“STEM” into Instructional Design

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IT 651 - System Design of Performance Technology

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Part I: Needs Assessment

Background:

In education, there has been an emphasis on instructional strategies that will help students become college and career ready by high school graduation. In the 21st century teachers have shifted from just teaching content to having students learn through team building and problem solving activities. Science, Technology, Engineering and Mathematics (STEM) education has become important to get students ready for their career choices. STEM education allows students to enjoy learning by applying their skills to real-life situations. According to William L. Havice, “integrative STEM education involves problem-based and project-based learning that allows learners to explore real-world problems, simultaneously developing cross-curriculum skills while working in small, collaborative groups” (2015). STEM education has become a high demand in schools around the country. Schools are always looking for employees specializing in STEM related fields.

Current Situation:

In school districts all around the country students are often disengaged in classroom settings. Fun and engaging STEM based learning environments are often proposed as a possible solution to this apathy. According to Alpaslan Sahin and Namik Top, “statistics have shown that U.S education suffers from lack of rigorous K-12 education, especially in STEM areas” (2015). This article shows how a certain type of STEM education specifically helps students have fun and learn about relevant subject

areas. An example of a school that uses this approach is Harmony Public Schools in Houston, Texas, which has adopted a new program called STEM Students on the Stage (SOS). This approach focuses on standards-based, project-based learning, which allows students to have individual choice with their projects.

In 2009, President Obama assembled *Educate to Innovate,* whose main goal was to move American students from the middle of the pack to the top in math and science. According to President Obama, one of the things he has been focused on as President has been to create a more hands-on learning approach with the STEM classes. Not only was he focused on the students becoming better thinkers and learners, he was also worried about training the teachers to be there for their students. According to the President, “We need to make this a priority to train an army of new teachers in these subject areas, and to make sure that all of us as a country are lifting up these subjects for the respect that they deserve” (Reeve). The President believes that we have to broader the scope to *all* learners. This means that we need to get more minorities, girls, and other underrepresented groups involved in STEM studies. Science, mathematics, engineering and math have been the more important subject areas due to making connections with them to real-life situations.

Ideal Situation:

In education, everyone wants students to be college and career ready. In order for this to happen students need to see more STEM lessons in their day-to-day school life. As mentioned above many schools have transferred their whole school over to

teaching STEM lessons everyday. Not all schools can do this, as it is both a time consuming and resource intensive endeavor. For many schools, realistically, the solution may be more granular, in that they may be able to integrate these STEM skills into existing subject areas through adding new small-scale lessons, or modifying existing lessons to incorporate STEM skills. Further still, game-based STEM activities, that can be integrated into smaller lessons, are fun ways to get students engaged in learning. According to Anthony K. Betrus and Luca Botturi’s article, *Principles of Playing Games for Learning*, there are many advantages to playing games, which includes increased motivation, getting a complex understanding of content, reflect their own learning, getting feedback and self-regulation (2010). These small-based STEM games can be powerful because they give students more ambition to learn in a fun new way.

This way the teachers are still able to teach the content they need to cover throughout the school year. It also gives the students a better connection to what they are learning because they are involved in more hands-on lessons.

Identified Needs and Gaps:

There is a large need for workers with degrees in math, science, technology, and engineering. The growth of jobs in the science and engineering fields has increased by 1.4%, but the workforce has only grown .2%. Although there is a growth in science and engineering fields, there are only about 70,000 engineers in the U.S. According to the Trends in International Mathematics and Science Study (TIMSS) in 2011, only 7% of 8th graders in the U.S. showed advanced mathematics knowledge (viewing STEM pbl

influence). This is something that needs to be changed by adding more STEM lessons in curriculum throughout a student’s educational career. An interest needs to be sparked by letting these students create their own learning.

According to Million Women Mentors, a nonprofit, women hold fewer than 25% of jobs in STEM fields in the United States (Fueling). Now more than ever we need to encourage young women to participate in science and math courses. In order to do this, we need to implement these real world examples and STEM projects into the curriculum. Melissa Moritz, deputy director of STEM initiatives at the U.S. Department of Labor suggests that teachers should be encouraging students to explore the world around them and ask questions as early as Pre-K (Fueling).

Part II: Task Analysis

Game Overview:
Robot turtles board game consists of players moving across the playing board to gain robot jewels.

Target Audience:
Elementary students age 3-8

Objective:
The students will be *organizing* their cards in a sequence of when they used them to create a program.

Task:
The Turtle Master draws one of his/her cards and places it in front of him or herself next to other cards if they have been played.

Objective:
The students should *collaborate* with the Turtle Mover why they used the specific card they chose to move their Turtle.

Task:
The Turtle Masters will discuss with the Turtle Mover why they made that specific move. Why the move was or was not a good choice, or why they chose a different move. If at any time a Turtle Master wants to undo their turn, he or she just needs to say, “Bug” and tap on their Bug Tile. This allows for the Turtle Master to play a new card. (Note: This can only be done before a Turtle Master makes his/her next turn).

Objective:
The students will make *predictions* by drawing the path of their Turtle on scratch paper as a guide to how they want their Turtle to reach the Jewel Tile.

Task:
Using scratch paper to draw a path of the Turtle so the students can have a visual of how they want their Turtle to move.

Game Overview:
Cubetto is a robot with a variety of functions, and some of these functions include Cubetto moving forward and turning to be able to make it to his home.

Target Audience:
Children ages 3 and up

Objective:
The students will be *discussing* why they are programming Cubetto the way they have been.

Task:

Discuss with the students why they chose to have Cubetto go that specific route to get him home. This may help bring about additional questions such as,
Could there be a different approach?
What might work better?
How did you feel during the game?

Objective:
The students will make *predictions* on scratch paper where they believe is the best way to get Cubetto home.

Task:
Students will be drawing a sketch of the program Cubetto will be performing when moving through the map, so they have a visual of the moves Cubetto made throughout his journey.

Objective:
The students will *experiment* with Cubetto to come up with a different activity that involves Cubetto performing a different task.

Task:
The students can turn Cubetto into a drawing bot. Students can use tape to hold markers on each side of Cubetto to allow for him to draw circles.
You can create a maze where Cubetto has to find his way out.
Using a variety of other maps and incorporate Cubetto into the theme some how, such as on the space map, create a jetpack on Cubetto to make it seem like he is actually in space.
Create a storyboard using other maps to have Cubetto be the main character and have certain things happen in the story.

(Note: These are just some of the other activities you can do with Cubetto, Here is a link where you can find more, https://www.primotoys.com/resources/)

Game Overview:
Welcome to the Bee-Bot web site! Bee-Bot is an exciting new robot designed for use by young children. This colorful, easy-to-operate, and friendly little robot is a perfect tool for teaching sequencing, estimation, problem-solving, and just having fun!
Sturdy construction and colorful design entice children to put Bee-Bot through its paces. Directional keys are used to enter up to 40 commands which send Bee-Bot forward, back, left, and right. Pressing the green GO button starts Bee-Bot on its way. Bee-Bot blinks and beeps at the conclusion of each command to allow children to follow Bee-Bot through the program they have entered and then confirms its completion with lights and sound. Children want to use Bee-Bot over and over and are inspired to enter ever more creative and complex command sequences.
Bee-Bot moves in 6” steps and 90º turns. Compact size and durable materials make Bee-Bot child- and classroom-friendly. Bee-Bot is equally adaptable to home and school environments and boosts enthusiasm for experimentation and learning wherever it is

used. Bee-Bot is powered by a built-in rechargeable battery. Recharging is done via a standard USB recharger or USB computer port. A USB recharger cable comes with each Bee-Bot.

Target Audience:
Children ages 4-8

Objective:
The students will be *experimenting* with Bee-Bot so they can get used to how it works to use his functions for activities.

Task:
Students will experiment with Bee-Bot to get the feel for his actions.

Objective:
The students will be *applying* the activities they did with Bee-Bot to create their own activities involving Bee-Bot.

Task:
The students will come up with an activity involving Bee-Bot to learn a new task. Teacher can help with these activities if students get stuck.

Objective:
The students will *use* Bee-Bot to program to make him move around an obstacle course.

Task:
The teacher will have an obstacle course setup where the students will need to write down the program when going through the obstacle course. The students will have to make their way around the course by making Bee-Bot moving forward, backward, left, etc.

Game Overview:
Osmo Coding uses beautifully crafted physical blocks to control Awbie™, a playful character who loves delicious strawberries. Use coding commands to help Awbie on a wondrous tree-shaking, strawberry-munching adventure! Start with simple coding combinations and build up to more challenging ones as you discover his world.

Target Audience:
Children ages 5-12

Objective:
The students will look around the map and *identify* which coding blocks they need to use to get to the next part of the map.

Task:
Observe the map and think of ways they could make it passed the part of the map.

Objective:

The students will be *engaged* in the debriefing stage when discussing their feelings about the game.

Task:
The students will discuss how they feel about the coding aspect and what they think of the game.

Objective:
The students will be *experimenting* with the coding blocks to get from Point A to Point B with Awbie.

Task:
Basically, the students will be using a variety of coding blocks to move the main character in the game, Awbie around in his world to collect strawberries and other collectible things in the world.

Objective:
The students will use scratch paper to *sketch* the programming code used throughout the game so they know exactly how they went from area to area.

Task:
The students will be drawing the code they will be using on scratch paper so at the end of the game, they have a long program showing how they got through the maps.

Game Overview:
Osmo is a unique gaming accessory that will change the way your child plays. The groundbreaking system fosters social intelligence and creative thinking by opening up the iPad to the endless possibilities of endless play.
(Note: The objectives and tasks that go along with Osmo in this document are specific with all of the various games, such as Osmo - Numbers, Words, etc.)

Target Audience:
Children ages 6 and up

(Osmo - Newton) Objective:
The students will be *predicting* how they will go about solving the task by using scratch paper to make their predictions.

Task:
Students will draw on scratch paper where they think the balls will come from to fill up the light.

(Osmo - Words) Objective:
Students will be *engaged* in the debriefing by discussing strategies that worked and did not work.

Task:

The students will be discussing how they felt during this game. Ask questions such as,
What did you learn?
Were some of the levels more difficult than others, and if there strategy changed?

Objective:
The students will *create* a running document of all the words used in the game to refer to them later on.

Task:
Students will use scratch paper to write down each of the words used throughout the game to eventually use them for an additional activity later on.

Objective:
The students will *use* the words from the game they used in their running document to make flash cards.

Task:
Using all of the words from the game, we will create flashcards using index cards that will help students practice spelling and practice sounds of vowels.

(Osmo - Numbers) Objective:
The students will be *experimenting* with numbers to creatively come up with their own number problems and solutions.

Task:
We could use the numbers for creating number problems for the students to solve, starting out easy and keep getting more complicated.

Objective:
The students will be *solving* math problems using the iPad and Number Tiles laid out in the play area in front of the iPad to learn math facts.

Task:
Since the students have what they need setup, they can begin by solving math problems on the iPad using the Number Tiles.

Objective:
Using the created math facts, the students will be *tested* on how well they can name their math facts as quickly as they can.

Task:
Have students create their own activities that involve learning math facts. After the students have created their math flashcards using the numbers, we will begin by testing the student’s fluency.

Game Overview:
In Code Master, your Avatar will travel to an exotic world in search of power Crystals. For all 60 levels, you’ll have to use programming logic to help your Avatar collect the Crystals and land at the Portal. Think carefully, in each level, only one specific sequence of actions will lead to success.

Target Audience:
Children ages 8 to adult

Objective:
The students will *discuss* with their partners about their thought processes before starting the level.

