Fidget Fix

Grade 4

STEAM

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BIG IDEAS

The concept behind this lesson was to evolve an existing unit towards a more fully STEM integrated program. The purpose of this unit is for students to learn about the Engineering Design Process, develop an understanding of its importance, and make connections with how this process transfers between content areas and into real world scenarios. The Engineering Design Challenge that 4th graders will participate in will be to design and create a fidget toy. This lesson, as part of the larger unit, will focus on deepening student understanding of science concepts including energy, rotational motion, and friction. In addition, the challenge will incorporate some constraints pertaining to measurement and data concepts. This knowledge will be combined with students' learning and understanding of art content including lines, shapes, angles, and texture to design the fidget toy. Once students have developed a design, they will use 3D printing technology to bring it to life.

EDUCATION STANDARDS

NGSS Performance Expectation(s)

3-5-ETS1- **Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.**

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts:
Asking Questions and Defining Problems Asking questions and defining problems in 3–5 builds on grades K–2 experiences and progresses to specifying qualitative relationships. Define a simple design problem that can be solved through the development of an object, tool, process, or system and includes several criteria for success and constraints on materials, time, or cost.	***ETS1.A: Defining and Delimiting Engineering Problems*** *Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account.*	***Influence of Science, Engineering, and Technology on Society and the Natural World*** *People's needs and wants change over time, as do their demands for new and improved technologies.*

PA Core & PA STEELS STANDARDS:

Math: ***CC.2.4.4.A.1-*** Solve problems involving measurement and conversions from a larger unit to a smaller unit.

STEELS: 3.2.4.C- Ask questions and predict outcomes about the changes in energy that occur when objects collide.

ITEEA Standards

• Apply the technology and engineering design process. • Evaluate designs based on criteria, constraints, and standards. • Practice successful design skills.
National Art Standards Visual Arts- Creating Anchor Standard 1: Generate and conceptualize artistic ideas and work. Anchor Standard 2: Organize and develop artistic ideas and work. Anchor Standard 3: Refine and complete artistic work.

MEASURABLE STUDENT LEARNING OBJECTIVES

Students will be able to:

- Apply their knowledge of lines, shapes, angles, and texture to create a design for a fidget toy.
- Explain the Design Engineering Process and provide examples of where it is found in real life scenarios.
- Design, build, and test a prototype for a fidget toy following the Design Engineering Process.
- Apply their knowledge of 3D printing technology to design and create toy or part of a toy.
- Critique their fidget toy designs and make recommendations for improvements.

STEM INTEGRATION

STEM Subject areas integrated into lesson:

- Science
- Technology
- Engineering
- Math

Additional subject area integrated into lesson:

- Visual art

I am the STEAM specialist in my district for grades K-5. In the district, we have been working towards a more fully integrated STEM program. Developing this program is essential and powerful in assisting students to make connections between disciplines that are traditionally taught in isolation. The goal of this lesson, unit, and program is to provide project-based learning opportunities that will naturally enhance students understanding of concepts learned in core classes and allow them to transfer that knowledge to a real-world scenario. Through this lesson, students will acquire the understanding of the Engineering Design Process and will step into the role of an engineer to complete a challenge. This challenge will begin with a problem and students will work in teams to develop a design for a fidget toy. As part of the arts program, students learn about lines, angles, shapes, and texture. Through a collaborative effort, the art specialist will work together with my class to develop a design for the fidget toys. In STEAM, instruction prior to the challenge will deepen student understanding of energy, rotational motion, torque, and friction. We will also discuss the sizing constraint that students will need to incorporate when thinking about their toy design. In designing, students' will use their knowledge from both disciplines to create a design of their fidget toy. Their designs will begin on paper in art class and evolve to digital format using Tinkercard in STEAM. After student designs are complete, we will build background on 3D printing technology and the engineers will print their designs. Finally, students will work to improve their design textures by adding makerspace materials. They will complete the design challenge by testing, improving, and making recommendations for additional enhancements. This lesson provides students with an engaging way to connect content they are learning across the curriculum.

