MUNCIE COMMUNITY SCHOOLS & BALL STATE UNIVERSITY TEACHERS COLLEGE

S.T.E.M. UNIT FOR MUNCIE P3

Professional Development Differentiated & Digitized

Jon M. Clausen, Karen Huey, Jordan Wallace, Katlyn Redman, & Jeremy Svoboda
S.T.E.M. UNIT DEVELOPMENT & IMPLEMENTATION

PD3 students conceptualized, planned, and implemented a four week S.T.E.M. unit for an area after school program. The unit was taught three times for a total of twelve weeks. Focusing on electricity and circuits, PD3 students created a variety of hands on activities and made use of several different technologies. The unit was differentiated for first, second, and third graders.
Early in the semester PD3 students were challenged to create a STEM unit for children participating in an after school program. The students leapt at the challenge and constructed a four week unit focused on circuits and electricity. Each week BSU students created engaging lessons and activities that utilized different technologies, but did so in ways that allowed 1st, 2nd, and 3rd graders to learn in meaningful ways. They then taught the lessons and modeled the instructional strategies with technology for teachers and aids in the after school program. This chapter discusses the preparation, planning, implementation, and assessment of the circuits unit.

**Preparation**

Program faculty were approached by staff from the Muncie P3 after school program about the possibility of developing STEM activities for 1st, 2nd, and 3rd graders in a four week rotation during the semester. Lessons would take place on Friday afternoons, function as a way to expose students in these early grades to Science, Technology, Engineering, and Mathematics (S.T.E.M.) content, and to model hands-on, creative teaching strategies.

In preparing to plan the unit lessons, PD3 students had to decide on what content to cover, how they wanted to teach that content, and what kinds of technologies may be available to support instruction and engage students in meaningful ways. They were not familiar with some of the new technologies available, and expressed concern in developing a unit without spending time with the technologies they might use with children in the after school program.

Following suggestions with the “Invent to learn” text and other readings profiling technology use with children, PD3 students spent time exploring a variety of technologies and discussed how they might be used with kids. Some of these technologies included augmented reality, virtual reality, 3d scanning and modeling, 3D printing, robotics, coding, and other technologies. This time to explore was vital in helping the PD3 students learn about the technologies, but it also helped them to think critically about how
different technologies might be used within teaching and learning contexts. They also asked questions about the types of instructional strategies they would utilize with the children. Once the PD3 students had spent some time exploring, they began to consider ideas for the development of a four week S.T.E.M. unit for the after school program.

Another element of their planning was to learn about the children they would be working with. To do this, PD3 students read about the history of the Whitely community where the elementary school is located, and where most of the children live. They visited the Civil Rights museum at Shaffer Chapel to learn more about the community’s strong cultural and historical heritage, and how the community continues to lead several initiatives to improve the lives of people in Muncie Indiana. Watch the embedded video (Movie 3.1) to learn more about the Whitely community and the Shaffer Museum.

Movie 1.1 Shaffer Museum

The PD3 students also visited the Connection Corner. The Connection Corner is a Digital Media Center and branch of the Muncie Community Library. The Connection Corner is located directly across from Longfellow elementary school and is a location for several children to go after school. Directors of the Connection Corner have established several digital activities for the kids including 3D printing, video editing, digital design, and audio recording. After the visit, PD3
students were excited about creating active and engaging activities for children in the after school program.

In order to learn more about context of the after school program, PD3 students toured Longfellow elementary school. While visiting the school, PD3 students were able to visit the classrooms and speak with teachers in the after school program. They learned more about the typical schedule for the children and discussed how they might differentiate the lessons so they would be successful in the elementary classrooms.

**Planning: Unit Lesson Plans**

The PD3 students and faculty brainstormed possible ideas for an instructional unit and utilized the Technological Pedagogical Content Knowledge (TPACK) model as a helpful tool in narrowing down ideas and to consider the variety pedagogical approaches and technologies we might use in the different lessons we would design. PD3 students examined state standards for each grade level, science and mathematics standards, and National Educational Technology Standards for Students (NETS-S) to help them identify what children should know and be able to do with content and technology.

