Transformation 2013 Design Challenge Planning Form

Design Challenge Title: PIMP MY PLAYGROUND RIDE

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School: Manor TSTEM HS

Subject: IPC/Algebra I

Abstract: Students demonstrate and investigate simple machines by designing a playground ride for an elementary school that can be used to teach lessons on simple machines. Students will demonstrate simple machines by designing rides that involve several simple machines. They will characterize their rides using the concepts of mechanical advantage, force, and momentum. They will use these concepts to determine the safety of their ride and to design a 5E lesson plan that uses their ride to teach a simple machines lesson to an elementary school class.

MEETING THE NEEDS
OF STEM EDUCATION
THROUGH DESIGN CHALLENGES

Begin with the End in Mind

- ***Does this design challenge meet the criteria for STEM student needs (21st century skills, TEKS, TAKS)?***

Summarize the theme or "big ideas" for this design challenge.

Students demonstrate and investigate simple machines by designing a playground ride for an elementary school that can be used to teach lessons on simple machines. Students will demonstrate simple machines by designing rides that involve several simple machines. They will characterize their rides using the concepts of mechanical advantage, force, and momentum. They will use these concepts to determine the safety of their ride and to design a 5E lesson plan that uses their ride to teach a simple machines lesson to an elementary school class.

Identify the TEKS/SEs that students will learn in the design challenge (two or three).

TARGET SKILLS:

IPC

(4C) analyze the effects caused by changing force or distance in simple machines as demonstrated in household devices, the human body, and vehicles; and (4D) investigate and demonstrate mechanical advantage and efficiency of various machines such as levers, motors, wheels and axles, pulleys, and ramps. (A) calculate speed, momentum, acceleration, work, and power in systems such as in the human body, moving toys, and machines; (B) investigate and describe applications of Newton's laws such as in vehicle restraints, sports activities, geological processes, and satellite orbits;

ALGEBRA I

Linear functions: (A.6F) interpret and predict the effects of **changing slope** and *y*-intercept in applied situations

NON-TARGETTED ELA TEKS (1) Writing/purposes. The student writes in a variety of forms, including business, personal, literary, and persuasive texts, for various audiences and purposes. The student is expected to: (A) write in a variety of forms using effective word choice, structure, and sentence forms with emphasis on organizing logical arguments with clearly related definitions, theses, and evidence; write persuasively; write to report and describe; and write poems, plays, and stories; (B) write in a voice and style appropriate to audience and purpose; and (C) organize ideas in writing to ensure coherence, logical progression, and support for ideas. (2) Writing/writing processes. The student uses recursive writing processes when appropriate. The student is expected to: (A) use prewriting strategies to generate ideas, develop voice, and plan; (B) develop drafts, alone and collaboratively, by organizing and reorganizing content and by refining style to suit occasion, audience, and purpose; (C) proofread writing for appropriateness of organization, content, style, and conventions; (D) refine selected pieces frequently to publish for general and specific audiences; and (E) use technology for aspects of creating, revising, editing, and publishing. (3) Writing/grammar/usage/conventions/spelling. The student relies increasingly on the conventions and mechanics of written English, including the rules of grammar and usage, to write clearly and effectively. The student is expected to: (A) produce legible work that shows accurate spelling and correct use of the conventions of punctuation and capitalization such as italics and ellipses; (B) demonstrate control over grammatical elements such as subject-verb agreement, pronoun-antecedent agreement, verb forms, and parallelism;

Identify key skills students will develop in this design challenge.

- Identify and demonstrate the 6 simple machines
- Calculate the mechanical advantage of the 6 simple machines

- Calculate the speed, momentum, and force of children using their rides and use these calculations to assess the safety of their ride
- Use linear equations to predict how the quantities above will change when the dimensions of their rides are changed

Identify the 21st century skills that students will practice in this design challenge (one or two).

www.21stcenturyskills.org

Critical Thinking and Problem Solving

Arguably some of the most important skills for which we advocate, critical thinking and problem solving skills require the ability to:

Exercise sound reasoning in understanding

Make complex choices

Understand the interconnections among systems

Frame, analyze and solve problems

Communication Skills

Communication skills require the ability to articulate thoughts and ideas clearly and effectively.

Creativity and Innovation Skills

Creativity skills require the ability to:

Demonstrate originality and inventiveness in work

Developing, implementing and communicating new ideas to others

Being open and responsive to new and diverse perspectives

Collaboration Skills

Mastering collaboration skills requires the ability to:

Work effectively with diverse teams

Be helpful and make necessary compromises to accomplish a common goal

Information and Media Literacy Skills

Mastering Information and Media Literacy skills requires the ability to:

Understand, manage and create effective oral, written and/or multimedia communication in a variety of forms and contexts

Analyze, access, manage, integrate, evaluate and create information in a variety of forms and media

Contextual Learning Skills

Identify STEM outcomes to be included in this design challenge.