NATURE OF STEM

The lesson is an integration of science, technology, engineering, and 21st century skills. This engineering design challenge incorporates the pivotal parts of the design process and naturally integrates students' critical thinking, creative, collaborative, and communicative skills. It takes the exploration of the natural world (science & math) and requires that students apply that knowledge to the artificial (manmade). This will allow students to develop a more complex understanding of the content.

MATERIALS NEEDED

Paper	3D printer
Pencil	PLA Filament
Ruler	Tinkercard Software
Computer	Makerspace materials

ENGAGING CONTEXT/PHENOMENON

The Engineering Design Challenge in this lesson involves students design and creating a fidget toy. One of the most essential parts of the lesson is to “hook” students’ interest and elicit questions and excitement for the project ahead. The engaging phenomena I intend to use is a brief video of a fidget spinner in space. As a whole class, we will watch the video and it will lead us into a conversation about the science behind how this fidget spinner is working in space.

A second video will be used to engage students when we begin discussing the Engineering Design Process. This video features the fidget spinner that can spin that has set the world record for longest spin time. This video details some of the engineering that went into the design. This video will lead us into the conversation about what it means to be an engineer and the process that is followed in engineering.

DATA INTEGRATION

Students will learn about the concept of centripetal force. To develop their understanding of this concept they will watch the following NASA video.

https://www.nasa.gov/stemonstrations-centripetal-force.html

Students will use their knowledge of centripetal force to collect data about the number and types of toys that use centripetal force. Students will use this collected data to help them design their own fidget toy.

TEACHER BACKGROUND KNOWLEDGE

The teacher should have a core understanding of the Engineering Design Process. The following are links to help build this knowledge:

Engineering Design Process

The teacher should have a core understanding of the science behind fidget toys. The following are links to help build this knowledge:

Physics behind fidget spinners

Let's Explore of Rotational Motion with a Fidget Spinner

The teacher will also need to have a basic understanding of using Tinkercad to design and printing using 3D print technology. The following are some links to help build this knowledge:

Tinkercad for Beginners

3D Printing Basics

In addition, the teacher will collaborate with the art teacher to gain a clear understanding of the concepts taught in art and how they will be applied to the design of the fidget toy.

DIFFERENTIATION OF INSTRUCTION

This lesson can be adjusted in order to meet the unique needs of students in my classes. The following are some possible differentiations that can be made:

- Enabling text to speech application for the Wonderopolis lesson.
- Pre-arranging materials for Design Engineering challenge.
- Allowing additional time for completion of the protoype and one-to-one support throughout the building.
- Scaffolding the creation process by allowing students to design a piece or the entire fidget toy using Tinkercad based on need.
- Enabling accessibility tools on the Chromebooks such as enlarge pointer or text for Tinkercad and other websites.
- Providing students with specific jobs within their groups to ensure engagement of all students including the more reserved/hesitant students.

- Offering additional resources with greater text complexity for high achieving students and early finishers.

REAL-WORLD CONNECTIONS FOR STUDENTS

There are several real-life connections in this lesson. As noted above, the lesson will be part of larger unit teaching students about the Design Engineering Process. Once students have developed an understanding for this Design Engineering process, they will also learn about how it is relevant to many careers in engineering.

Furthermore, through the collaboration of art and STEAM, students will see how their creativity can be transferred from one environment to another. The goal is for students to see the connection between content areas, but more importantly to see how it can translate to everyday life. They will be learning about engineering and more specifically, toy designing and engineering. Even if students are not interested in this exact career path, perhaps they will at least see the avenue of applying their artistic abilities and creativity to a career in engineering or design.

INTEGRATION POSSIBLE MISCONCEPTIONS

Possible misconceptions about engineering:

- There is only one kind of engineering.
- It is too difficult.
- It is an industry dominated by males.