Student ideas coalesced around circuits and electricity as the concepts they would focus on in their unit after they investigated a variety of standards, explored a variety of different technologies, and discussed learning theory and pedagogical strategies that provide children opportunities to construct their own knowledge. PD3 students wanted to create engaging lessons that allowed the children make connections with their prior knowledge and experiences, to scaffold the lessons and activities each week, to provide students different technologies to demonstrate their learning, and to model instructional practices for teachers and aids in the after school program.

PD3 students recognized that they were also working through an instructional design process in an active and constructionist manner. While planning and designing the lessons, PD3 students addressed several of the ISTE NETS-T and INTASC standards including ones focused on planning for instruction, designing digital age learning experiences, and modeling professional practices. An added element was that PD3 students were than able to actually enact the lessons and activities they had designed.

Some examples of ways PD3 students utilized different technologies in their planning included Google Docs to collaborate and edit each of the lessons. They also integrated digital photography, hyperlinks, youtube videos, and the Internet to locate additional resources into the lesson plans. In addition to the collaborative planning, they also gathered various materials (conductive dough, clay, foil, fuzzy sticks, tape scissors, etc... for use with the lessons.

Complete lesson plans can be accessed in chapter 2.

**APPENDIX 1: LESSON ONE: WHAT IS A CIRCUIT?**

Week one of the S.T.E.M. unit focused on the basics of electricity and construction of a circuit. In their research and exploration, PD3 students located the “Squishy Circuit” materials that have been developed by Dr. AnnMarie Thomas at the University of St. Thomas in Minneapolis Minnesota. Squishy Circuits use conductive and non-
conductive dough, Light Emitting Diodes (L.E.D’s), and a battery pack as a creative and playful way for young children to learn about the basics of electricity and circuits.

The lesson PD3 students developed involved both large group and small group activities. The elementary children were able to move and be physically engaged during the lesson. They also had creative independence to construct their own creators and circuits using the different types of dough. Check out some of the creative Squishy Circuit Creations in image gallery 3.1.

APPENDIX 2: LESSON TWO: CONDUCTIVITY

The second lesson in the S.T.E.M. unit built off of the previous weeks work with squishy circuits, and focused on different types of materials and whether they are a conductor or an insulator of electricity. In order to engage the elementary kids, PD3 students developed a lesson that utilized Makey Makey construction sets so that the kids could run experiments and reinforce their understanding of circuits.

When connected to a computer via the USB connection, the Makey Makey’s allows the user to transfer some keyboard controls to whatever is connected to the Makey Makey. Using alligator clips, the user can control the mouse click, direction keys, and other keyboard keys. The alligator clips are then connected from the Makey Makey to anything that is conductive. If the object is conductive it will take the place of the standard keyboard key to control the input to the computer. For example, a user may connect a banana to the Makey Makey and anytime the user touches the banana the computer cursor adds a space.

PD3 students set up stations for small group work so that children could test a variety of objects and control whatever might be on the computer screen. As part of their planning, PD3 students thought that a fun way to engage the children would be to have they play a video game as a way to test conductivity. They investigated a variety of websites with video game emulators and eventually searched the Scratch website for a variety games and sounds that could be controlled with the Makey Makey.
In the first small group activity, elementary students tested items such as oranges, carrots, gummy worms, coins, erasures, wood and straws to see if they were conductive. For example, if the students were trying to move a character through a maze, the item connected to the Makey Makey would need to be conductive. If not, the character would not move. The elementary students also needed to apply their knowledge of circuits to make the character on the screen move. If they were not completing a closed circuit nothing would happen. As soon as they completed the loop, allowing electricity to pass from the computer, through them, and then through the conductive item they were touching, the character would move.

In the second activity, after school students rotated around the room to play different games located at each station. This allowed them to once again apply and transfer their knowledge to different situations and with different materials. Check out image gallery 3.2 to see some examples of how PD3 students and the after school kids created circuits and tested conductivity with Makey Makey’s.