Task:
The students will be discussing with their partner about everything that is going through head for trying to complete the various levels.
Ask the questions,
Why should we start here?
Why can we only go this way?
Which Action Tokens do we need to use on this level?
How should we place the Action Tokens on the Guide Scroll?

Objective:
The students will be *explaining* to the class what they wrote in their journals to make sure they wrote a journal entry.

Task:
After reaching the Portal on each level, the students should discuss with their partners some of things they were writing in their journals. During the debriefing, the instructor will randomly point to a specific attempt outlined in the student's journal, and ask them to explain what they did to the class.

Objective:
The students will be *recording* their solutions in a performance record so they can keep track of how they beat each level.

Task:
Students will record their solutions after each successful attempt, and note their logic in an associated space next to their solution, using the guide sheet provided by the instructor.

Objective:
The students will *create* their own visual representation of the guide after they complete each level by labeling each action token.

Task:
Have students transcribe/draw the visual solution from the scroll and overlaid chips. Place students solutions on the document camera (elmo) to show to the rest of the class, have them explain how they arrived at

their solution (they should refer to their notes next to their recorded solution to do this).

Game Overview:
Snap Circuits works in just three steps: Snap together magnetic circuit blocks, drag-and-drop wireless programming right from the iPad app, and the smart lens technology gives you x-ray vision to see how things work.

Target Audience:
Children ages 7 and up

Objective:
The students will *reflect* on how they can use the Snap Circuits after experimenting with them.

Task:
Before starting any activities with the Snap Circuits, the students will experiment with them to figure out the different uses of them. This might include using them as a flashlight for example.

Objective:
The students will *create* an activity or game that involves the Snap Circuits being the main materials, then being able to execute the activity or game.

Task:
The students will then come up with an activity that involves using Snap Circuits to focus on a particular task.

Game Overview:
Cranium Cadoo is the outrageously fun game designed especially for kids. Every turn gets players creating, thinking, giggling, and grinning. You won’t believe what cans can do!

Target Audience:
Children ages 7 and up, but there needs to be at least two players.

Objective:
The students will be *demonstrating* various tasks by drawing cards and acting out what the card says.

Task:
The students will start by drawing cards after rolling the die and they have to act out, sculpt, or decode whatever to card says to do.

Game Overview:
Instructures is a challenging and competitive game for a variety of ages and skill levels. Two teams race to build the structure on the card. (The Blueprint) by using only verbal

instructions from one team member (The Foreman). The team to correctly complete the structure wins the round and is one step closer to winning the game!

Target Audience:
Children ages 8 and up, but there needs to be at least four players.

Objective:
One student on each team will be *repeating* clues to another teammate so he or she can create various structures.

Task:
The students will choose a blueprint manager and a foreman on each team. The foreman begins instructing his/her crew by giving hints.

Objective:
The students will *discuss* how well they were able to build the structures.

Task:
Decide whether or not the crew has to switch jobs (if someone else wants to be the foreman next time or the crew and vice versa).

Game Overview:
Today, Dartmouth College’s Tiltfactor, an interdisciplinary studio that designs and studies games for social impact, announced the launch of two new crowdsourcing games, Smorball (smorballgame.org) and Beanstalk (beanstalkgame.org). The games have been created to improve access to books and journals online in the Biodiversity Heritage Library (BHL) collection by verifying the accuracy of text previously encoded by optical character recognition software (http://www.tiltfactor.org/game/smorball/).

Target Audience:
High School Biology/Science Students or possibly Computer Science students.

Objective:
Students will first understand the context in which the game exists, and the purpose for playing it.

Task:
The students will participate in some sort of research about the game and reporting of it to the group.

Objective:
They will then engage with the game, and then reflect about what contributions to the Biodiversity Heritage Library they made, and how they think their playing helped.

Task:
The students will now begin to experiment with the game by typing the words how they appear on the screen.

Task:

The students will then participate in group reflections about their potential contributions to the game.

Game Overview:
Tynker helps children develop programming and computational thinking skills in a fun, intuitive, and imaginative way. Over 28 million children have started learning to code with Tynker, both at home and in school. Tynker courses build a strong foundation in STEM skills (science, technology, engineering, and math) and critical thinking abilities, preparing children for 21st century degrees, careers, and lives. Tynker is based in Mountain View, CA and is backed by NEA, GSV Capital, Cervin Ventures, Reach Capital, Felicis Ventures, 500 Startups, New School Ventures, and prominent angel investors. Visit us at www.tynker.com,www.facebook.com/gotynker or www.twitter.com/gotynker

Target Audience:
Children ages 8 and up

Objective:
Given a laptop students will complete a game on tynker to practice a math skill.

Task:
The students will use games like minecraft on tynker to learn a math skill.

Game Overview:
With Scratch, you can program your own interactive stories, games, and animations — and share your creations with others in the online community.
Scratch helps young people learn to think creatively, reason systematically, and work collaboratively — essential skills for life in the 21st century.
Scratch is a project of the Lifelong Kindergarten Group at the MIT Media Lab. It is provided free of charge.

Target Audience:
Children ages 7 and up

Objective:
Given a laptop students will recreate a math concept using block code.

Task:
The students will log on to scratch and create a new project.

Task:
The students will then recreate a math topic taught in class by using the block code

Game Overview:
http://mathbydesign.thinkport.org/default.aspx?skipTo=windjammer&cb=1475716552114
Get creative, build, play and learn! Students become virtual junior architects of two interactive environments, Flossville Town Park and Windjammer Environmental Center to build a skateboard ramp, cover a picnic area, dig out a pond and more. As students

work their way through mind-boosting challenges, they use critical thinking and problem solving skills to increase their knowledge of geometry and measurement concepts. Real-life Math in Action videos embedded in the interactive demonstrate how math is used in everyday life from decorating cakes to designing landscapes or creating beautiful sculptures. *(For students taking Algebra I and II)*

Target Audience:
Students ages 14 and up

Objective:
Given a laptop the students will use math topics from Algebra I to solve real life construction problems.

Task:
The students will use their prior knowledge of topics like perimeter to solve park construction problems.

Game Overview:
Two Lives Left and Rui Viana have released Cargo-Bot, a puzzle game where the player commands a robot to sort crates. Cargo-Bot presents players with fiendishly clever puzzles and features stunning retina graphics. It is available for free on the App Store.

Target Audience:
Children ages 12 and up

Objective:
Given a laptop the students will solve the different puzzles using logic

Task:
Students will use the crane in the game to move the crates to different platforms according to the puzzle.

Game Overview:
According to Graphite.com, “*Light-bot…was developed for kids by an undergraduate student who’s been coding since he was a kid himself.*” As such, this student-centered, STEM education app teaches computer programming concepts through puzzles and problem-solving tasks. Students move a robot through a maze by using programming commands, Boolean Logic, and conditionals. This is a fun, game-based way to teach students the basics of programming. Also, check out the Hour of Code Special Online Edition!

Target Audience:
Children ages 4 and up

Objective:

Using a laptop the students will move the robot using code to make the squares light up

Tasks:
The students will use code blacks to move the robot around the puzzle to light up the blue square

Game Overview:
We are parents like you. Some of us even struggled with math as kids. We now work hard to make sure children can effectively learn math while having fun. We have a mission: bringing math to life!

Our company was co-founded by Jean-Baptiste Huynh, a math teacher who was frustrated because he felt he was failing his students. Traditional teaching methods were simply not working for his students so he decided to innovate. His research lead him to a simple, but powerful learning strategy: play! A few years later, DragonBox Algebra was born and has been widely praised as one of the most innovative math learning games of all time.

We listen to children. We play with them. Each one of our award-winning DragonBox games underwent hundreds of iterations, based on the feedback of kids, parents and teachers.

At WeWantToKnow we take video games very seriously. We make sure that they are extremely fun and engaging. We also work very hard so they provide rigorous, effective learning. Actually, our team includes many PhDs, and we work together with universities and schools around the world to make sure our products really help kids to improve their learning.

Target Audience:
Children ages 4 and up

Objective:
Using a tablet and internet access the students will solve basic equations in game form

Task:
The students will use the game to sharpen their basic algebra equation solving skills by playing this game.

Game Overview:
Lure of the Labyrinth is a digital game for middle-school pre-algebra students. It includes a wealth of intriguing math-based puzzles wrapped into an exciting narrative game in which students work to find their lost pet - and save the world from monsters! Linked to both Common Core and national (NCTM) standards, the game gives students a chance to actually think like mathematicians.

Target Audience:
Children ages 12 and up

Objective:
Using a laptop the students will solve math based puzzles

Task:
The students will play the multiple games available to practice their math skills

Game Overview:
The challenges and laser make the hugely popular Laser Maze Game fun. The fact that it’s a logic maze game that teaches STEM skills makes it a perfect game for anyone. Laser Maze requires you to use mirrors, beam-splitters, a little science and brainpower to direct the laser through a series of mind-challenging mazes and light up the target. This award-winning maze game is designed for solo play, but it’s so much fun everyone in the family will want a turn.

Target Audience:
Children ages 8 and up

Objective:
Using the game board students will solve the puzzle using logic.

Task:
The students will solve the lazer puzzle using logic and science skills.

Game Overview:
It’s a maze game. It’s a marble game. Actually, it’s a gravity-powered logic maze game that builds reasoning skills and visual perception. The best part is – it’s fun to play and learn! Use the challenge cards to strategically place towers and create a path for your marble to reach the target. With 60 challenges to test your skills, this fun maze game is definitely a marble run for brainiacs!

Target Audience:
Children ages 8 and up

Objective:
Using the game board given the students will solve the gravity puzzle by using logic skills

Task:
The students will try and solve the puzzle given by setting up the blocks and getting the marble through the hole.

Game Overview:
Crafty Cut is a unique puzzle game which allows the player to explore the relationship between 2D and 3D geometry.
Using an intuitive cutting mechanic, the player is tasked with revealing new 2D facets from an increasingly complex array of 3D shapes, delivered through ‘Easy’, ‘Tricky’ and ‘Fiendish’ level progression.

Each level presents a target shape which must be revealed within a set number of moves from a specific 3D object. Performance is based on the quality of the match and graded on a three-star criteria: correct number of sides, correct internal angles, and correct length of sides.
The game aims to give students a hands-on experience of manipulating 3D objects, breeding familiarity with the names and properties of 2D and 3D shapes and creating confidence with them generally. The broader aim is to make maths less intimidating by presenting it in a fun and visually arresting way.

Target Audience:
Children ages 14 and up

Objective:
Using a tablet and internet access the students will practice their geometric shapes.

Task:
The students will get a geometric shape and will use their finger to cut it apart into other shapes.

Game Overview:
FAKTR is an arcade-style action game about prime factorization, developed for iOS and Android tablets as part of the Amplify Curriculum. FAKTR gently teaches players about the difference between prime and composite numbers and how to factor numbers by creating factor trees. It also provides a lot of practice for determining which prime numbers divide evenly into composite numbers under 150, without resorting to “flash card mechanics”. Although it’s designed for students in grades six through eight, it’s been enjoyed by players as young as six!

Target Audience:
Children ages 12 and up

Objective:
Using a tablet and internet connection the students will practice their factoring skills.

Task:
The students will factor numbers by doing the puzzle on the app.

Game Overview:
The students will be building a structure out of spaghetti and marshmallows to see who can hold the most amount of weight.

Target Audience:
Children ages 8 and up

Objective:

Using the tools given the students will build a structure to hold a textbook.

Tasks:

The students will build a pulley machine out of spaghetti and marshmallows to build a structure to hold a textbook.