Possible misconceptions about 3D printing:

- It is too complex.
- It is too expensive

LESSON PROCEDURE

5E	Details of 5E Lesson Implementation
Engage This engage phase of the	**Procedure:** Upon entering the classroom, students will gather in the front of the room. This often where we begin class to have a discussion. Teacher will play the “Fidget Spinner in Space” video. After the video is played, teacher will ask class to make some

lesson is meant to grab students' attention and spark curiosity about the phenomena and topic.	observations about what they are seeing. This will allow for pre-assessment of student knowledge of science behind fidget toys. Using Google Classroom, students will disperse around the room and will work in pairs and be asked to follow the link to the Jamboard where they will post some thoughts about the science involved in the video and fidget toys using the sticky notes feature. This will be followed by a conversation about energy and friction. Teacher will introduce additional vocabulary and concepts to build student understanding using the Google Slides. Students will gather in the front of the room once again, and teacher will play the second engaging video, "The Longest Fidget Spinner Spin Ever". Teacher will ask students about the steps in the Engineering Design Process. Students will do a think-pair-share and share out their ideas. The rest of the class will be dedicated to review of steps in the process through discussion and viewing informational videos. **Modifications** Fidget toys for students who have a sensory needs, voice to text and/or visual accessibility features enabled on Chromebook, closed captioning for video. **Standards Addressed** **STEELS: 3.2.4.C-** Ask questions and predict outcomes about the changes in energy that occur when objects collide. **Formative/Summative Assessments** Observation, evalution of Jamboard responses **Resources** Videos played during lesson: A Fidget Spinner in Space The Longest Fidget Spinner Spin Ever Google Slide Deck: Fidget Toy Challenge
Explore	**Students will be working on this same concept using the art**

Now that students are engaged in the topic and we have discussed the science behind fidget toys. They will have the opportunity to apply that knowledge to the Engineering Design Challenge.	**concept of line, shapes, pattern, angles, and texture. The classes will be taught in parallel.** **Procedure:** Upon arrival, students will join again in the front of the room. The teacher will present the picture of the fidget toy in space and we will review the science and engineer concepts from the prior class. The teacher will revisit concepts including axis, axle, center of mass, rotation, torque, and inertia. The concept of centripetal force will also be introduced to students and the NASA video will be viewed. Prior to this class, students have reviewed art concepts that will apply to the Fidget Toy Engineering Design Challenge so those ideas are fresh in their minds. The challenge will be posed to students, they are engineers working for Fat Brain toys and there is a demand from customers for new and improved fidget toys. Their team is tasked with designing and creating these new toys. The criteria will be outlined for students and the class will work together to identify the constraints. The Fidget Fix Google Slides will be used to facilitate this conversation. Students will be divided into groups of 2 or 3 and they will use all of the knowledge that they have learned about fidget toys to begin designing their prototype. They will have access to Fidget Toy Research that can help with idea generation. Students will conduct research and make a list of toys that use centripetal force. They will use their newly acquired knowledge to complete a planning guide to track their progress. This will include brainstorming solutions and choosing one of those designs. Once they have selected the design, teams will decide possible materials they may use to create texture or improve the design once the initial is 3D printed. Planning guides will be collected at the end of class and passed to the art teacher so she can pick up on the development of the plan using art concepts. The planning guides will then be returned to the STEAM lab for the next step in the process. **Modifications** Providing students with specific jobs within their groups to ensure engagement of all students including the more reserved/hesitant students. Extended planning time. Assistance in