APPENDIX 3: LESSON THREE: THE DESIGN PROCESS
The third week of the S.T.E.M. unit asked kids in the after school program to use their creativity, to collaborate, and to work through the design process, as they designed and tested their own electric vehicles. Since the previous two weeks had the children specifically focus on the characteristics of a circuit and to construct circuits out of different materials, the third week was intended to have the kids think creatively about the future of electricity and how they can be engineers and designers. Prior to the activities for the week, Teachers were provided a copy of “Going Places” by Paul and Peter Reynolds to read to students. The book inspires children to use their imagination and to think creatively.

After reviewing the terminology and activities of the first two weeks, the group leader in the third week presented children with a challenge, “can they create a mode of transportation powered by electricity?” The criteria provided to each team was intentionally kept vague as to allow for the kids to have ownership over their creation. The few guidelines were given to the kids:
* The mode of transportation has to travel around a track and be driven by each member of the team.

* The mode of transportation must be constructed with the provided materials (things like paper cups, popsicle sticks, tape, cardboard, fuzzy sticks, etc...)

* The mode of transportation will use a Sphero robot as the power source for the vehicle.

Children were then divided up into their perspective teams. Working with their team leaders (PD3 students or instructional aids) the children worked through an iterative design process. They began by asking questions about the problem they were trying to solve. They then brainstormed ideas for the design and had to decide which design would move to the next phase. From there, they drew sketches and gathered the needed equipment and materials. Next they constructed their mode of transportation and tested it to see how it would work.

At this step in the process team leaders would connect an iPad to the Sphero robots so that students could practice driving as well as testing their designs with the power source of their vehicle. At the end of class time, teams were asked to share their initial designs and how they had modified or improved their designs. The session ends with a homework assignment for the kids to consider how else they might improve on their designs for the last week when they will race in the
Sphero Circuit! Image gallery 3.3 has several pictures of students sharing ideas, collaborating, and designing their vehicles.

APPENDIX 4: LESSON FOUR: RACING ON THE SPHERO CIRCUIT

On the final day of the S.T.E.M. unit, PD3 students, children in the after school program, and teachers participate in the Sphero Circuit Race. As kids came into the classroom, the room had been reconfigured so that a race track (constructed out of tape on the floor) was in the center of the room. Desks and other tables had been moved to the perimeter, and “pit” areas for each team are set up so they could completed any modifications or repairs to their modes of transportation. The teams are then given 15 to 20 minutes to make and test any final design modifications. Once the final modifications have been made, the teams were asked to sit around the perimeter of the track and some basic guidelines for the races are discussed. Good sportsmanship was stressed and the children participated in a conversation deciding appropriate behaviors during the competition. The remainder of the time was spent racing and having fun!

**Differentiation**

Lesson plans were modified for each specific grade level. Differentiating the lessons required PD3 students to consider the instructional contexts where the lessons would take place, the grade level of the students, the developmental ages of the children, materials and other resources. Also, each time a specific lesson was taught, PD3 students reflected on what worked well and what they would have done differently.

For example, the first round of lessons took place at BSU Teachers College while the other two rounds took place at the elementary school where the children attend school. Differences in the physical location of where the lessons took place impacted the time spent on lessons, classroom management, and resources. The third graders who came to campus had to travel from their school to the university. This travel time cut into the time the children had work on their activities. This changed once we started meeting the children at the elementary school. We had more time to work on the projects and the children were used to the regular routines of their day.
A specific example of how PD3 students differentiated their lessons was in the conductivity lesson. The first time PD3 students taught the lesson for the third graders they had the children construct their own controllers with the Makey Makey. After reflecting on the first time the lesson was taught, PD3 students decided to modify the lesson so that they would work along side the children to create the controllers. They also decided to have children rotate around the room so that everyone would get a chance to play different games and use different materials to control the computers. This allowed both the children and PD3 students to reinforce the main concepts of how to create a circuit and how conductors and insulators either block or allow electricity to pass through. PD3 students made additional modifications to differentiate the lessons depending on the individual students who were in their small groups.