Contextual learning skills require the ability to take advantage of education in a variety of contexts both inside and outside the classroom, and understanding that knowledge is acquired within a context

Craft the Driving Question

- ***Have you posed an authentic problem or significant question that engages students and requires STEM knowledge to solve or answer?***

State the essential question or problem statement for the design challenge. The statement should encompass all design challenge content and outcomes, and provide a central focus for student inquiry.

(VERY ROUGH DRAFT FOR PROJECT ENTRY TASK)

There is a growing market for state-of-the-art playgrounds that combine the joy of play with the joy of learning. You have been hired by Boundless Playgrounds (www.boundlessplaygrounds.org) to develop a playground ride targeted for Texas elementary schools that incorporates the Science TEKS. To earn a TEA endorsement, the ride must incorporate ideas related to "simple machines" and must come with sample lesson plans that demonstrate how the ride can be used by teachers to teach science. In order to meet Boundless Playground's standards, the ride must be fun, safe, and age-appropriate.

Your task is to invent a new playground ride that incorporates at least 4 of the 6 simple machines. To pass the Boundless Playground's first pre-production review, you must build a prototype of your ride and use this model to estimate the safety of the ride. To demonstrate the safety of your device, you will need to collect and analyze data that models the motion of children who may use your ride. This data must be presented in multiple ways in order to persuade the committee members that your device is safe. [NOTE: We will have a Know/Need to Know discussion that discusses what these safety tests must entail.]

In addition, you will develop a lesson plan that will help Boundless playground market your ride to Texas school districts. The lesson plan must be written in 5E form and must teach children about simple machines and mechanical advantage.

At the end of three weeks, you will present your concept model and your lesson plan at a Boundless Playgrounds Poster session. At this poster session, you will present your design to representatives from Manor ISD, the Manor Parks Departments, UTeach, and [Boundless Playground or like industry rep].

Plan the Assessment

STEP 1: Define the products and artifacts for the design challenge.

Early in the challenge:

- **Entry Document Form –** Students state their understanding of their roles, the problem, and the expectations for the solution of the problem. They also create a Know/Need to Know list.
- **Inspiration Board –** Students working in groups create a board filled with labeled pictures of things that will inspire their design
- **Group Contract –** Students outline their roles within their groups and the expectations associated with those roles. Students develop policies that describe what will happen when students do not meet group expectations.

During the challenge:

- **Lever Lab Report**
- **HW (1 or 2)** on Mechanical Advantage and Efficiency
- **Brainstorm List (20 Engage Activities)**
- **Know/Need to Know Lists on 5E components**
- **Labeled sketch of concept model**
- **Concept model of their ride**
- **Simples machines lab sheets**
- **Lab Report for an Experiment (of their design) that tests their concept model**
- **5E Lesson Draft**
- **Quiz on Simple Machines**

End of the challenge:

- **Final Draft of 5E**
- **Tri-fold poster of their concept model**
- **Test on Simple Machines**

Plan the Assessment

STEP 2: State the criteria for exemplary performance for each product.

- ***Do the products and criteria align with the standards and outcomes for the design challenge?***

Product: Entry Document Form **Criteria:** Students demonstrate that they understand their roles, the problem, and the expectations for the product. Students create a detailed know/need to know list that relates to the project task
Product: Inspiration Board **Criteria:** Each group has a couple pictures found by each individual in the group that can inspire their design. Each picture is labeled to show the parts they know (their street names and the simple machines in them) and parts they are confused about. Students are able to explain the sources of their inspiration to their peers in a gallery walk. [Note: This is like a Know/Need to Know list in project form]
Product: Group contract **Criteria:** Students write out rules that relate to the collaboration norms they want within their group. Students outline their project roles. Students list actions and consequences in the event that a group member can not or will not fulfill responsibilities of his/her role.
Product(s): Lab Report #1 (Levers) and Lab Report #2 **Criteria:** Students record observations in written and numerical form. Students tabulate and graph data. Students draw a best fit line and use its slope to find either mechanical advantage or efficiency.
Product: Sketch of Concept Model **Criteria:** Sketch is labeled and includes at least 4 of the 6 simple machines. The labels point out the simple machines and the materials they intend to use for their concept model and potential materials for the real version of their ride.
Product: Concept Model **Criteria:** Model resembles their actual ride and is sturdy enough for an experiment that measures the mechanical advantage of at least one part of their ride.
Product: Proposal for Experiment on their Concept Model **Criteria:** Students describe a method that can feasibly measure the mechanical advantage of one part of their ride. Students draw a qualitative graph for what they might get when they perform this experiment. (1 page written description + 1 graph)
Product: Brainstorm List for Engage **Criteria:** Each group comes up with 20 potential engage activities for their 5E lesson. Not every idea has to work – it's just an exercise to help them to jumpstart their creativity