Part III: Learner Analysis

Learner’s Ages:

These lessons are designed for students in grades PreK-12th, ages 3-18.

Learner’s Abilities and Socioeconomic Status:

Learners abilities will vary as these lessons are meant for students all around the country. Therefore, most classrooms are all inclusive, which means many students may have an Individualized Educational Plan (IEP). Recommendations will be made to the accommodations for those specific students.

Learner’s Demographics:

Again, learner’s abilities will vary since these lessons are designed for any teacher to use across the country. Therefore, the demographics of the students will vary.

Academic Motivation:

STEM related games and activities have been an important aspect for teacher to use in their classrooms to help learners become more engaged in the skills needed to gain 21st century skills. Generally, STEM games and activities focus on a specific concept in the desired subject area(s).

Previous Experience:

Students in PreK-4th grade will not need any prior experience with code or code language for the lessons that are being designed. Students in 5th grade-12th grade will need some prior knowledge of coding to little experience.

Learning Styles:

There will be a variety of STEM games from PreK-12 to help students have fun and enjoy subject areas such as science, technology, engineering and mathematics. All learners will be considered as well as their various learning styles.

Learners Attitudes and Perceptions:

We hope to get learners more interested in Math, Science, and Technology by using small-based STEM-related games/activities and 21st century skills.

“Active learning strategies, in which students must engage, think, and solve problems, have been shown to increase retention of knowledge; develop higher-order skills such as analysis, synthesis, and evaluation; and increase student retention in STEM fields.” (https://www.whitehouse.gov/blog/2016/08/17/call-action-incorporating-active-stem-learning-strategies-k-12-and-higher-education) This is why getting students involved in STEM education is so important. It allows them to retain information better, which in turn makes them a better learner. Standing at the front of the room and lecturing is just not cutting it anymore for students in the 21st century. They need these different ways to learn and grow as students in order to succeed in the classroom. Also, when they are learning and using these higher order thinking skills, the students are creating and using

skills that they will need out in the real world. STEM not only helps students succeed in the classroom but also out in the 21st century.

Part IV: Context Analysis

What is Being Taught:

The STEM lessons will be included into different, already existing, units throughout the school year. The goal of the lessons that are being created are to introduce students to more STEM based activities.

Learner Characterics:

Students may or may not be receptive to teachers using more technology and more relevant content in their classes.

Some students may have IEPs that will need accommodations built into the lessons.

Every student has a different learning style that will also be accounted for.

Environmental Characteristics:

As teachers, we cannot assume each child has access to the internet or smart devices. This is why we are having students engage in the STEM games within a classroom setting to have students learn real world skills.

Available Teaching Materials:

The teacher will have all of the specific teaching materials that the students need for each game or activity.

Budget:

Ideally for this project we would have an unlimited technology budget so that we could have and purchase all of the games and resources that we need. Some of the games or apps are free but many would have to be purchased ahead of time. Most schools have a technology budget that is set aside for things like this, but may not be able to afford all of the items we are using in our lessons. If needed teachers may pick and choose which lessons will work the best for them and their students even if it is just the ones with the free technology!

Administrative Support:

Administrators in schools nationally are supporting the shift toward more STEM lessons. The U.S. is severely behind many other countries when it comes to Math and Science scores. By incorporating these lessons and more real life problems we are trying to raise those scores.

Community Resources:

For some of the lessons, we are having students create their own activities based on using the some of the materials given to them. For example, in the lesson with Bee-Bot, the instructor is having students use materials in the classroom or materials from their home to come up with their own activity that involves solving a particular task with Bee-Bot.

Cultural Constraints:

This will be a challenge for us when we evaluate the lessons because we will not be able to get to know the students before having the students try out the games and activities. We will need to contact the teacher ahead of time so we can get a feel for what kinds of learners we will be dealing with. This could possibly help determine which lessons we have the students perform.

Relevance of Skills in Real Life:

It is extremely important for students to gain problem solving skills and have students use their critical thinking skills because students need these specific skill sets in the 21st century. These skills will help students become college and career ready by high school graduation.

Part V: Instructional Plans & Materials

Topic: Dash & Dot Rescue **Age:** 8-12 **Grade Level:** 2-6 **Time:** 60 minutes

Goals:
To have the students *problem solve* using basic coding skills to circumvent physical obstacles.
Students should *collaborate* with fellow students to make predictions, and revise their predictions based on outcomes.
Students should be self-reflective and be able to *discuss* their strategies both during the activity as well in the debriefing.

Objectives:
1. Calibrate Dash Robot and come up with proportional formula for distance turns (eg: 100 cm = 90 cm or 90 degrees = 110 degrees)
2. Students will *measure* distance and turning radius in predicting what will be needed to circumvent a given obstacle.
3. Students will *collaborate* and *communicate* with fellow students to revise predictions.
4. Students will *express* their rationale for why they did what they did during the debriefing.
5. Students will *extend* their reflection to a narrative that they write after the activity is complete. (optional)

Standards:
P21 Standards
Make Judgements and Decisions
- Reflect critically on learning experiences and processes

Common Core Learning Standards for Mathematics (2.MD), (3.MD), (4.MD), (5.MD)
Measurement & Data
- Measure the length of an object by selecting and using appropriate tools such as rulers, yardsticks, meter sticks, and measuring tapes. (2.MD.1)
- Estimate lengths using units of inches, feet, centimeters, and millimeters. (2.MD.3)
- Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch. Show the data by making a line plot, where the horizontal scale is marked off in appropriate units-whole numbers, halves, or quarters. (3.MD.4)
- Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz; l, ml; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Express equivalent measurements in a two-column table. (4.MD.1)

- Convert among different-sized standard measurement units within a given measurement system (eg., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems. (5.MD.1)

Materials:

A) Fully Charged Dash and Dot Robot
B) Meter Sticks (1 per 2 students)
C) Obstacles (can be themed, or random, teacher’s choice)
D) Scratch Paper
E) Performance Record (Worksheet)

Procedures:

Setup: Turn on Dot and place him in one area (usually a corner) of the room. Place a series of obstacles around the room along a path (6-8 obstacles recommended). You can use tables, chairs, or other furniture to create the path. The path should be essentially “walled off” with empty space in the middle (usually 3-5 feet wide). Along the path, and inside the walls, place various obstacles (pro-tip: try “evil action figures”). Students will need to measure and provide “code” to circumvent obstacles (eg. Move Forward 80 cm, Turn Right 90 degrees, etc.). There should be a clear “start” and “finish” to the walled of path. Think of this as a “gauntlet” for Dash to move through to rescue Dot.

Briefing: Explain to students that “Dot” has been captured and needs to be rescued (Feel free to ad-lib the narrative). Introduce the “obstacles,” and if they are characters, introduce them. Students will in neutral space (not in the obstacle course) input commands to Dash to measure “programmed distance” vs. “actual distance.” For example, “Move Forward 100 cm” may result in Dash moving forward 90 cm due to the floor’s friction.

Action: Students will be presented with the first obstacle. Students will huddle together in groups of 3-4 to predict (based on measurements with their rulers and/or protractors) distances and turns that will be coded. This should be recorded on their scratch paper. Once the obstacle has been successfully conquered, they will transcribe the successful solution to their performance record. (Material D).
Measure Distance
Recommend Code
Test Code
Re-Measure
Re-Code
Until Obstacle is “conquered”

Students will reflect on the choice they made, and if needed change their original input.

It is important for the teacher to observe and take notes. These will be used in the debriefing.

Debriefing:
Ask students “*How do you feel*?” Listen to their answers, and based on their feelings, ask the questions,
“*What happened* to make you feel that way?” They will describe what happened, and you can prod them and ask them why they made the decisions to make these things happen? As you pod them, and enough “things that happened” are brought up, you can ask them, “What would you do differently if you had the chance to do it again?” As they respond and give their feedback, recite back them what they said, but do so using the word “learn” (eg. “So, you learned that it was important to start Dash in the exact same spot each time”).
Then follow up with:
“What else did you learn?“ Listen to their responses, continue as needed to go back to things that happened, moving forward to what they learned, and eventually ask the question, “So why does this all matter?” Asking them to extend their learning beyond this specific classroom event.

Assessment:

1) Students will record in their performance record the ratio of programmed vs. actual distance and turning radius measurements (eg: 100 cm = 90 cm or 90 degrees = 110 degrees)
2) Examine the Scratch Paper to make sure they were recording their predictions
3) Examine the performance record to see that they wrote down the successful codes.
4) Students are engaged in the debriefing. (making eye contact, participating verbally)
5) Narrative of game events is complete, details of how to grade the narrative are up to the individual instructor. (optional)

Scoring Rubric:

Criteria	Unsatisfactory	Developing Skills	Proficient	Exemplary
Calibration	Students have not successfully calibrated the actual vs. programmed distances and turning radius.	Do or do not, there is no try. (Yoda)	Do or do not, there is no try. (Yoda)	Students have successfully calibrated the actual vs. programmed distances and turning radius. (this should be considered a “mastery skill”)
Scratch Paper	Some	At least one	About one half	Scratch Paper

	obstacles have no predictions.	prediction is noted for each problem.	of the predictions have less than 2 predictions noted	shows at least 2 predictions for each of the obstacles.
Performance Record	Students are not able to write in their process for each level.	Students are missing most of the process for each level.	Students are able to write in most of the process, but not all.	Students are able to write in the whole process of what they did for each level.
Debriefing Behavior	Students could not discuss their feelings about the game.	Students could only give 1 or 2 details of how they felt after the game.	Students could express 3 or 4 details about their feelings of the game.	Students successfully discussed with their partner at least 5 details of how they felt after playing the game.
Extending Activity Performance	Students are not able to to come up with a different activity that involves Dash and Dot, and are not able to perform/teach the activity.	Do or do not, there is no try. (Yoda)	Do or do not, there is no try. (Yoda)	Students are able to come up with a different activity involving Dash and Dot, and are able to perform/teach the activity.

Topic: Robot Turtles **Age:** 4-8 **Grade:** PreK-3 **Time:** 60 minutes

Goals:
To have the students *problem solve* using basic coding skills to help the turtles reach their specific Jewel Tile.

Objectives:
1) The students will be *organizing* their cards in a sequence of when they used them to create a program.
2) The students should *collaborate* with the Turtle Mover why they used the specific card they chose to move their Turtle.
3) The students will make *predictions* by drawing the path of their Turtle on scratch paper as a guide to how they want their Turtle to reach the Jewel Tile.

Standards:
NYS Prekindergarten Foundation for Common Core
Engagement
1. Actively and confidently engages in play as a means of exploration and learning.
    A) Interacts with a variety of materials through play.
    B) Uses “trial and error” method to figure out a task, problem, etc.

Materials:
A) Game Board
B) 4 Robot Turtle Tiles
C) 4 Jewel Tiles
D) 36 Obstacle Tiles
E) 4 Bug Tiles
F) 4 Code Card Decks (44 cards each)

Procedures:
Setup:
A) If playing this game for the first time, you will want to punch out all of the tiles (square and round) before you begin the coding.
B) Sort each deck into piles with the symbol on the bottom of the cards. You should have five different piles for each turtle. Be sure to set the Laser and Function Frog piles off to the side and only use the Turn Right, Turn Left and Step Forward cards for the first game.
C) Each Turtle Master (child) choose one out of the four Robot Turtle Tiles and sit on the corresponding side of the board.
D) Now, we can place the Jewel Tiles in the center of the board along with the Robot Turtle Tile in its respective corner.
E) Place each of the card piles (Turn Left, Turn Right and Step Forward) and the bug tile next to the player with the matching colored Turtle (Code cards should be face up).