**Assessment**

Assessment of 1st, 2nd, and 3rd graders was grounded in a constructionist paradigm. Students demonstrated their understanding through the construction of their own creations. Within each lesson of the unit the first, second, and third graders manipulated different materials and constructed different models to test their internal cognitive understanding of the concepts of electricity and circuits. Students tested their understanding about conductivity and the flow of electricity through the different creatures they made with squishy circuits, and through their demonstration of building game controllers with the Makey Makey’s. Assessment of the design process was also done through the work of the students. As they constructed their electric modes of transportation they continually asked questions, imagined, planned, created, and improved their designs until it was time to race.

PD3 students intentionally planned the lessons to give the 1st, 2nd, and 3rd graders as much agency as possible in their learning. They allowed the elementary students to make choices, to collaborate, and to construct models of their understanding. The elementary students also drew from their prior knowledge and experiences as they participated in the different lessons.
The appendix chapter contains the S.T.E.M. lesson plans developed by PD3 students for first, second, and third graders. The lessons focus on electricity and circuits, but also on creativity and the design process. The lessons were taught several times to children in an after school program.
PD3 students developed a four week STEM unit for 1st, 2nd, and 3rd graders in an after school program at a local elementary school. The unit focused on circuits and electricity. It also engaged students in learning about the design process. Activities within each lesson included a variety of activities, small group work, and assessments where students constructed models of their learning that were then shared with others. Lessons within the unit were also differentiated for the different instructional contexts, the grade level of students, and the available materials.

S.T.E.M. LESSON PLANS
- Appendix 1: Week 1. What is a Circuit?
- Appendix 2: Week 2, Conductivity, is it a Conductor or Insulator?
- Appendix 3: Week 3, The Design Process, Creating an Electric Vehicle
- Appendix 4: Week 4, Racing on the Sphero Circuit!!!
Appendix 1

Week 1: What is a Circuit?

Goals (What is trying to be achieved at the end of the lesson):
* Introduce students to circuits and terminology about circuits
* Introduce how circuits work
* Introduce formal knowledge/definition of circuits and the components of a circuit

Objectives (Performance):
* Students will demonstrate basic terminology when using squishy circuits
* Students will show basic circuit construction skills by building a circuit as a class and also individual circuits with the squishy circuits
* Students will be able to explain, in their own words, how a squishy circuit works
* Students will use squishy circuits to create a circuit of their own that demonstrates their understanding of how a circuit works

Standards (Content, Grade level, Technology):
Below are the Process Standards and Science Standards for First, Second, and Third, grade according to the Indiana Department of Education.

Process Standards
- SEPS.1 - Posing questions (for science) and defining problems (for engineering)
- SEPS.2 - Developing and using models and tools
- SEPS.3 - Constructing and performing investigations
- SEPS.6 - Constructing explanations (for science) and designing solutions (for engineering)
- SEPS.8 - Obtaining, evaluation, and communicating information

Science Standards
- K-2.E.1 Pose questions, make observations, and obtain information about a situation people want to change. Use this data to define a simple problem that can be solved through the construction of a new or improved object or tool.
• K-2.E.2 Develop a simple sketch, drawing, or physical model to illustrate and investigate how the shape of an object helps it function as needed to solve an identified problem.
• K-2.E.3 Analyze data from the investigation of two objects constructed to solve the same problem to compare the strengths and weaknesses of how each performs.

International Society for Technology in Education (ISTE) National Educational Technology Standards

ISTER National Educational Technology Standards for Students (NETS-S), the following standard(s) is identified:

**Knowledge Constructor** - Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts, and make meaningful learning experiences for themselves and others
1. Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits
2. Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solution.