	facilitating the communication in groups as needed. **Standards Addressed** **3-5-ETS1** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. **ITEEA-** Apply the technology and engineering design process **ITEEA-** Practice successful design skills. **National Art Standards: Visual Arts: Creating** Anchor Standard 1: Generate and conceptualize artistic ideas and work. Anchor Standard 2: Organize and develop artistic ideas and work. **Formative/Summative Assessments** Observation, engagement with research materials, progression of planning guide completion. **Resources** Google Slide Deck: Fidget Toy Challenge Fidget Toy Research NASA Centripetal Force Video
Explain In this phase, students will apply the knowledge they have acquired to create a digital format	**Procedure:** Students will return to the STEAM lab with a finalized plan and sketch for their fidget toys. The next step in the process will be to transfer the physical sketch to a digital format using Tinkercad. These next steps will be outlined for students. Prior to beginning this process, the teacher will introduce 3D printing and students will complete the Wonderopolis Lesson: How Do 3D printer's work. This lesson will assist in building background for students with no prior 3D printing knowledge or experience. Once students have completed the Wonderopolis lesson, they will begin to create their design on Tinkercad using shapes, lines, and

of their fidget toy designs.	angles. At the end of class, all designs will be saved and students will share some tips or challenges with each other to help troubleshoot design issues. **Modifications** Providing students with specific jobs within their groups to ensure engagement of all students including the more reserved/hesitant students. Extended design time. Additional scaffolding for Tinkercad design or use of existing fidget toy templates as needed. Assistance in facilitating the communication in groups as needed. Use of Immersive Reader on Wonderopolis website. **Standards Addressed** **3-5-ETS1** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. **ITEEA-** Apply the technology and engineering design process **ITEEA-** Practice successful design skills. **National Art Standards: Visual Arts: Creating** Anchor Standard 2: Organize and develop artistic ideas and work. Anchor Standard 3: Refine and complete artistic work. **Formative/Summative Assessments** Observation, progression of transferring physical design to digital format. **Resources** Wonderopolis Lesson: How Do 3D Printers Work? Tinkercad Design Website
Elaborate In this phase students will have the	**Procedure:** Upon completion of Tinkercard design, students will download their designs to their computers and share them with the teacher. Then, the teacher will work with groups to import the designs into the slicing software. 3D printers work in the metric

opportunity to extend and elaborate on their learning. They will 3D print their designs and enhance them using makerspace materials. In addition, students will test and improvements and recommendations for improvements to fidget toy designs.	system so the groups will figure out conversions between the customary units (in which they designed the fidget) to the metric (in which they will print the fidget). Students will apply their knowledge of 3D printing to complete the print. Once complete, they will use available makerspace materials to enhance the design and ensure that it meets all outlined criteria for the challenge. Once the fidget toys are completely assembled, groups will proceed with testing and improving their designs. Each group will have the opportunity to complete up to 4 trials. The teacher will be facilitating the process, but this is designed to be almost entirely student centered. Students will access the Jamboard one final time to share their ideas of improvement. This will be followed by a brief class discussion. Once all 4th graders have completed the Fidget Fix Challenge, the teacher will hold a gallery walk so that students can see the designs of their peers. **Modifications** Extended time for completion of creating, testing, improving, and sharing phase. Assistance in facilitating the communication in groups as needed. Voice to text and/or visual accessibility features enabled on Chromebook. **Standards Addressed** **3-5-ETS1** Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost. **Math**: ***CC.2.4.4.A.1-*** *Solve problems involving measurement and conversions from a larger unit to a smaller unit.* **ITEEA:** Evaluate designs based on criteria, constraints, and standards. Anchor Standard 3: Refine and complete artistic work. **Formative/Summative Assessments** observation, success with

	measurement conversions during 3D printing, completion of challenge **Resources** Tinkercad Design Website
_ **Evaluate** This phase will take place throughout all 4 weeks and will allow both students and the teacher to determine acquisition and application of knowledge.	**Procedure:** The teacher will evaluate students formatively throughout the course of the 4 weeks, adjust instruction as needed. As a summative evaluation, a performance rubric will be used. Through observation and discussion responses based on higher level questions, the teacher will determine students understanding and application of concepts taught over the 4-week period. **Modifications** Extended time for completion of creating, testing, improving, and sharing phase. **Standards Addressed** **Formative/Summative Assessments** Engineering Design Performance Rubric **Resources** Engineering Design Rubric (see attached document) Self-assessment

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