Briefing:
The Turtle Masters and Turtle Mover will discuss that they need to reach their respective Jewel Tile to win, which is placed in the center of the game board. They will talk about how the youngest player goes first.

Action:

A) The Turtle Master draws one of his/her cards and places it in front of him or herself next to other cards if they have been played.
B) Each time the Turtle Masters draw a card, they should place the cards in front of them in a sequence so they have a long program showing everyone how the Turtle reached the Jewel Tile.
C) The Turtle Masters DO NOT move their Turtle Tiles, instead, the Turtle Mover will move them for the players while making funny turtle noises.
D) The game is not over until ALL Turtle Masters have created a specific program of Code Cards that has them reaching the Jewel Tile.
E) The Turtle Masters will discuss with the Turtle Mover why they made that specific move.
F) If at any time a Turtle Master wants to undo their turn, he or she just needs to say, “Bug” and tap on their Bug Tile. This allows for the Turtle Master to play a new card. (Note: This can only be done before a Turtle Master makes his/her next turn).
G) After the Turtle Masters have been playing for a while, and really have a good grasp on the game, then you can start adding in Unlockables. (This includes, Ice Walls, Laser Card, Stone Walls and Crates. Be sure to only introduce ONE Unlockable card at one time).

Debriefing:
The players will discuss with another player how they felt about the game. Talk about what they learned, what they found difficult, what was simple, etc.

Assessment:

1) Students will be graded on, if they created a sequence of cards to have a long program at the end of the game.
2) Students will be engaged in the debriefing.
3) Examine scratch paper to be sure students recorded their predictions.

Scoring Rubric:

Criteria	Unsatisfactory	Proficient	Exemplary
Program	Not creating a sequence of cards throughout the game.	Placing some cards in a sequence throughout the game.	Having a long sequence at the end of the game with all cards used.

Discussion	Not communicating with Turtle Mover about why they made the decisions they did throughout the game.	Do or do not.	Communicating with Turtle Mover why they decided to move their Turtle Tile to specific places.
Scratch Paper	Students did not use scratch paper to make predictions.	Do or do not.	Students used scratch paper to make predictions of the route they wanted their Turtle Tile to go to get to the Jewel Tile.

Topic: Cubetto **Age:** 3-7 **Grade:** K-2 **Time:** 60 minutes

Goals:
To have students use *problem solving* skills and *communication* to complete a variety of tasks for Cubetto.
Objectives:

1) The students will be *discussing* why they are programming Cubetto the way they have been.
2) The students will make *predictions* on scratch paper where they believe is the best way to get Cubetto home.
3) The students will *experiment* with Cubetto to come up with a different activity that involves Cubetto performing a different task.

Standards:
P21 Standards
Collaborate with Others

- Demonstrate ability to work effectively and respectfully with diverse teams
- Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal

ISTE Standards
Creative Communicator for Students

6b Students create original works or responsibly repurpose or remix digital resources into new creations.

Materials:

A) 16 Coding Blocks (4 Forward, 4 Left, 4 Right, 4 Function)
B) 1 Interface Board
C) 1 Cubetto Robot
D) World Map
E) Story Book
F) Instruction Manual

Procedures:
Setup:
Choose which map you would like to play on and place the control board in front of the students. Next steps include, taking out the three different types of blocks to use on the Control Board.

Briefing:
Discuss with the students they will need to use the blocks in order to help Cubetto move around the map. The different blocks being used will be Forward, Left, Right, and Function.

Action:

A) Students will read through the instruction manual to figure out how to play and if the students are not able to read then an adult or older relative can help to explain the rules.
B) Students will start by taking turns getting used to the coding blocks and programming Cubetto so he can make it around the map.
C) Students will be drawing a sketch of the program Cubetto will be performing when moving through the map, so they have a visual of the moves Cubetto made throughout his journey.
D) After students have become comfortable with the game, the students can be timed to see who can have Cubetto make it home quicker.

Debriefing:
Discuss with the students why they chose to have Cubetto go that specific route to get him home. This may help bring about additional questions such as,
Could there be a different approach?
What might work better?
How did you feel during the game?

Extending Activities:
1) The students can turn Cubetto into a drawing bot. Students can use tape to hold markers on each side of Cubetto to allow for him to draw circles.
2) You can create a maze where Cubetto has to find his way out.
3) Using a variety of other maps and incorporate Cubetto into the theme some how, such as on the space map, create a jetpack on Cubetto to make it seem like he is actually in space.
4) Create a storyboard using other maps to have Cubetto be the main character and have certain things happen in the story.

(Note: These are just some of the other activities you can do with Cubetto, Here is a link where you can find more, https://www.primotoys.com/resources/)

Assessment:
1) Students will be engaged in the debriefing stage where they will discuss how well the path worked or did not work.
2) Have students use scratch paper to predict the best way they think Cubetto can make it to his home from where they started.
3) Have students come up with additional activity where Cubetto can carry out a different task other than just being programmed to move across a map. (This can be any of the extended activities that have been suggested, or be a made up activity created by the student).

Scoring Rubric:

Criteria	Unsatisfactory	Proficient	Exemplary

Discussion	Not discussing with partner about how well they were able to get Cubetto to his home, or the troubles along the way.	Do or do not.	Discussing with partner how well they were able to get Cubetto get home, or the troubles along the way.
Scratch Paper	Students have not used the scratch paper to outline their path to help Cubetto get home.	Do or do not.	Students created an outline on scratch paper with the path of Cubetto to reach his home.
Extended Activity	Students could not come up with an extended activity involving Cubetto to learn a different task.	Do or do not.	Students were able to come up with an extended activity that involved using Cubetto to learn a different task.

Topic: Osmo Games - Newton **Age:** 5-7 **Grade:** K-2 **Time:** 60 minutes

Goals:
The students will be participating in a variety of games and activities that involve *critical thinking, problem solving* skills, and *communication*.

Objectives:
1) The students will be *predicting* how they will go about solving the task by using scratch paper to make their predictions.

Standards:
P21 Standards
Implement Innovations

- Act on creative ideas to make a tangible and useful contribution to the field in which the innovation will occur

Materials:
A) iPad
B) iPad Base
C) Reflector
D) Piece of Paper/Whiteboard

Procedures:
Setup:
A) To start, the students will need to place the iPad into the base and attach the reflector to the front camera of the iPad.
B) Next, the students should place a white clean sheet of paper and use a pencil (to draw the lines/erase the lines to create new lines) or whiteboard in front of the iPad. This will be your canvas for drawing.

Briefing:
The students should predict what would happen if they took a certain approach, and why it will/will not work.

Action:
The students will be drawing lines on the paper/whiteboard to help the balls fill up the balls of light.

Debriefing:
The students should discuss why their strategy did or did not work. This should spark other questions,
How did you feel about the game?
What would you change if you could do it again?
What was the best/worst strategy?

Assessment:

1) The students will communicate with a partner and need to write down their predictions on scratch paper to determine if their predictions were right.

Topic: Osmo Games - Words **Age:** 5-7 **Grade:** K-2 **Time:** 60 minutes

Goals
The students will be participating in a variety of games and activities that involve *critical thinking, problem solving* skills, and *communication*.

Objectives
1) Students will be *engaged* in the debriefing by discussing strategies that worked and did not work.
2) The students will *create* a running document of all the words used in the game to refer to them later on.
3) The students will *use* the words from the game they used in their running document to make flash cards.

Standards
P21 Standards
Apply Technology Effectively
- Use technology as a tool to research, organize, evaluate and communicate information

Materials:
A) iPad
B) iPad Base
C) Reflector
D) Flat Surface
E) Letter Tiles

Procedures:
Setup:
The students will start by putting the iPad into the base and add the reflector on the camera of the iPad. Make sure you are using a flat surface so it is easy for the reflector to recognize the Letter Tiles.

Briefing:
The students will be discussing some of the different possibilities of words that the picture could be associated with.

Action:
A) Since the students have what they need setup, they can begin by looking at the picture on the iPad. This will give the students hints about which letters they need to use to create the word associated with the picture.
B) We could also use the Letter Tiles to have students spell harder words, without the use of the game as an extended activity.
C) Using all of the words from the game, we will create flash cards that will help students practice spelling and practice sounds of vowels.

Debriefing:
The students will be discussing how they felt during this game. Ask questions such as,
What did you learn?
Were some of the levels more difficult than others, and if there strategy changed?

Assessment:

1) Students will discuss with their partners about the strategies used for the more difficult levels.
2) Running document on scratch paper with words students created.
3) Flash cards

Scoring Rubric:

Criteria	Unsatisfactory	Proficient	Exemplary
Discussion	Not discussing with partner about the strategies used for the varying difficulty levels.	Do or do not.	Discussing with partner the strategies used for the varying difficulty levels.
Scratch Paper	Student not writing down all of the words used in the game.	Do or do not.	
Flash Cards	Student could not create flashcards using the words throughout the game.	Do or do not.	Student was able to create flashcards using the words throughout the game.

Topic: Osmo Games - Numbers **Age:** 5-7 **Grade:** K-2 **Time:** 60 minutes

Goals:
The students will be participating in a variety of games and activities that involve *critical thinking, problem solving* skills, and *communication*.

Objectives:
1) The students will be *experimenting* with numbers to creatively come up with their own number problems and solutions.
2) The students will be *solving* math problems using the iPad and Number Tiles laid out in the play area in front of the iPad to learn math facts.
3) Using the created math facts, the students will be *tested* on how well they can name their math facts as quickly as they can.

Standards
P21 Standards
Solve Problems

- Solve different kinds of non-familiar problems in both conventional and innovative ways

Materials:
A) iPad
B) iPad Base
C) Reflector
D) Flat Surface

Procedures:
Setup:
The students will start by putting the iPad into the base and add the reflector on the camera of the iPad. Make sure you are using a flat surface so it is easy for the reflector to recognize the Number Tiles.

Briefing:
The students will be discussing some of the different possibilities they can use the number for.

Action:
A) Since the students have what they need setup, they can begin by looking at the picture on the iPad.
B) We could use the numbers for creating number problems for the students to solve, starting out easy and keep getting more complicated.
C) Have students create their own activities that involve learning math facts.

Debriefing:
The students will discuss with their partner how they feel about the activity.

Why this helped or did not help them learn math facts?
Talk about how the students could come up with other ways to learn math facts.

Assessment:

1) The number problems that students come up with to help with math facts.
2) The students will also be graded on how well they can get through the math facts in the game and with the math problems the students came up with.
3) Having a timer and assessing students to see how fast they know their math facts. This is to work on their fluency.

Scoring Rubric:

Criteria	Unsatisfactory	Proficient	Exemplary
Math Problems	Not being able to create own math problems using numbers from the game.	Do or do not.	Creating math problems using numbers from the game.
Fluency	Student is not able to get through any of the math problems in a timely manner.	Student is able to get through some of the math problems in a timely manner.	Student effectively is able to get through each of the math problems with no difficulty in a timely manner.
Extended Activity	Student could not come up with an extended activity involving Cubetto to learn a different task.	Do or do not.	Student was able to come up with an extended activity that involved using Cubetto to learn a different task.

Topic: Osmo Coding **Age:** 5-7 **Grade:** K-2 **Time:** 60 minutes

Goals:
Interact with the game to Use *problem solving* skills to move Awbie around in his world to collect strawberries and interact with a variety of different things.

Objectives:
1) The students will look around the map and *identify* which coding blocks they need to use to get to the next part of the map.
2) The students will be *engaged* in the debriefing stage when discussing their feelings about the game.
3) The students will be *experimenting* with the coding blocks to get from Point A to Point B with Awbie.
4) The students will use scratch paper to *sketch* the programming code used throughout the game so they know exactly how they went from area to area.