ISTE National Educational Technology Standards for Teachers (NETS-T), the following standard are identified:

**Facilitate and inspire student learning and creativity** - Teachers use their knowledge of subject matter, teaching and learning, and technology to facilitate experiences that advance student learning, creativity, and innovation in both face-to-face and virtual environments.
1. Promote, support, and model creative and innovative thinking and inventiveness
2. Promote student reflection using collaborative tools to reveal and clarify students’ conceptual understanding and thinking, planning, and creative processes
3. Model collaborative knowledge construction by engaging in learning with students, colleagues, and others in face-to-face and virtual environments

**Engage in professional growth and leadership** - Teachers continuously improve their professional practice, model lifelong learning, and exhibit leadership in their school and professional community by promoting and demonstrating the effective use of digital tools and resources.
1. Participate in local and global learning communities to explore creative applications of technology to improve student learning
2. Exhibit leadership by demonstrating a vision of technology infusion, participating in shared decision making and community building, and developing the leadership and technology skills of others.

Key Terms:
For a handout of the key terms, use the Squishy Circuit Vocabulary sheet provided.

- Electron
- Circuit
- Open/Closed
- Types of Circuits: Parallel/Series
- Conductor/Insulator
- Ground
- LED - Light Emitting Diode
- Positive/Negative Charge

Materials:
The list provided below is broken up into various sections for the purpose of gathering materials to begin the unit, demonstrate the lesson, and make the circuit. Please note the quantity of materials vary based on class size and resources.

- **Beginning the Unit**
  - Computer/Projector
    - To play and view introduction video
  - Index cards, yarn, markers, hole punch
    - Make name tags for students if needed
- **Demonstrating the Lesson**
  - Introduction Video
    - Need to have access to youtube
  - Electric Ball
    - To show how electricity travels through things
- **Materials for Squishy Circuits Activity**
• LED bulbs
• Conductive Dough
• Non-Conductive Dough
• Battery Packs
• Batteries

Description/Process (What will be happening during the lesson?):

View the Week One Outline for a more in-depth outline that includes activities, questions with possible answers, and outlined schedule.

Introduction
Students are grouped based on tables
  * Go around room and have students introduce themselves
Launch/Attention Grabber
• Make a human Circuit
  • Have student hold hands to make a circle.
  • Group leader is at one end next to the plugged in Electric Ball
• Group leader asks, What is a circuit is?
  *
• Identify some definitions we will use briefly
  • Circuit, closed & open circuit
• Introduce lesson with students sitting on the carpet up front and show introduction video
  *

Activity
Split back into groups
Each group will build squishy circuits alongside group team leaders
Instructor will lead a group discussion in...
What makes a circuit
open/closed circuits
conductive/non-conductive materials

Additional Learning: https://drive.google.com/open?id=0B3bvkKRNWGLNSS13WIJ1Smx2REk
Appendix 2

Week 2: Conductivity, is it a Conductor or Insulator?

Goals:
• Build on students knowledge from previous week and continue introduction to circuits and electricity
• Continue working with circuits
• Building more knowledge using Makey Makey
• Introduce formal knowledge/definition of circuits and the components of a circuit
• Clearly identity insulators and conductors

Objectives (Performance):
• Students will demonstrate basic terminology when using Makey Makey circuits
• Students will show basic circuit construction by building a circuit as a group and also individual circuits with the Makey Makey circuits
• Students will be able to recall terms and vocabulary from the previous lesson
• Students will use Makey Makey circuits to create a circuit of their own that demonstrates their understanding of how a circuit works
• Students will be able to determine what is conductive and nonconductive from a variety of objects

Standards (Content, Grade level, Technology):

Process Standards
• SEPS.2 - Developing and using models and tools
• SEPS.5 - Using mathematics and computational thinking
• SEPS.6 - Constructing explanations (for science) and designing solutions (for engineering)
• SEPS.8 - Obtaining, evaluation, and communicating information
Science Standards

• 3-5.E.1 - Identify a simple problem with the design of an object that reflects a need or want.
• 3-5.E.3 - Construct and perform fair investigations in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved

International Society for Technology in Education (ISTE) National Educational Technology Standards

**ISTE National Educational Technology Standards for Students (NETS-S)**

**Knowledge Constructor** - Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others

1. Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits
2. Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions

**ISTE National Educational Technology Standards for Teachers (NETS-T), the following standard are identified:**

**Facilitate and inspire student learning and creativity** - Teachers use their knowledge of subject matter, teaching and learning, and technology to facilitate experiences that advance student learning, creativity, and innovation in both face-to-face and virtual environments.

