  ○ Introduce controls: moving workplane, how to resize, making sure design is *on* workplane (not above or below)
● Explore menus to see what shapes they can build with.
	1. What shape should we use for a house?
	2. What shape should we use for a window?
	3. What shape should we use for an animal?
	4. *This* is where you find:
	  a. 3-D shapes
	  b. Dimensions
	  c. How to insert a hole
	  d. How to move your design around (ctrl + move mouse)
	  e. How to change design height/width

TinkerCAD habitat designing (40 minutes) **(s)(h)** ● At this time, students will be asked to take the habitat design on paper and try their best and create it into TinkerCAD. ● The teacher will instruct each student to begin tinkering their design for their habitat in TinkerCAD on their own computer. ● The teacher will walk around and monitor student progress on their design as well as monitoring that students are staying on target with their assigned task.	1. What part of the habitat are you responsible for designing? 2. What shapes are you wanting to use for your design? 3. What measurements are you using for your design?
Closure Total Time:10 minutes	
(s)(h) ● Students will be asked to submit/save their designs and close their computers. ● The teacher will ask students to take their Tinkering with Habitats handout and turn it over to the Exit Ticket on the back. ● Students will fill out the exit ticket in full and turn it in when they are finished. ● Lastly, an appointed teacher will decide which group has the best habitat that will be printed using the 3D printers in class.	1. Everyone please save what you have of your design and close your computers. 2. Please fill out the exit ticket in full and turn it in when you are finished. 3. <u>Closing question:</u> What is one thing you learned about TinkerCAD or 3-D printing today?
Adaptations to Meet Individual Needs: ● Pair inclusion students in appropriate groups who have a higher understanding of the content.	
Management/Safety Issues:	

- Monitoring the students use of computers and appropriate behaviors.
- Be Responsible using technology devices.

Materials/Resources
● Computers per group ● Lesson and animal plan from previous lesson in class ● TinkerCAD registration and class preparation ● Nicknames from TinkerCAD for the students ● Rulers ● Google Slide presentation ● Tinkering with Habitat Handout ● 3D printed samples

Rationale/Theoretical Reasoning
Student Challenges/Misconceptions: ● Milimeters are smaller than centimeters, therefore the number of millimeters in a centimeter should be smaller. ● TinkerCAD/3-D printing beds do not have limitations; restrictions aren't important in the design process
Rationale / Theory: **TPACK -** Through this lesson, we have several components of the TPACK and SAMR Models integrated. A main one that is integrated is **Technological Pedagogical Knowledge** through the introduction of TinkerCAD and how to use it. We will have an introduction PowerPoint that will introduce TinkerCAD's basic components and how to use them. We will also be using materials, such as, a Smartboard, to project this introductory slideshow. **Technological Content Knowledge** is also integrated through the use of a Smartboard, the class set of laptops, TinkerCAD, and a 3-D printer to teach the scientific content of animal habitats. Through the integration of these types of technology, students will be given an alternative way to learn about how certain habitats are suitable for certain animals.This could also be categorized as simply **Technological Knowledge** as well. **Pedagogical Knowledge and Pedagogical Content Knowledge** can also be found through the use of direct instruction in the introduction of TinkerCAD and how to use it. Also, throughout the entire lesson, we are integrated Inquiry-based instruction through the use of this computer program and a 3-D printer. Also, we will be using phenomenon to inspire student's creativity of creating their animal and a suitable habitat. **SAMR -** Through this lesson, we are **redefining** ways students learn about the components of a certain habitats and their effect on animals that live there. Through the use of the program, TinkerCAD, it allows for creation of new tasks that previously would be inconceivable. For example, students will begin by brainstorming a habitat and its component for an animal they have chosen, and through the designing process in TinkerCAD, this learning can be created three-dimensionally. Students can actually physically see and hold their creations when printed on a 3D printer, and see how they work together to serve the purpose of a habitat. **CT in Math and Science Taxonomy:** Referring to the "computational thinking in mathematics and science taxonomy" chart, for **Data Practices** throughout this lesson, students will be **visualizing and manipulating data** by visualizing their habitat through pencil and paper, as well as, through technology. Students will manipulate data by changing and working with dimension limitations of their habitat. For **modeling and simulation practices,** students will be **designing and constructing computational models** by physically drawing out the part of the habitat that they will be creating, as well as, constructing their design through TinkerCAD. For **Computational Problem Solving Practices,** students will be **developing modular computational solutions,** by actually designing their habitat/or component of one in TinkerCAD. Also, students will be **troubleshooting and debugging** by the thinking-process of how components of the habitat are going to fit together and follow dimension limitations. For **Systems Thinking Practices,** students will be **communicating information about a system** by working in their groups and assigning components within their habitats. Also, students will be **investigating a complex system as a whole** by discussing how their components will all come together to make a suitable habitat for their assigned animal.