Standards:
P21 Standards
Think Creativity
- Use a wide range of idea creation techniques (such as brainstorming)

Reason Effectively
- Use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation

Materials:
A) iPad
B) Reflector
C) iPad Base
D) 2 Awbie Stickers
E) 4 Running Code Blocks
F) 1 Jump Code Block
G) 2 Stop Code Blocks
H) 1 Replay Code Block
I) 1 Caution Code Block
J) 1 Star Code Block
K) 1 Play Code Block
L) 1 - #1 Code Block
M) 2 - #2 Code Blocks
N) 2 - #3 Code Blocks
O) 2 - #4 Code Blocks
P) 1 - #5 Code Block

Procedures:
Setup:

To set up this game, the students will need to place the iPad into the base and attach the reflector to the top of the iPad where the camera is located. Students will begin by learning what each coding block does in the game.

Briefing:
The students will discuss with the teacher the expectations when playing this game.

Action:

A) If this game is being played for the first time, you will be given hints and pop ups that will tell you which coding blocks you need for specific tasks in the game. This is to help you get used to the mechanics of the game.
B) Observe the map and think of ways they could make it passed the part of the map.
C) Basically, the students will be using a variety of coding blocks to move the main character in the game, Awbie around in his world to collect strawberries and other collectible things in the world.
D) The students need to make sure they are placing the coding blocks in the play area (in front of the iPad) so the actions are being programmed.

Debriefing:
The students will discuss how they feel about the coding aspect and what they think of the game.

Assessment:

1) Students will look at part of their map and predict in which direction they will have to go depending on the environment and/or obstacles.
2) Students will be discussing how they were able to make it through specific parts of the game, for an example, why they used the 3-coding block instead of the 2-coding block.
3) After the students have gotten further in the game where there is no more hints, the students will see how they can get from Point A to Point B in the least amount of moves.
4) The students will be using scratch paper to draw their specific programming code so they know how they ended up where they did.

Scoring Rubric:

Criteria	Unsatisfactory	Proficient	Exemplary
Observation	Not being able to determine where to go in the game by looking at the map.	Do or do not.	Being able to look at the map and know where to go.
Discussion	Not being able to	Do or do not.	Communicating

	communicate with partner how they were or were not able to complete specific parts of a map.		with partner how well they got through parts of the game.
Timed Challenge	Not being able to make it through the challenge in a timely manner.	Making it through the challenge but not as quick as partner, or someone else.	Making it through the challenge the fastest.
Scratch Paper	Not drawing the program code to know how they did or did not finish the map.	Do or do not.	Drawing out the program they used for parts of the game to know how they were able to reach the end.

Topic: Bee-Bot **Age:** 6-9 **Grade:** 1-4 **Time:** 60 minutes

Goals:
To have students *problem solve* and use *critical thinking* skills to use Bee-Bot in a variety of different ways.
Have the students *communicate* with their partners about their feelings, and how they can make the activity more fun and engaging.

Objectives:
1) The students will be *experimenting* with Bee-Bot so they can get used to how it works to use his functions for activities.
2) The students will be *applying* the activities they did with Bee-Bot to create their own activities involving Bee-Bot.
3) The students will *use* Bee-Bot to program to make him move around an obstacle course.

Standards:
NYS K-8 Social Studies Framework
K.6c Places, physical features, and man-made structures can be located on a map or globe and described using specific geographic vocabulary.
- Students will correctly use words and phrases to indicate location and direction (e.g., up, down, near, far, left, right, straight, back, behind, in front of, next to, between).

Materials:
A) Bee-Bot
B) Paper
C) Pencil
D) Obstacle Course Items

Procedures:
Setup:
The students just need to Set up by making sure Bee-Bot is fully charged and have an open floor plan.

Briefing:
The students will discuss what they think cardinal directions are.

Action:
A) Students will experiment with Bee-Bot to get the feel for his actions.
B) Then, the students will write down a code using cardinal directions of how they want Bee-Bot to move. For example, left would be west, right would be east, forward would be north, and backward would be south).

C) The students will discuss why or why not Bee-Bot was able to complete the commands. They may need to take a new approach.
D) The students will come up with an activity involving Bee-Bot to learn a new task. Teacher can help with these activities if students get stuck.
E) The teacher will have an obstacle course setup where the students will need to write down the program when going through the obstacle course. The students will have to make their way around the course by making Bee-Bot moving forward, backward, left, etc.

Debriefing:
Have students explain to their partners how they felt with the activity.
What went well?
What did not go so well?
How could we do things differently to make it more fun?
What are some other activities we can use Bee-Bot for?

Assessment:
1) Have the students discuss with a partner the different activities they would do with Bee-Bot when experimenting, and if the students are able to write, have them write it down in a journal.
2) Have the students perform the various activities they came up with to use with Bee-Bot. The students will be graded based on a rubric/checklist.
3) How well the students made it through the obstacle course with Bee-Bot.

Scoring Rubric:

Criteria	Unsatisfactory	Proficient	Exemplary
Discussion	No discussion on the different activities the students came up with.	Do or do not.	Discussion on the different activities the students came up with.
Extended Activity	Student is not able to perform his or her extended activity using Bee-Bot to learn a different task.	Do or do not.	Student was able to create and perform the extended activity using Bee-Bot to learn a different task.
Obstacle Course	Could not program Bee-Bot to make his or her way around the obstacle	Student could make it through the obstacle course through some	Student successfully made it through the obstacle course

	course.	guidance with Bee-Bot.	with Bee-Bot.

Topic: Circuit Maze **Age:** 7-11 **Grade:** 2-6 **Time:** 60 minutes

Goals:
Use *problem solving* skills and *critical thinking* to place blocks on the circuit board to light up the beacons.
To have students *communicate* with their partners how they were able to make the beacons light up.

Objectives:
The students will be *applying* what they know about circuits to create an electronic current.
The students will *discuss* with their partner how well their strategies worked, and if they need to change them to get the beacons to light up.
The students will *create* at least one extended activity/game that they can use electric currents.

Materials:
A) 3 AAA Batteries
B) 1 Game Grid
C) 60 Challenge Cards
D) Instruction Manual
E) 17 Game Tokens (1 two part Power Supply, 3 LED Beacons, 2 Straight, 1 Bridge, 1 Double-Corner, 2 T-Shaped, 5 Corner, 1 Switch and 1 Blocker)

Procedures:
Setup:
Take out all the pieces such as the circuit board and various circuits and beacons. Add in the 3 AAA batteries if there are none in the power supply.

Briefing:
The teacher will ask the students if they know anything about electrical circuits at all. Then, they will predict what they think they will need to do in the game without reading through the instructions.

Action:
A) The teacher and a student will demonstrate how to play the game so that everybody knows what they need to.

B) The students will start by selecting a challenge card and place the desired tokens shown on the challenge card.
C) Next, the students will connect other tokens to the tokens already on the board to light up the beacons.
D) After the students have worked through various difficulty challenges with the game, the students will come up with a write up about an extended activity they can use to create electrical currents.

Debriefing:
Discuss with a partner how they were able to light up the beacons. The students should talk about the strategies they used to place the blocks and get the beacons to light. This could spark some questions,
Are there other strategies that can be used?
Could we place the blocks in other places?

Assessment:
1) If the students were able to light up the beacons.
2) Have students discuss with their partner how well they were able to light up the beacons.
3) Have students create a write up of at least one other activity/game they can use that involves electrical current, then teach the class how to perform the activity/game.

Scoring Rubric

Criteria	Unsatisfactory	Proficient	Exemplary
Lit up beacons	Student could not get beacons to light up.	Do or do not.	Student was able to successfully get the beacons to light up.
Discussion	Not having discussion with partner talking about about the strategies they used to light up beacons.	Do or do not.	Having discussion about the various strategies used to light up the beacons.
Write-up	Not having a write-up of an extended activity students can think that involves electric circuits.	Do or do not.	Having a write-up of an extended activity students can think of that involves electrical circuits.

Topic: Code Master **Age:** 8-11 **Grade:** 3-6 **Time:** 60 minutes

Goals:
The students will *problem solve* when moving through the variety of difficulty-based levels using strategies and critical thinking skills.
Students should *collaborate* with fellow students to make predictions, and revise their predictions based on outcomes.
Students should be self-reflective and be able to *communicate* their strategies both during the activity as well in the debriefing.

Objectives:
1) The students will *discuss* with their partners about their thought processes before starting the level.
2) The students will be *explaining* to the class what they wrote in their journals to make sure they wrote a journal entry.
3) The students will be *recording* their solutions in a performance record so they can keep track of how they beat each level.
4) The students will *create* their own visual representation of the guide after they complete each level by labeling each action token.

Standards:
P21 Standards
Think Creatively
- Use a wide range of idea creation techniques (such as brainstorming)

Materials:
Complete boxed board game, “Code Masters” (1 box per 2 students)

Procedures:
Setup:
Take out all of the materials such as the game board, avatar, crystals, portal, guide scroll and instructions before playing the game. Assign points to various levels (1,2,4,4, green, yellow, blue, red). Indicate that the students should record a log of which puzzles they attempted, how long they took, and whether they were successful or not.

Action:
A) Play a round with the instructor and one other student to model the talk-aloud procedure you would like them to use when playing the game. Model the communication of the problem strategy to the class. Let them know this is how they will be evaluated, NOT just by solving the problem, but by explaining how they solved the problem. Emphasize that they will need to be able to explain how they solved any given puzzle during the debriefing.
B) Pair students into groups of two.

C) Before starting the game, the students will read through the instructions so they know how to play.
D) The students will start by selecting a level and its designated Guide Scroll.
E) The students will place the indicated pieces on the Map and tokens on the Guide Scroll as outlined.
F) The students will experiment with the Action Tokens needed to navigate through the Maps while collecting Crystals and landing on the Portal.
G) After reaching the Portal on the Maps, keep moving through each Map until you reach the last one.

Debriefing:
Discuss with the students how they felt after they have completed the game. Some questions might be,
“How did you feel when you completed a level?”
“How did it feel not completing a level?”
“What other strategies could you use to make it through the more difficult levels?”
What are some of the things you and your partner discussed when making it through the game?”

Assessment:
1) During gameplay students are communicating with each other about their logical thought processes. After successfully completing each puzzle, students can verbalize their problem solving strategy to each other and to the broader class if prompted.
2) During the debriefing, the instructor will randomly point to a specific attempt outlined in the student's journal, and ask them to explain what they did to the class.
3) Students will record their solutions after each successful attempt, and note their logic in an associated space next to their solution, using the guide sheet provided by the instructor.
4) Have students transcribe/draw the visual solution from the scroll and overlaid chips. Place students solutions on the document camera (elmo) to show to the rest of the class, have them explain how they arrived at their solution (they should refer to their notes next to their recorded solution to do this).

Scoring Rubric

Criteria	Unsatisfactory	Proficient	Exemplary
Discussion	Not discussing with partner about thought processes through each map.	Do or do not.	Discussing with partner about thought process through each map.
Journal	Student has not	Do or do not.	Students has

	been writing in a journal with the codes being used, and could not explain them.		written in their journal, and can explain the process of certain levels and maps.
Scratch Paper	Not writing down a running record of the solutions to each map and level.	Do or do not.	Writing down each solution to every map and level.
Scroll	Student can not draw or chooses not to draw the visual solution using the outline of the game scroll to create his or her own.	Do or do not.	Student is able to draw his or her own representation of the solution from the outlined scroll.