1. Promote, support, and model creative and innovative thinking and inventiveness
2. Promote student reflection using collaborative tools to reveal and clarify students’ conceptual understanding and thinking, planning, and creative processes
3. Model collaborative knowledge construction by engaging in learning with students, colleagues, and others in face-to-face and virtual environments

Materials:

• 2 Makey Makey kits per group. Each kit containing:
  • Makey Makey board
• 1 USB cable
• 7 Alligator clips
• 6 Connector wires
• 8 computers
• Projector
• Bananas
• Foil
• Gummy Worms
• 8 Play Doh-2 containers per group
• Pennies
• Carrots
• Pipe cleaners
• Pencils with paper
• Wooden Dowel Rods
• Straws
• Pen with paper
• Silver Coins

Description/Process (What will be happening during the lesson?)
When the students enter the classroom, they will join groups from previous week. Students will break back into their groups. In these groups, they will build Makey Makey circuits alongside an instructor. The students will create a circuit board and then work as a team to play games on the computer like: Pac-man, snake and Mario-kart. The Makey Makey is a group exercise that each student will need to work together in order for success to be achieved on the video game. The students each will have control over a function of the game meaning: the up button, down button, right and left button. In these groups, they will discuss what makes a circuit, open and closed circuits, conductive vs. non conductive materials, and if there is time parallel circuits vs. series circuits.

Welcome/Introduction
• Students come in, find their seats and place coats on back of the chair (3 minutes)
• Overall introduction of Today’s activity  (Group Leader) (4 minutes)
  • Large Group Activity: Review of last week
  • Review Key Terms & New Terms
    1. Electrons: An electron is a negatively charged subatomic particle.
    2. Electrical Current: The flow of an electrical charge
    3. Conductors: Allow for the flow of electrons
    4. Insulators: Block the flow of electrons
    5. Circuit: a circular path that starts and stops in the same place.
    6. Open Circuit: if the circle is not complete
    7. Closed Circuit: A closed path completing a circle
    8. Electricity: The flow of electrons around a circuit
    9. Ground (Earth): A common return path for electrical current. Prevents user contact with dangerous voltage

Transition Video: Makey Makey VIDEO (4 minutes)
https://vimeo.com/60307041
• Following video, inform students they will be working in small groups
• Discuss with students about the proper way to work in groups
• Have students identify specific behaviors for working well in groups and explain why those behaviors help the group accomplish its goals.
• Group leader informs the students that they will working with PD3 student team leaders and all of them will be doing some different experiments to test out whether or not some is a conductor or an insulator of electricity.

Small Group (10 minutes)
Activity One: What’s Conductive Material?
In your already assembled Makey Makey, have students choose one item on the table that they think is conductive. In a group, test each item to see if it’s conductive or not. Lead a deeper discussion by identifying the aspects of material that allows material to be conductive.

Activity Two: What’s your power source?
After students choose various items that might be conductive or not, shift the conversation back to the parts of a circuit. Here, discuss what the power source, ground, could be to complete the circuit. Mainly discuss that the circuit is complete because we are completing the circuit ourselves as the ground.

**Student Creations: (20 minutes)**
Split students up into pairs and allow students to create their own Makey Makey circuits out of whatever they like. Give them time to test their Makey Makey while we ask individual questions about their process or ideas. At this time students may try more challenging conductors, sources, etc... if they choose to.