so they arrive at least a few good ideas.
Product: Journal Entries on 5E model **Criteria:** Students create a Know/Need to Know list on each 5E component that is directly related to their lesson plan
Product: 5E Lesson Draft **Criteria:** Students submits a completed 5E lesson form. See 5E form at the end of this form.
Product: Revised Lesson Plan **Criteria:** One version with track changes that show comments from a UTeach PBI student who gave them electronic feedback on their draft. Another version that shows how they responded to the feedback.
Product: Tri-fold Poster Criteria: Poster includes: labeled sketch of their device, storyboard of their 5E lesson, at least one graph that describes the results of the experiment they performed on the device and a caption that explains the graph and what it means for kids who may use their ride

Tentative Calendar:

Days 1-2

- Hands On Discussion: Students play with fun* gadgets that involve simple machines and discuss how they work
- Project Launch: Students read an entry document that explains their role and their project. Students generate a Know/Need to Know list as a group or as a class.
- Group Contract: Students develop a contract that clarifies their roles, group expectations, & responsibilities
- Inspiration HW/Gallery Discussion: Students bring in labeled photos of things* that will inspire their design

Day 3-5

- 5E Lesson on Levers: A demonstration of 5E lesson and demonstrations on how to gather and organize data on mechanical advantage and efficiency
- HW on Mechanical Advantage of Levers and efficiency
- Students brainstorm and submit a labeled sketch of their design.
- Students brainstorm and submit a list of 20 Engage activities per group.

Day 6-8

After sketch is approved, students begin building a prototype sturdy enough for at least one experiment on mechanical advantage

Stations Lab on Simple Machines: Students work at their own pace at stations that demonstrate the mechanical advantage & efficiency of pulleys, screws, ramps, wheels & axles.

Workshops on Topics Related to Project

Day 9-10

Students complete their prototype

Students design an experiment to determine the mechanical advantage of their ride (or one piece of it).

Students create drafts for the remaining 5Es of their lesson plan.

Due Day 10: Draft of their 5E lesson.

Students take a quiz on simple machines

Tentative Calendar (cont.

Days 11-12	Days 13-15
Students perform experiment to measure M.A. and to estimate efficiency of their ride. Interactive discussion on Preparing Poster Presentations Students begin preparing tri-fold poster for poster session at the end of the week. Students revise their 5E lesson plans in response to online feedback on their lesson plans from UTeach students taking PBI	Draft Poster Session: Students present draft storyboard of their poster to their classmates Students share and respond to feedback from their peers. Final Poster Session: Students present their posters to a panel that includes engineers, UTeach students, Parks department reps, and Manor ISD reps Students take a test on Simple Machines. Final reflection discussion

Plan the Scaffolding Activities:

The following journal entries can be inserted when appropriate as warm-up exercises aimed at inspiring students and renewing their focus:

Day 1

What I Know – Jot down a list of words, terms, items, etc. you are familiar with that are related to the gadgets discussed in class.

Day 1

What I Need to Know – After listening to the class discussion of terms utilized in the gadgets, make a list of words, terms, items, ideas, concepts, etc. that you need to know or would like to know more about in the future and why.

Day 2

Describe your ideal role within your group and how you expect each of your group members to perform during the project.

Day 3

In what ways do mechanical advantage and efficiency apply to the gadgets discussed on days 1 and 2?

Day 4

Brainstorm a list of 3-4 Engage activities and choose one of your favorites. Describe in detail what it looks like to be involved in that Engage activity you proposed.

Day 5 – 6

While you are building your prototype, document the materials used and discuss the advantages and disadvantages for each prototype.

Day 7

In you own words, describe the mechanical advantage of pulleys, ramps, screws, wheels, and axles.

Day 8

In your own words, describe the efficiency of pulleys, ramps, screws, wheels, and axels.

Day 9 - 10

Write a mini-technical manual outlining the specific steps of the experiment that determines the mechanical advantage of your prototype. Include possible outcomes.