Topic: Snap Circuits **Age:** 7+ **Grade:** 2+ **Time:** 60 minutes

Goals:
To have students *communicate* with their partner about the different uses of the Snap Circuits.

Objectives:
1) The students will *reflect* on how they can use the Snap Circuits after experimenting with them.
2) The students will *create* an activity or game that involves the Snap Circuits being the main materials, then being able to execute the activity or game.

Standards:
P21 Standards
Think Creatively
- Use a wide range of idea creation techniques (such as brainstorming)
- Create new and worthwhile ideas (both incremental and radical concepts)

NYS Elementary Science Standards
Standard 4: The Physical Environment
Key Idea 4: Energy exists in many forms, and when these forms change energy is conserved.
4.1e Electricity travels in a closed circuit.

Materials:
A) Circuit Boards
B) Circuit Connector
C) App

Procedures
Setup:
The students will need to take out all of the different circuits. The students will experiment with the circuits to figure out how they work and see the different uses of them.

Briefing:
The students will be collaborating when talking about circuits and how they work. Students will also make predictions of what they think they will have to do, just by looking at the game.

Action:
A) The students will start by going through the instructions and the teacher will be there if they have any questions.

B) We will begin by having a student and teacher playing one or two different challenges so the students have a good understanding of the game.
C) The students will then pair up and experiment with the circuits.
D) Next, the students will write a page explaining the different uses of the snap circuits.

Debriefing:
The students will talk about how they feel about the various uses of Snap Circuits.
Ask the questions,
What did you learn?
What activities did you come up with?

Assessment:
1) Discussion about the various ways to use Snap Circuits.
2) Activity that the students came up with that helps other students learn more about electric currents.

Scoring Rubric

Criteria	Unsatisfactory	Proficient	Exemplary
Discussion	Not having discussions of the various uses of Snap Circuits.	Do or do not.	Having discussions of the various uses of Snap Circuits.
Extended Activity	Student did not come up with an activity, in which he or she can use Snap Circuits.	Do or do not.	Student came up with an activity in which he or she could use Snap Circuits.

Topic: Cadoo **Age:** 7+ **Grade:** 2-5 **Time:** 60 minutes

Goals:
To *communicate* effectively to help team get points based on the hints given to them to score points.
Have students being *creative*, *problem solving*, using *critical thinking* skills while having fun and learn about different things.

Objectives:
1) The students will be *demonstrating* various tasks by drawing cards and acting out what the card says.

Standards:
P21 Standards
Communicate Clearly
- Articulate thoughts and ideas effectively using oral, written and nonverbal communication skills in a variety of forms and contexts
- Listen effectively to decipher meaning, including knowledge, values, attitudes and intentions
- Use communication for a range of purposes (e.g. to inform, instruct, motivate and persuade)

NYS Elementary Science Learning Standards
Key Idea 3: Matter is made up of particles whose properties determine the observable characteristics of matter and its reactivity.

3.1a Matter takes up space and has mass. Two objects cannot occupy the same place at the same time.

3.1c Objects have properties that can be observed, described, and/or measured: length, width, volume, size, shape, mass or weight, temperature, texture, flexibility, reflectiveness of light.

Materials:
A) 300 Cards
B) Cadoo Board
C) Secret Decoder Mask
D) Cranium Clay
E) Colorful Tokens
F) A Six-Sided Die
G) Timer
H) Cranium Pad & Pencil
I) Rules Sheet

Procedures:
Setup:

The students will need to take out the game board and all of the pieces. Make sure to play on a flat surface so that you can place different tools on the game board.

Briefing:
The students will discuss with the teacher what kinds of activities they think they will have to perform during the game. This should spark questions,
What vocabulary terms do you think will be in this game?
What tasks will we have to do?
How do we win?

Action:

A) Before actually starting the game, the students will read through the rules sheet so they know how to play.
B) The students will start by drawing cards after rolling the die and they have to act out, sculpt, or decode whatever to card says to do.
C) The students need to place tokens on the board to get a four-in-a-row to win.

Debriefing:
The students will discuss how they felt after the game.
What did you learn from this game?
Would you play it again?
Do you think this game should be used in school?

Assessment:

1) The students need to apply the card they drew to the task they have to. This is to see how well they know vocabulary terminology and how well they can think on their feet.

Topic: Instructures **Age:** 8+ **Grade:** 3-5 **Time:** 60 minutes

Goals:
Have students look at blueprints to build structures with blocks, using *critical thinking* skills and being able to *problem solve*.

Objectives:
1) One student on each team will be *repeating* clues to another teammate so he or she can create various structures.
2) The students will *discuss* how well they were able to build the structures.

Standards
P21 Standards
Reason Effectively
- Use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation

Make Judgements and Decisions
- Interpret information and draw conclusions based on the best analysis

Materials:
A) 38 Wood Blocks
B) 72 Sets of Blueprints
C) Gameboard
D) Timer
E) Die
F) Instructions

Procedures:
Setup:
A) The students will need to get out the game board and other pieces.
B) Students should then divide them into two construction crews to go against each other.
C) Then, the students will choose a blueprint manager and a foreman on each team.
D) The foreman begins instructing his/her crew.
E) If a player lands on a special space on the board then each player plays that round in the specific way.

Briefing:
The students will communicate who wants to be the foreman, and who wants to be the rest of the crew.

Action:
A) Students will be using the clues given from the foreman to try building the structure only by using the clues.

B) Decide whether or not they need to switch jobs (if someone else wants to be the foreman next time or the crew and vice versa).
C) Continue building structures until a team wins.

Assessment:

1) Looking at how well each team worked together by providing clues to help crew members build the structure.
2) Discussing with the group how well they worked together, in case they need to switch roles.

Scoring Rubric

Criteria	Unsatisfactory	Proficient	Exemplary
Observation	Student did not work well with crew members to create the structures.	Do or do not.	Student worked diligently with crew members to create the various structures.
Discussion	Not being able to communicate with crew members how well they worked together, and if they need to switch roles.	Do or do not.	Being able to communicate effectively with crew members to be able to solve the building projects.

Topic: DragonBox Algebra **Age:** 10-16 **Grade Level:** 6-9 **Time:** 42 minutes

Goals:
Students should be self-reflective and be able to *discuss* their strategies both during the activity as well in the debriefing.
Students should be able to solve on paper, the basic equations given in the game.

Objectives
1.) Using a tablet and internet access the students will solve basic equations in game form

Standards
Expressions & Equations 6.EE
Reason about and solve one-variable equations and inequalities.
- Solve real-world and mathematical problems by writing and solving equations of the form x + p = q and px = q for cases in which p, q and x are all nonnegative rational numbers.

P21 Standards
Make Judgements and Decisions
- Reflect critically on learning experiences and processes

Materials:
A. Tablet
B. Internet Access
C. DragonBox App
D. Scrap Paper

Procedures:
Setup: Each student will begin by turning on and signing into their tablets. They will then open the app on the tablet. Once in they will begin by playing the game.

Briefing: Explain to students that they will be using this app to practice their equation solving in a different way. They will be using this game to refine their problem solving skills and to help those struggling students learn in a different way.

Action: Students will be presented with the first level. As they are solving the levels they will be recording their answers on a separate sheet of paper. As they are doing this you will be taking notes as well so that you can use them during the debriefing part of the lesson.

Debriefing: As they are continuing on to different levels in the game the students will record their work and answers to the questions on their piece of paper. At the end we will discuss as a class what they have learned from playing the game, like which level was the hardest, the easiest parts, if they liked learning this way, etc…

Assessment:

1.) Students will record their answers on a sheet of paper that will be collected at the end of class.
2.) Students are engaged in the debriefing. (making eye contact, participating verbally)

Scoring Rubric:

Criteria	Unsatisfactory	Developing Skills	Proficient	Exemplary
Scratch Paper	Some equations have no solutions.	At least one step is noted for each problem.	About one half of the equations have solutions	Scratch Paper shows all the solutions to the equations.
Debriefing Behavior	Students could not discuss their feelings about the game.	Students could only give 1 or 2 details of how they felt after the game.	Students could express 3 or 4 details about their feelings of the game.	Students successfully discussed with the class at least 5 details of how they felt after playing the game.

Topic: Cargo Bot **Age:** 10-13 **Grade Level:** 6-8 **Time:** 42 minutes
Goals:
To have the students *problem solve* using basic coding skills to solve the obstacles in the game.
Students should be self-reflective and be able to *discuss* their strategies both during the activity as well in the debriefing.

Objectives:
1.) Given a laptop the students will solve the different puzzles using logic

Standards
- Learning and Innovation Skills: Learning and innovation skills increasingly are being recognized as the skills that separate students who are prepared for increasingly complex life and work environments in the 21st century, and those who are not. A focus on creativity, critical thinking, communication and collaboration is essential to prepare students for the future.

Materials:
A.) Laptop
B.) Cargo-Bot app
C.) Scrap paper

Procedures:
Setup: Each student needs to have their laptop signed in and open to the app. Then you should have a class discussion on what the symbols in the game mean. There is directional arrows and symbols for the platforms.

Briefing: Explain to the students that they will be having a contest! Our goal is to complete the puzzle given in the least amount of code. For every level the students will write down their moves and their thought process behind them.

Action: Students will be presented with their first puzzle. They will then use the code blocks to solve the puzzle. They will be moving the crates around to the specific spots the game tells them to. The moves and their thoughts should be recorded on their piece of paper. If the students need to make changes to their solution then they should be recorded as well. It is important for the teacher to take notes as they will be used in the debriefing.

Debriefing: The players will discuss with another player how they felt about the game. Talk about what they learned, what they found difficult, what was simple, what they would do differently etc.

Assessment:

1.) Students will record their steps to finding the solution on their piece of paper.
2.) Students are engaged in the debriefing. (making eye contact, participating verbally)

Criteria	Unsatisfactory	Developing Skills	Proficient	Exemplary
Scratch Paper	Some obstacles have no solutions.	At least one solution is noted for each problem.	About one half of the problems have wrong solutions	Scratch Paper shows the correct solution to the problems.
Debriefing Behavior	Students could not discuss their feelings about the game.	Students could only give 1 or 2 details of how they felt after the game.	Students could express 3 or 4 details about their feelings of the game.	Students successfully discussed with the class at least 5 details of how they felt after playing the game.

Topic: Light Bot **Age:** 10-16 **Grade:** 7-9 **Time:** 42 minutes

Goals:
To have students use *problem solving* skills and *communication* to complete a variety of tasks for Light Bot.

Objectives
Using a laptop the students will move the robot using code to make the squares light up

Standards:
P21 Standards
Learning and Innovation Skills

- Learning and innovation skills increasingly are being recognized as the skills that separate students who are prepared for increasingly complex life and work environments in the 21st century, and those who are not. A focus on creativity, critical thinking, communication and collaboration is essential to prepare students for the future.

Materials:

A) Tablet
B) Internet Connection
C) Light Bot App
D) Separate Sheet of Paper

Procedures:
Setup: Each student needs to have their laptop signed in and open to the app. Then you should have a class discussion on what the symbols in the game mean. There is directional arrows and symbols for the platforms to light them up.

Briefing: Explain to the students that they will be having a contest! Our goal is to complete the puzzle given in the least amount of code. For every level the students will write down their moves and their thought process behind them.

Action: Students will be presented with their first puzzle. They will then use the code blocks to solve the puzzle. They will be moving the robot around to the specific spots the game tells them to light up the blue spaces. The moves and their thoughts should be recorded on their piece of paper. If the students need to make changes to their solution then they should be recorded as well. It is important for the teacher to take notes as they will be used in the debriefing.