**Transition (6 minutes)**
Watch “O say can you see” while Team Leaders set up games.
https://www.youtube.com/watch?v=Uiq0DTCJvy0

**Team Game: (15 minutes)**
Build a game controller for the group of students to play together. Have students construct their own arrow key for them to control and then spend the rest of the time playing the game together and working on their teamwork skills.
Team Game Link:
https://scratch.mit.edu/projects/31651654/ (This link is to Tetris)
https://scratch.mit.edu/projects/21113772/

**Conclusion/Wrap Up: (5 minutes)**
Bring students’ attention back to the front of the class and ask students what they learned about
- A circuit
- Conductors
- What’s conductive?
- An open circuit/closed circuit
- Energy sources
**Appendix 3**

**Week 3: The Design Process, Creating an Electric Vehicle**

**Goals:**
- Gain students interest by providing them with a prompt that connects with previous weeks discussions about electricity and creative problem solving.
- Continue building on knowledge learned from previous session by introducing more terminology regarding circuits
- Have students collaborate together to successfully solve the solution for their problem
- Construct the physical model of their problem

**Objectives (Performance):**
- Students will use process skills to determine what the problem(s) is that they need to solve
- Students will show understanding of the problem by constructing a model of their solution
- Students will be able to explain their thought process if asked
- Students will be able to use their model in the next lesson if successful

**Standards (Content, Grade level, Technology):**

[Link to Indiana Third Grade Standards](http://www.doe.in.gov/sites/default/files/standards/indiana-third-grade-standards-2016-41116.pdf)

**Process Standards**
- SEPS.2 - Developing and using models and tools
- SEPS.5 - Using mathematics and computational thinking
- SEPS.6 - Constructing explanations (for science) and designing solutions (for engineering)
- SEPS.8 - Obtaining, evaluation, and communicating information
Science Standards

- 3-5.E.1 - Identify a simple problem with the design of an object that reflects a need or want.
- 3-5.E.3 - Construct and perform fair investigations in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

International Society for Technology in Education (ISTE) National Educational Technology Standards

*ISTE National Educational Technology Standards for Students (NETS-S)*
[https://drive.google.com/file/d/0B4P1LJfd4W4mZk5NVUxoS0ZoaVk/view?usp=sharing](https://drive.google.com/file/d/0B4P1LJfd4W4mZk5NVUxoS0ZoaVk/view?usp=sharing)

**Empowered Learner** - Students leverage technology to take an active role in choosing, achieving and demonstrating competency in their learning goals, informed by the learning sciences.
1. Articulate and set personal learning goals, develop strategies leveraging technology to achieve them and reflect on the learning process itself to improve learning outcomes.

**Knowledge Constructor** - Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others.
1. Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits.
2. Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions.

**Innovative Designer** - Students use a variety of technologies within a design process to identify and solve problems by creating new, useful or imaginative solutions.
1. Know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts or solving authentic problems.
2. Select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.
3. Develop, test and refine prototypes as part of a cyclical design process.
4. Exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems.

**Creative Communicator** - Students communicate clearly and express themselves creatively for a variety of purposes using the platforms, tools, styles, formats and digital media appropriate to their goals.

1. Choose the appropriate platforms and tools for meeting the desired objective of their creation or communication.
2. Create original works or responsibly repurpose or remix digital resources into new creations.
3. Communicate complex ideas clearly and effectively by creating or using a variety of digital objects such as visualizations, models or simulations.
4. Publish or present content that customizes the message and medium for their intended audiences.

**Materials:**

- Introduction video that sets up the problem
- STEM Challenge handout
- Pencils for each student
- Computer
- Sphero
- Lids
- Foil
- String
- Popsicle sticks
- Fuzzy sticks
- Dowel rods
- Straws
- Tape
- Rubber bands
- Note cards
- Paper cups
- 4 pairs scissors
• Scrap boxes
• Balloons
• Paper Clips

Description/Process (What will be happening during the lesson?)

Introduction (5-7 minutes)
Students come in and get in the groups they have been working with for the past weeks
Introduce lesson by the introduction video or script*

Group Activity (33 minutes)
Instructors will guide the conversation by identifying the problem they are trying to solve
Facilitating a brainstorming time
Assign group roles (coloring role, constructing, etc)
Assist students if necessary when constructing the model
Testing of their model
Improving the model (if needed)

Conclusion (10 minutes)
Groups will come to the front of the class to share their design and describe what materials they used.