Day 11 - 12

Predict outcome of experiment that determines the mechanical advantage of your prototype. Then document the process and outcome of your experiment.

Day 13

Outline ideas of how posters will be created and presented to illustrate prototype and experiment.

Day 15

Now that you have completed your project, go back to your "Need to Know" journal and choose one concept that you did not know at that time. Apply what you have learned about mechanical advantage and/or efficiency to that particular term, idea, concept, gadget, etc.

Day 15

How have your group members met your expectations for performance during the project process?

Day 15

What was your favorite part of the project? What was your least favorite part of the project?

Map the Design Challenge

Look at the major product for the design challenge and analyze the tasks necessary to produce a high-quality product. What do students need to know and be able to do to complete the tasks successfully? How and when will they learn the necessary knowledge and skills?

- ***Do the products and tasks give all students the opportunity to demonstrate what they have***

Product:	**(check appropriate box)**		
Knowledge and Skills Needed ***Elaborate on the knowledge and skills (TEKS student expectations) required to accomplish each step of the task.***	**Already Learned**	**Taught before the project**	**Taught during the project**
1. Graph linear data [Fout vs Fin and Wout vs Win], draw a best fit line to the data, and measure the slopes of these lines.	X	X	
2. Correctly associate the slopes in 1 with mechanical advantage and efficiency.			X
3. Use spring scales and force probes to measure forces.			X
4. Use mechanical advantage to predict output forces associated with the input forces that kids that apply on their rides.			X
5. Design/perform an experiment to measure the relationship between a dependent and independent variable	X	X	
6. Understand concept of mechanical advantage well enough that they can present what they learned in a 5E lesson format.			X
7. Make predictions by using interpolations and extrapolations on linear graphs.	X	X	
8. Format graphs (label them appropriately and use correct independent and dependent) variables so that they can use these graphs to answer questions and tell stories	X	X	
9.			
10.			

What PBL tools will you use? (check appropriate box)

X Know/need to know lists	☐ Gallery walks
X Daily goal sheets	☐ _____
X Journals	☐ _____
X Briefs	☐ _____
X Task lists	☐ _____
☐ Problem logs	☐ _____
☐ Project flow charts	☐ _____

Title: Pimp my (Playground) Ride	
TEKS: **IPC** (4C) analyze the effects caused by changing force or distance in simple machines as demonstrated in household devices, the human body, and vehicles; and (4D) investigate and demonstrate mechanical advantage and efficiency of various machines such as levers, motors, wheels and axles, pulleys, and ramps. (A) calculate speed, momentum, acceleration, work, and power in systems such as in the human body, moving toys, and machines; (B) investigate and describe applications of Newton's laws such as in vehicle restraints, sports activities, geological processes, and satellite orbits; **ALGEBRA I** **Linear functions: (**A.6F) interpret and predict the effects of **changing slope** and *y*-intercept in applied situations	
Storyboard Poster Session: Students present draft of their poster to their peers. Students read entry document and have a class and/or group discussion based on that documents that generates a Know/Need to Know List related to the project and also outlines the student roles, problems, and expectations within the project context.	
Engage Activity Identify/focus on instructional task, connect between past & present learning experiences, lay groundwork for activities (ex. Ask a question, define a problem, show a surprising event, act out a problematic situation)	**Hands On Discussion**: Students play with fun* gadgets that involve simple machines and discuss how they work **Project Launch:** Students read an entry document that explains their role and their project. Students generate a Know/Need to Know list as a group or as a class **Group Contract:** Students develop a contract that clarifies their roles, group expectations, & responsibilities **Inspiration HW/Gallery Discussion**: Students bring in labeled photos of things* that will inspire their design. Post these in walls and explain their sources to other students in a gallery walk.
Exploration Activity Students get involved with phenomena and materials, students work in teams to explore through inquiry	**5E Lesson on Levers:** A demonstration of 5E lesson and demonstrations on how to gather and organize data on mechanical advantage and efficiency **Review of design sketch**: Students brainstorm and submit a labeled sketch of their design. Teachers give them feedback on their designs. **Construction of concept model:** Students build concept model and review their progress with teacher as major pieces of the model are completed. **Stations Lab on Simple Machines**: Students work at their own pace at stations that demonstrate the mechanical advantage & efficiency of pulleys, screws, ramps, wheels & axles.