Debriefing: The players will discuss with another player how they felt about the game. Talk about what they learned, what they found difficult, what was simple, what they would do differently etc.

Assessment:

3.) Students will record their steps to finding the solution on their piece of paper.
4.) Students are engaged in the debriefing. (making eye contact, participating verbally)

Criteria	Unsatisfactory	Developing Skills	Proficient	Exemplary
Scratch Paper	Some obstacles have no solutions.	At least one solution is noted for each problem.	About one half of the problems have wrong solutions	Scratch Paper shows the correct solution to the problems.
Debriefing Behavior	Students could not discuss their feelings about the game.	Students could only give 1 or 2 details of how they felt after the game.	Students could express 3 or 4 details about their feelings of the game.	Students successfully discussed with the class at least 5 details of how they felt after playing the game.

Topic: Crafty Cut **Age:** 8-12 **Grade Level:** 8-9 **Time:** 42 minutes

Goals:
To have the students problem solve using their geometric shape skills in order to solve the puzzle provided.
Students should *collaborate* with fellow students to make predictions, and revise their predictions based on outcomes.
Students should be self-reflective and be able to *discuss* their strategies both during the activity as well in the debriefing.
Students should be able to create a cross section of a 3D shape by using the app.

Objectives

1.) Using a tablet and internet access the students will practice and explore geometric shapes.

Standards:
Geometry 8.G
Understand congruence and similarity using physical models, transparencies, or geometry software.

- Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them.

P21 Standards
Make Judgements and Decisions

- Reflect critically on learning experiences and processes

Materials:

A) Tablet or iPad
B) Internet access
C) Scrap Piece of Paper

Procedures:
Setup: Each student needs to have their laptop signed in and open to the app. Then you should have a class discussion on how to use the app. The app will ask them to cut the shape in front of them to make it look a certain way. All the student has to do is swipe their finger across the section where they want to cut.

Briefing: Explain to the students that you are having a contest for the person who completes the most tasks.For every level the students will write down their moves and their thought process behind them. The student at the end will win a prize for completing the most challenges.

Action: Students will be presented with their first challenge. The student will use the piece of paper to record their shapes that they cut in the app and the solution to the problems that they are solving. If the students need to make changes to their solution then they should be recorded as well. It is important for the teacher to take notes as they will be used in the debriefing.

Debriefing: The players will discuss with another player how they felt about the game. Talk about what they learned, what they found difficult, what was simple, what they would do differently etc.

Assessment:

5.) Students will record their steps to finding the solution on their piece of paper.
6.) Students are engaged in the debriefing. (making eye contact, participating verbally)

Criteria	Unsatisfactory	Developing Skills	Proficient	Exemplary
Scratch Paper	Some obstacles have no solutions.	At least one solution is noted for each problem.	About one half of the problems have wrong solutions	Scratch Paper shows the correct solution to the problems.
Debriefing Behavior	Students could not discuss their feelings about the game.	Students could only give 1 or 2 details of how they felt after the game.	Students could express 3 or 4 details about their feelings of the game.	Students successfully discussed with the class at least 5 details of how they felt after playing the game.

Topic: FAKTR **Age:** 12-16 **Grade Level:** 6-9 **Time:** 42 minutes

Goals:
Students should be self-reflective and be able to *discuss* their strategies both during the activity as well in the debriefing.
Students should be building on prior knowledge in order to factor some of the numbers that the game is asking them to factor.
Students should be applying and practicing their factoring skills.

Objectives

1.) Using a tablet and internet connection the students will practice their factoring skills.

Standards
Common Core Learning Standards
Seeing Structure in Expressions A-SSE
Interpret the structure of expressions.

- Interpret expressions that represent a quantity in terms of its context. a. Interpret parts of an expression, such as terms, factors, and coefficients.

P21 Standards
Make Judgements and Decisions

- Reflect critically on learning experiences and processes

Resources

A) Tablet or iPad
B) Internet access
C) Answer sheet (separate sheet of paper)

Procedures:
Setup: Each student needs to have their laptop signed in and open to the app. Then you should have a class discussion on how to use the app. First the students will go into puzzle mode. Here they will complete factor trees for the numbers provided.

Briefing: Explain to students the purpose of the game. They will be going through a series of puzzles to factor the numbers in front of them. Once they have completed 10 puzzles then they may move on to the action mode! Here they will use the faktorship to blast the factors!

Action: Students will be presented with their first puzzle. The student will use the piece of paper to record their answers to the factorization problem. If the students need to make changes to their solution then they should be recorded as well. It is important for the teacher to take notes as they will be used in the debriefing.

Debriefing: The players will discuss with another player how they felt about the game. Talk about what they learned, what they found difficult, what was simple, what they would do differently etc.

Assessment:

7.) Students will record their steps to finding the solution on their piece of paper.
8.) Students are engaged in the debriefing. (making eye contact, participating verbally)

Criteria	Unsatisfactory	Developing Skills	Proficient	Exemplary
Scratch Paper	Some obstacles have no solutions.	At least one solution is noted for each problem.	About one half of the problems have wrong solutions	Scratch Paper shows the correct solution to the problems.
Debriefing Behavior	Students could not discuss their feelings about the game.	Students could only give 1 or 2 details of how they felt after the game.	Students could express 3 or 4 details about their feelings of the game.	Students successfully discussed with the class at least 5 details of how they felt after playing the game.

Topic: Lure of the Labryinth **Age:** 14-16 **Grade Level:** 8-10 **Time:** 42 minutes

Goals:
Students should be self-reflective and be able to *discuss* their strategies both during the activity as well in the debriefing.
Students should be able to apply their pre algebra skills in the game.
Students should be able to be use their problem solving skills using basic algebra skills.

Objectives
1.) Using a laptop the students will solve math based puzzles

Standards
Common Core Standards
Reasoning with Equations & Inequalities A-REI
Solve equations and inequalities in one variable.
- Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

Materials:
A) Laptop
B) Internet access
C) Website
D) Piece of Paper

Procedures:
Setup: Each student needs to have their laptop signed in and open to the website. The students will have to make their own free accounts. Then you should have a class discussion on how to use the website and where to find the start of the game.

Briefing: Explain to students the purpose of the game. They will be helping to save the world from monsters by completing math puzzles that are embedded into the game. They have three worlds that they need to complete. Are they ready for the task?

Action: Students will be presented with their first puzzle. The student will use the piece of paper to record their answers to the problem. If the students need to make changes to their solution then they should be recorded as well. It is important for the teacher to take notes as they will be used in the debriefing.

Debriefing: The players will discuss with another player how they felt about the game. Talk about what they learned, what they found difficult, what was simple, what they would do differently etc.

Assessment:

9.) Students will record their steps to finding the solution on their piece of paper.

10.) Students are engaged in the debriefing. (making eye contact, participating verbally)

Criteria	Unsatisfactory	Developing Skills	Proficient	Exemplary
Scratch Paper	Some obstacles have no solutions.	At least one solution is noted for each problem.	About one half of the problems have wrong solutions	Scratch Paper shows the correct solution to the problems.
Debriefing Behavior	Students could not discuss their feelings about the game.	Students could only give 1 or 2 details of how they felt after the game.	Students could express 3 or 4 details about their feelings of the game.	Students successfully discussed with the class at least 5 details of how they felt after playing the game.

Topic: Tynker **Age:** 14-17 **Grade Level:** 8-10 **Time:** 42 minutes

Goals:
To have the students *problem solve* using basic coding skills to create transformations of shapes.
Students should *collaborate* with fellow students to make predictions, and revise their predictions based on outcomes.
Students should be self-reflective and be able to *discuss* their strategies both during the activity as well in the debriefing.

Objectives
1.) Given a laptop students will complete a game on tynker to practice a math skill.

Standards
Common Core
Congruence G-CO
Experiment with transformations in the plane
- Know precise definitions of angle, circle, perpendicular line, parallel line, and line segment, based on the undefined notions of point, line, distance along a line, and distance around a circular arc.
- Represent transformations in the plane using, e.g., transparencies and geometry software; describe transformations as functions that take points in the plane as inputs and give other points as outputs. Compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch).

P21 Standards
Work Creatively with Others
Develop, implement and communicate new ideas to others effectively
- Be open and responsive to new and diverse perspectives; incorporate group input and feedback into the work.

Materials:
A) You will need the tickle app (only available for IOS)or tynker(IOS and Android users)
B) An iPad or an iPhone
C) Internet Access
D) Masking Tape
E) Parrot Mini Drone
F) Kuta Math Worksheet

Procedures:
Setup: Start by downloading the tickle app on your iOS device.Start a new project in the app by clicking on the plus sign in the top right hand corner on your device. Choose the rolling spider template. Give your students a starting line with the masking tape. Have

the students start off by flying the drone in a square (by using the code below) starting at the masking tape line.

Briefing and Action: Explain to the students that they will talk in pairs as to why the code has to say turn by 90 degrees to make the square. Now have students figure out what the code should be for the drone to fly in a triangle, hexagon, and a pentagon. When the activity is complete, have the students brain storm, on a separate sheet of paper, why the angles have to be 90, 120, 72, and 60 degrees. Have the students share what they have written down.

Debriefing: When the activity is complete, have the students brain storm, on a separate sheet of paper, why the angles have to be 90, 120, 72, and 60 degrees. Have the students share what they have written down. As a class discuss the exterior angles of a polygon and how to find them, reinforcing what they just found with the drone.

Assessment:
https://cdn.kutasoftware.com/Worksheets/Geo/6-Polygons%20and%20Angles.pdf
The students will be graded based on the worksheet that they are given in class.

Scoring Rubric:

Criteria	Unsatisfactory	Developing Skills	Proficient	Exemplary
Worksheet	Some problems have no solutions.	At least one solution is noted for each problem.	About one half of the problems have wrong solutions	Worksheet shows the correct solution to the problems.
Debriefing Behavior	Students could not discuss their feelings about the game.	Students could only give 1 or 2 details of how they felt after the game.	Students could express 3 or 4 details about their feelings of the game.	Students successfully discussed with the class at least 5 details of how they felt after playing the game.

Topic: Scratch **Age:** 16-18 **Grade Level:** 10-11 **Time:** 126 minutes

Goals:
To have the students *problem solve* using basic coding skills to circumvent physical obstacles.
Students should *collaborate* with fellow students to make predictions, and revise their predictions based on outcomes.
Students should be self-reflective and be able to *discuss* their strategies both during the activity as well in the debriefing.
Students should be able to apply their transformation skills during the activity.

Objectives:
1.) Given a laptop students will recreate a math concept using block code.

Standards
NYS Common Core Standards:
G-CO: Experiment with transformations in the plane;
- Represent transformations in the plane using, e.g., transparencies and geometry software; Given a rectangle, parallelogram, trapezoid, or regular polygon,
- Describe the rotations and reflections that carry it onto itself

P21 Standards
Make Judgements and Decisions
- Reflect critically on learning experiences and processes

Materials:
A) Laptop
B) Internet access
C) Scratch Website
D) Worksheet

Procedures:
Setup: Students will start by creating their own scratch account in order to save their work throughout the lesson. Then they will go through the hour of code process to get basic coding experience. They will then make a triangle based on the skills they just learned.

Briefing: Explain to the students that they will be creating their own transformation problem using the block code on scratch. The students will start off by making a triangle by experimenting with the code in scratch based on what they learned in the hour of code.

Action: Once they have drawn the triangle, then they will experiment with rotation, translation, and dilation of the triangle. The students will then repeat steps 3 and 4 but with a square and any other shape that they can create.