Additional Learning:
Bluetooth technology- Spheros are connected to iPads through Bluetooth.
Connect the precious circuit work the Spheros- specifically how they charge
Appendix 4

Week 4: Racing on the Sphero Circuit

Goals
* Finish design process and construction of electric vehicle.
* Race chariots
* Summarize the past 4 weeks-what did they learn?

Objectives (Performance)
* Students will demonstrate their knowledge of how to connect the Sphero to the iPad
* Students will construct a vehicle out of random materials that will connect to the Sphero
* Students will explain their design process, how their chariot works, and how they constructed it.

Standards (Content, Grade level, Technology):

Process Standards
- SEPS.2 - Developing and using models and tools
- SEPS.5 - Using mathematics and computational thinking
- SEPS.6 - Constructing explanations (for science) and designing solutions (for engineering)
- SEPS.8 - Obtaining, evaluation, and communicating information

Science Standards
- 3-5.E.1 - Identify a simple problem with the design of an object that reflects a need or want.
- 3-5.E.3 - Construct and perform fair investigations in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved
Knowledge Constructor - Students critically curate a variety of resources using digital tools to construct knowledge, produce creative artifacts and make meaningful learning experiences for themselves and others.

1. Students plan and employ effective research strategies to locate information and other resources for their intellectual or creative pursuits
2. Students build knowledge by actively exploring real-world issues and problems, developing ideas and theories and pursuing answers and solutions

Materials
- Spheros robots (Charged prior to activities)
- iPads (Charged prior to activities)
- Built chariots
- Tape Race track
- Chariot constructive materials- Dr. Clausen’s black box of goodies

Description/Process (What will be happening during the lesson?)

Introduction (10 minutes)

1. Students will come into the classroom and gather in the front of the room.
2. Group leader will ask students what they remember about the design process.
   - Student will share their prior knowledge and provide some examples of how they went through that process the previous week.
3. Group leader will facilitate a conversation with students about continuing the design process and for the students to consider how they may improve the performance of their electric vehicles.
4. Students will be dismissed from the front of the room to their team “pit” areas where they are given 15-20 to revise their designs and test drive their electric vehicles.

Pit Time (15 - 20 minutes)
**Race Guidelines**

1. Once the final designs are ready to race, students will sit in their teams around the race track.
2. Group leader will discuss behavior expectations with students.
3. Ask students how they should want to behave so that everyone has fun.
4. Ask student to provide examples of good and bad behavior in this kind of setting.
5. Ask students what kinds of restrictions might be placed on those who do not follow the agreed upon behaviors and actions.
6. Group leader will review the race guidelines
   - One lap around the track for each member of the design team.
   - Each team member drives the vehicle at least one lap
   - Group leader also engages in safety guidelines
   - Stay off of the track area during the race
   - If a vehicle goes off the track, move out of the way carefully so someone does not get kicked or the vehicle does not get stepped on.
   - Be good sports. This competition is intended to be fun. Cheer on yourselves, teammates, and other teams!
7. Group leader identifies the race match ups

**Ready to Race!!!**

1. Group leader asks the first teams to come to the starting line and to sit in the order they are going to drive the vehicles.
2. Once the teams are ready, the Sphero Robots are connected and oriented to the iPad, and the cars are placed on the starting line the group leader will start the first race.
3. At the end of the tournament, teams get their pictures taken with their vehicles.

**Clean up**

1. Once the tournament is over ask children and others in the room to help pick up.
   - Pull tape off of the floor
   - Collect all remaining building materials
   - Collect Sphero robots
   - Collect iPads
2. Collect any remaining items so that the room is back to the way it was before the STEM activities for today started.
Lorem ipsum dolor sit amet, consectetur adipisicing elit, sed do eiusmod tempor incididunt ut laborum et dolore magna aliqua. Ut enim ad minim veniam, quis nostrud exercitation ullamco laboris nisi ut aliquip ex ea commodo consequat.