References

TPACK -

SAMR -
Defining Computational Thinking for Mathematics and Science Classrooms, by Weintrop, et.al
https://ccl.northwestern.edu/2015/Weintrop%20et%20al.%20-%202015%20-%20Defining%20Computational%20Thinking%20for%20Mathematics%20an.pdf

Maker Lesson Summary

Primary Maker Lesson Tool Used	TinkerCAD
Names of collaborators	
Subject(s) and grade level	4th grade Science

Lesson Description: (*Give a brief synopsis of what took place in your lesson*)

Our lesson for 4th Grade at __ Elementary School was an introduction to the program, TinkerCAD. We began the lesson with a brief review of the metric system and the differences between centimeters and millimeters. This review would allow students to better understand the limitations of the printer bed and how to accommodate accordingly. Next, we introduced what the program actually looks like and where to find the basic controls throughout it (i.e., basic shapes, how to move the workplane, how to change measurements, etc.). We walked the students through and introduced how to create a "house" in the program and where to find the materials needed to do so. After we had briefly introduced the program, we gave the student's their assignment for creating a habitat that was suitable for their animal. Some students were quick to understand and begin working through the program and building their habitat or piece to their habitats. Other students had difficulty with managing the controls and how to productively create their habitats.

Lesson Implementation: (*Where did you teach your lesson, description of class, students, etc***.)**

We had 87 students total split into two rooms. The students were grouped into groups of 3-5 students. Each group worked independently on designing their habitats on their paper, measuring their designs based on the constraints in TinkerCAD, and designing their models in the program.

Connection to important concepts and skills within the discipline and/or across subject areas: (*Describe the main content that you were teaching for all that apply. Refer to your selected standards in your plan and the theory/rationale of your plan as needed.)*

Science: TN Science Content Standard:

4.ETS2 1. Use appropriate tools and measurements to build a model. 2. Determine the effectiveness of multiple solutions to a design problem given the criteria and constraints.

4.ETS1: 1. Categorize the effectiveness of design solutions by comparing them to specified criteria for constraints.

2.LS2: 1. Develop and use models to compare how animals depend on their surroundings and other living things to meet their needs in the places they live. 2. Predict what happens to animals when the environment changes (temperature, cutting down trees, wildfires, pollution, salinity, drought, land preservation).

The students were learning about habitats and what animals need to survive in their habitats. The teacher had previously discussed with them habitats and they were building habitats with candy and other items. For our lesson, we came into the classroom to review with the students about habitats and what animals need to survive such as a food source, water source, and a structure/shelter. The students were walked through each step in how to open TinkerCAD and log in with their own personal information. We taught the students about how to use the program, how to build, connect pieces, make hollow sections etc. The students were given time to do their own designs on paper. The students each had a part of the habitat to draw and design. Once the students drew their designs, they measured their designs and used those measurements in TinkerCAD when designing their models based on the constraints of TinkerCAD measurements.

Math:

- **4.MD.A.1** Measure and estimate to determine the relative sizes of measurement units within a single system of measurement involving length, liquid volume, and mass/weight of objects using customary and metric units.
- **4.MD.A.3** Know and apply the area and perimeter formulas for rectangles in real world and mathematical problems. For example, find the width of a rectangular room given the area of the flooring and the length, by viewing the area formula as a multiplication equation with an unknown factor.
- Students also had to convert basic measurements from centimeters to millimeters and back.