Debriefing: When the activity is complete, have the students brain storm, on a separate sheet of paper, why the angles have to be 90, 120, 72, and 60 degrees. Have the students share what they have written down. As a class discuss the exterior angles of a polygon and how to find them, reinforcing what they just found with the drone.

Scoring Rubric:

Criteria	Unsatisfactory	Developing Skills	Proficient	Exemplary
Scratch Page	No transformations completed.	At least one transformation is completed.	About one half of the transformations are complete.	All transformations are complete.
Debriefing Behavior	Students could not discuss their feelings about the game.	Students could only give 1 or 2 details of how they felt after the game.	Students could express 3 or 4 details about their feelings of the game.	Students successfully discussed with the class at least 5 details of how they felt after playing the game.

Topic: Build a Skateboard Ramp **Age:** 16-18 **Grade Level: 10-12** **Time:** 42 minutes

Goals:
To have the students *problem solve* using math skills to be able to solve the problem of building a skateboard ramp.
Students should *collaborate* with fellow students to make the ramp, and revise their solutions based on outcomes.
Students should be self-reflective and be able to *discuss* their strategies both during the activity as well in the debriefing.

Objectives

1.) Given a laptop the students will use math topics from Algebra I to solve real life construction problems.

Standards
Common Core
Define trigonometric ratios and solve problems involving right triangles

- Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

Materials:

A) Laptop
B) Internet Access
C) website
D) Rubric

Procedures:
Setup: Each student should sign into a laptop. Then they should be on the math by design website. They can play as a guest or they can create an account to save their work.

Briefing: Explain to the students that they will be virtually building a skate ramp for their neighborhood online. They need to work the best that they can in order to insure the safety of those that will be using it. They will go through a series of problems in order to build the ramp.

Action: Students will be solving the various math problems in order to build a skate ramp. The student will use the piece of paper to record their answers to the problem. If the students need to make changes to their solution then they should be recorded as well. It is important for the teacher to take notes as they will be used in the debriefing.

Debriefing: The players will discuss with another player how they felt about the game. Talk about what they learned, what they found difficult, what was simple, what they would do differently etc.

Assessment:

11.) Students will record their steps to finding the solution on their piece of paper.

12.) Students are engaged in the debriefing. (making eye contact, participating verbally)

Criteria	Unsatisfactory	Developing Skills	Proficient	Exemplary
Scratch Paper	Some problems have no solutions.	At least one solution is noted for each problem.	About one half of the problems have wrong solutions	Scratch Paper shows the correct solution to the problems.
Debriefing Behavior	Students could not discuss their feelings about the game.	Students could only give 1 or 2 details of how they felt after the game.	Students could express 3 or 4 details about their feelings of the game.	Students successfully discussed with the class at least 5 details of how they felt after playing the game.

Topic: Lazer Maze Game **Age:** 15-18 **Grade Level:**10-12 **Time:** 84 minutes

Goals:
To have the students *problem solve* using basic coding skills to circumvent physical obstacles.
Students should *collaborate* with fellow students to make predictions, and revise their predictions based on outcomes.
Students should be self-reflective and be able to *discuss* their strategies both during the activity as well in the debriefing.
Students should be applying their knowledge of trigonometric ratios to puzzles that are provided in the game to light up the target.

Objectives
1.) Using the game board students will solve the puzzle using logic.

Standards
Common Core
Define trigonometric ratios and solve problems involving right triangles
- Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems.

P21 Standards
Make Judgements and Decisions
- Reflect critically on learning experiences and processes

Materials:
A) Lazer Game
B) Piece of paper
C) Partner

Procedures:
Setup: Each student needs to be paired with a partner. They will begin the game by setting up one of the puzzles provided to see how the game and laser works.

Briefing: Explain to the students the point of the game. Our goal is to complete the puzzle given in the most efficient way possible. For every level the students will write down their moves and their thought process behind them.

Action: Students will be presented with their first puzzle. They will then use the deflector pieces to solve the puzzle by lighting up the target. They will be moving the pieces around to see what the most efficient way would be, with the least amount of blocks. The moves and their thoughts should be recorded on their piece of paper. If the students need to make changes to their solution then they should be recorded as well. It is important for the teacher to take notes as they will be used in the debriefing.

Debriefing: The players will discuss with another player how they felt about the game. Talk about what they learned, what they found difficult, what was simple, what they would do differently etc.

Assessment:

13.) Students will record their steps to finding the solution on their piece of paper.
14.) Students are engaged in the debriefing. (making eye contact, participating verbally)

Criteria	Unsatisfactory	Developing Skills	Proficient	Exemplary
Scratch Paper	Some obstacles have no solutions.	At least one solution is noted for each problem.	About one half of the problems have wrong solutions	Scratch Paper shows the correct solution to the problems.
Debriefing Behavior	Students could not discuss their feelings about the game.	Students could only give 1 or 2 details of how they felt after the game.	Students could express 3 or 4 details about their feelings of the game.	Students successfully discussed with the class at least 5 details of how they felt after playing the game.

Topic: Gravity Maze **Age:** 15-18 **Grade Level:** 10-12 **Time:** 84 minutes

Goals:
To have the students *problem solve* using math and physic skills to circumvent physical obstacles.
Students should *collaborate* with fellow students to make predictions, and revise their predictions based on outcomes.
Students should be self-reflective and be able to *discuss* their strategies both during the activity as well in the debriefing.

Objectives

1.) Using the game board given the students will solve the gravity puzzle by using logic skills

Standards:

- STANDARD 1—Analysis, Inquiry, and Design Students will use mathematical analysis, scientific inquiry, and engineering design, as appropriate, to pose questions, seek answers, and develop solutions.
- Engineering design is an iterative process involving modeling and optimization (finding the best solution within given constraints) which is used to develop technological solutions to problems within given constraints. (Note: The design process could apply to activities from simple investigations to long-term projects.)

Materials:

A) Gravity Maze Game Board
B) Partner
C) Piece of Paper

Procedures:
Setup: Each student needs to be paired with a partner. They will begin the game by setting up one of the puzzles provided to see how the game and gravity works.

Briefing: Explain to the students the point of the game. Our goal is to complete the puzzle given in the most efficient way possible. For every level the students will write down their moves and their thought process behind them.

Action: Students will be presented with their first puzzle. They will then use the tower pieces to solve the puzzle by reaching the target. They will be moving the pieces around to see what the most efficient way would be, with the least amount of blocks. The moves and their thoughts should be recorded on their piece of paper. If the students need to make changes to their solution then they should be recorded as well. It is important for the teacher to take notes as they will be used in the debriefing.

Debriefing: The players will discuss with another player how they felt about the game. Talk about what they learned, what they found difficult, what was simple, what they would do differently etc.

Assessment:

15.) Students will record their steps to finding the solution on their piece of paper.
16.) Students are engaged in the debriefing. (making eye contact, participating verbally)

Criteria	Unsatisfactory	Developing Skills	Proficient	Exemplary
Scratch Paper	Some obstacles have no solutions.	At least one solution is noted for each problem.	About one half of the problems have wrong solutions	Scratch Paper shows the correct solution to the problems.
Debriefing Behavior	Students could not discuss their feelings about the game.	Students could only give 1 or 2 details of how they felt after the game.	Students could express 3 or 4 details about their feelings of the game.	Students successfully discussed with the class at least 5 details of how they felt after playing the game.

Topic: Spaghetti and Marshmallow Bridge **Age:** 14-17 **Grade Level:** 9-11 **Time:** 42 Minutes

Goals: To have the students *problem solve* using basic skills to circumvent physical obstacles.
Students should *collaborate* with fellow students to make predictions, and revise their predictions based on outcomes.
Students should be self-reflective and be able to *discuss* their strategies both during the activity as well in the debriefing.

Objectives

1.) Using the tools given the students will build a structure to hold a textbook.

Standards:
Common Core
Critical Thinking and Problem Solving

- Mathematics Practices Make sense of problems and persevere in solving them

Materials:

A) Spaghetti
B) String
C) Marshmallow
D) Masking tape
E) Rubric

Procedures:
Setup: Provide the students with the materials that they would need to build a structure only from spaghetti, string, tape, and a marshmallow. Put them in groups of three to work on this project and only give them an allotted time to have to work on it.

Briefing: Explain to the students the point of the project. They need to be able to hold a textbook up for 30 seconds. The strongest structure will be the winner! They can only use the materials given and can only take the time during class to finish it. This activity will allow the students to work in groups and to use their problem solving skills.

Action: The students will be given the materials and allowed to work during the allotted time frame. During this time the teacher will be taking notes so that they can be used for the debriefing portion of the lesson.

Debriefing: The players will discuss with another student how they felt about the activity. Talk about what they learned, what they found difficult, what was simple, what they would do differently etc.

Assessment:

17.) Students will test their structure to see if it will hold the weight for the 30 seconds or not.

18.) Students are engaged in the debriefing. (making eye contact, participating verbally)

Criteria	Unsatisfactory	Developing Skills	Proficient	Exemplary
Structure	No structure at all	Structure only holds for a few seconds.	Structure holds for at least 10 seconds	Structure holds for the whole 30 seconds
Debriefing Behavior	Students could not discuss their feelings about the game.	Students could only give 1 or 2 details of how they felt after the game.	Students could express 3 or 4 details about their feelings of the game.	Students successfully discussed with the class at least 5 details of how they felt after playing the game.

Part VI: Formative Evaluation

Purpose:

The purpose of the evaluation is to determine whether or not the STEM games are helping students to gain a deeper understanding in science, technology, engineering and mathematics areas. The lessons are designed to fit into existing curriculum with students needing very little knowledge of technology to complete the activities.

Audience:

- Administrators
- Staff
- Teachers
- Students

Issues:

- **Student Interest in Technology**

  -There may be some student resistance to technology because they are not used to using it for educational reasons. They have to use it in a way that they are using coding to solve some sort of task. This is foreign for most students.

- **Technology Failures**

-Teachers always have to have a backup plan when it comes to technology. Some of these lessons do not have to do with technology but the ones that do, the technology may not work when it is needed.

- **Instructional Length**

-Some lessons that we have created may be too much for the time that is planned. Also, some lessons may be over the ability levels of the students involved.

Resources:

The way we are evaluating students is different from ordinary assessments. The assessments we have come up with will reflect what each student was able to learn during each game or activity. The assessments in particular will help students self evaluate themselves throughout the activities. We chose to create rubrics where students could check off why they made a specific move.

Some suggestions we have been given involve using rubrics or informal assessments to help students get a deeper understanding of the content of the games or activities being taught. The games and activities we have chosen for this project will help students learn and hopefully have fun while learning content related to STEM topics.

Part VII: Conclusion & Next Steps

This project required us to create lessons based on small-based STEM games and activities. We decided to choose games for this project because of all of the research done that showed how effective games are on people's’ learning.

By playing educational games, it can motivate students to want to learn. Most games require goals and objectives, which will help students gain rewards in the games by completing achievements. According to K. Nachimuthu and G. Vijayakumari, “Copier Marinka, (2005) found out that, educational games are enhancing learning, because it increases children's enjoyment, attention, effort, and concentration skills” (2011). Educational games do more than just motivate students to learn, also increases enjoyment, concentration skills, effort, and attention. Research that has been done is showing that teachers should incorporate some educational games into their lessons to get students more engaged and with that, should help students becoming ready to learn.

Virtual Reality-specific games have showed there is promise for children to learn from video games. One video game in particular, lightbrush, allows you to draw in a 3-D virtual reality world where there are so many possibilities. You can go from area to area drawing on different canvases or look at other canvases other people have created.

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