Explanation (Time:) Students discuss observations, ideas, questions and hypotheses with peers, facilitators, groups. Learners apply labels to their experiences – thus developing common language, clarification/explanation of key concepts (ex. Writing, drawing, video/tape recordings)	**Engage Brainstorming Activity:** Students brainstorm and submit a list of 20 Engage activities per group**.** **Workshops:** Teacher hold short workshops on concepts in response to student requests and in response to misconceptions as they appear in formative assessments. **5E Lesson Plan Writing/Revising:** Students draft a 5E lesson that uses their ride and revise their draft in response to feedback from UTeach pre-certifying teachers taking PBI.
Elaboration (Time:) Expand on concepts learned, make connections to other related concepts, apply understandings to the world. (ex. Extend & apply knowledge) Leads to more inquiry and new understandings.	**Concept Model Experiment**: Students design and perform an experiment to measure the mechanical advantage of at least one part of their ride. **5E Lesson Plan Writing/Revising:** Students draft a 5E lesson that uses their ride and revise their draft in response to feedback from UTeach pre-certifying teachers taking PBI.
Evaluation (Time:) Ongoing diagnostic process to determine if the learner has attained understanding of concepts & knowledge (ex. Rubrics, teacher observation with checklist, student interviews, portfolios, project products, problem-based learning products, assessments) Leads to opportunities for enrichment through further inquiry and investigation.	**5E Lesson on Levers:** See Engage. **Inspiration HW/Gallery Discussion**: See Engage. **Engage Brainstorming Activity:** See Explain. **Construction of concept model:** See Explore. **Stations Lab on Simple Machines**: See Explore. **Workshops:** See Explain. **5E Lesson Plan Writing/Revising:** Students draft a 5E lesson that uses their ride and revise their draft in response to feedback from UTeach pre-certifying teachers taking PBI. **Storyboard Poster Session**: Students present draft of their poster to their peers. **Final Poster Session:** Students present their poster to a panel of teachers, school/parks administrators, and engineers. **Simple Machines Quiz** **Simple Machines Test**
Materials/Equipment: Tri-fold Poster Boards (1 per group of 3-4 students). Materials to build concept models (glue guns, glue sticks, cardboard, plastic, papers, possibly Lego blocks).	
Modification for SE/GT/ESL: **GT:** Final Product Rubrics will include "Awesome" Content standards in addition to Unsatisfactory, Proficient, and Advanced categories. Students who complete all the standards up to the Advanced categories will earn the right to perform activities in the Awesome categories	

and possibly earn a place on the Wall of Awesome.

ESL:
Students include excerpts in their posters that translate main ideas into their native languages.
Students assigned as a special outreach role – they will take the lead in designing ESL activities for their 5E lesson based on what helps them learn.
Group students together with compatible language skills – e.g. pair ESL students who students fluent in their native language and English.

SE:
Student grouped in mixed ability groups.
Students awarded participation points for tutoring and getting tutored.
Workshops: short targeted lessons for small groups of students who are having trouble with some concepts. These can occur while other group members continue work on the project.

Exit Activity:
Day 1: **Storyboard Poster Session**: Students present draft of their poster to their peers.

Day 2: **Final Poster Session:** Students present their poster to a panel of teachers, school/parks administrators, and engineers.

Homework Ideas:
Day 1 or 2: Students bring in labeled photos of things* that will inspire their design. Post these in walls and explain their sources to other students in a gallery walk.

Day 3-5: Students complete 1 or 2 short HW sets on mechanical advantage and efficiency.

Need to have Basis: Students will assign each other HW in order to meet project milestone deadlines.

[5E form for students' lesson plans – page 1 of 2]

NAME:

TITLE OF LESSON:

LENGTH OF LESSON:

NAME OF COURSE:

GRADE LEVEL:

I. OVERVIEW (1-2 paragraph summary of what the lesson is about and what students will do)

II. SOURCES OF THIS LESSON:

III. TEKS ADDRESSED:

IV. PERFORMANCE OR LEARNER OUTCOMES: Student will be able to

V. RESOURCES, MATERIAL AND SUPPLIES NEEDED:

VI. SAFETY CONSIDERATIONS:

VII. SUPPLEMENTARY MATERIALS, HANDOUTS (OPTIONAL)

[5E form for students' lesson plans – page 2 of 2]

5-E ORGANIZATION

ENGAGE: **Estimated time:** **Teacher Asks/Does**	**Student Responses/Does**
EXPLORE: **Estimated time:** **Teacher Asks/Does**	**Student Responses/Does**
EXPLAIN: **Estimated time:** **Teacher Asks/Does**	**Student Responses/Does**
EXTEND/ELABORATE **Estimated time:** **Teacher Asks/Does**	**Student Responses/Does**
EVALUATE **Estimated time:** **Teacher Asks/Does**	**Student Responses/Does**