The students had to take ideas that they had previously thought about that included taking an animal and making a structure for the animal to live in, a food source, and a water source so that animal could survive. Students had restrictions on how big their design could be. The students had to take their designs and convert the measurements to millimeters and centimeters to make sure that their design would be accepted. The students also had to know how to recognize basic shapes.

Computational Thinking Skills:

- **CC.3** Contribute, individually or as part of a team, to work to identify and solve authentic problems or produce original works using a variety of digital tools and devices.
- **4.CCP.1** Recognize the input and output devices along with the components that form an interdependent system with a common purpose.

The students had to work together as a team to make sure that they made all of the things that the animal would need to survive. The students also needed to work individually to design their part of the habitat for the animal. The students used shapes and other online tools to design their part of the habitat that their animal needed.

Connecting to the SAMR Model

Explanation: https://www.schoology.com/blog/samr-model-practical-guideedtech-integration

What level of the SAMR model do you feel your enacted lesson reached? Why? (*Refer back to what you included on your lesson plan as needed)*

Through this lesson, we were **redefining** ways students learn about the components of a certain habitats and their effect on animals that live there. Prior to the introduction of TinkerCAD, students were asked to brainstorm their habitats through the use of various Through the use of the program, TinkerCAD, it allowed for the creation of new tasks that previously would be inconceivable. We began by asking students to brainstorm a habitat and its component for an animal they have chosen, and through the designing process in TinkerCAD, this learning is created three-dimensionally. As soon as we get these designs printed, students can actually physically see and hold their creations and see how they work together to serve the purpose of a habitat suitable for their animal.

Reflection:

What Went Well? (*Be thorough - give specific examples)*

S: I think the lesson plan went well in using the powerpoint to explain to the students about measurements and using TinkerCAD. It was able to keep us on track and follow our plan to make the lesson successful. I think the students had a lot of fun tinkering with their models and designing their habitats. I only seen two students get frustrated and upset. Most of the students were very creative and jumped right in. I enjoyed seeing how creative they could be since they had never used the program before.

H: Overall, I think our lesson went well. I think, for the majority, the students got a good grasp on TinkerCAD and the basics of the program. Some students looked at this opportunity to express their creativity and show what kinds of cool habitat items that they could create. Some students even went as far as creating a *whole* habitat rather than just a component of one. Also, students really enjoyed seeing the 3-D examples that we brought in for them to look at and hold. I thought this really put TinkerCAD into perspective and show them what their designs would look/feel like if they were printed.

B: I thought the lesson went well for the circumstances that were presented. The students did a great job with dragging and dropping on tinkercad. The students listened well and logging on was not as difficult as I thought it would be.

What would you change? (*Be thorough - give specific examples & explain why.)*

S: I would have changed the time limits for the students. I would have given them more time to spend in TinkerCAD creating their models to print. I believe combining two classrooms into one was ok, but there were only two of us in the room who were experienced with the program trying to help 45 students and teachers understand how to use certain features. Some of the students did not finish their designs. I also think the lesson would have went better if it was not right at the end of the day. The students were very interested in learning about the designs and seeing what we brought, but I felt like we were rushed.

H: If I were to change anything of this lesson, I would also have to say the time limitations. More time was definitely needed for the students to work on their designs and express their full creativity through their habitats. I felt like the time limitation put pressure on a lot of students to put something together and finish. For example, some students only put together one, basic component of a habitat, like a ball for a toy, instead of building upon that creatively. Also, because of the lack of time, we were not able to finish and allow student's time for completion of the exit ticket, or our summative assessment. With more time, it would have allowed students to complete that and give us, as teachers, more insight of how the students felt about the program.

B: If I had anything to change I would change the time that we had to do everything. I feel like this lesson may have been better over a two day time rather than just an hour and a half. I also would have changed the amount of students in each class. It was difficult to try to get to every student because students were everywhere. In the end I believe the students received a concept of what tinkcad is and hopefully it'll be easier for them in the future.