

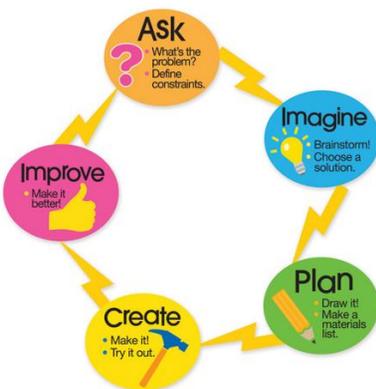
ENGINEERING A BOARD GAME

“Games are architectures for engagement”

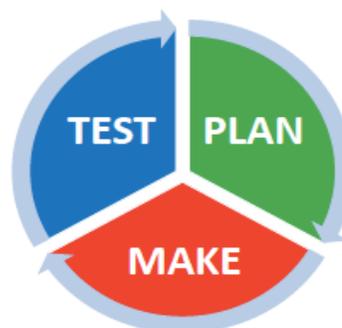
The quote above is from Constance Steinkuehler, a professor at the University of Wisconsin-Madison and an expert in the use of games in education. Our classrooms should be places where students are engaged in learning. So why not combine the fun of games with an Engineering Design challenge? Think of using a board game design project as a way to: (1) introduce the Engineering Design Process into any classroom and subject, (2) engage students in a creative and collaborative project that involves planning, spatial reasoning, and technical writing, and (3) provide an opportunity to apply and work with concepts from any topic. Board game design is the ultimate STEAM project, requiring content knowledge, spatial and mathematical reasoning, visual design components, and the ability to communicate clear instructions. It meets NGSS, Common Core, and a range of discipline-specific standards. And it can be scaled to meet different grade level and class time requirements.

There is a great deal of Engineering that goes into developing a board game. Packaging must be designed, themes and layouts need to be created, a playing “process” must be described, materials need to be sourced, it must be tested and modified by obtaining user feedback, and it needs to be presented in an engaging manner. Add to that the ability to focus the theme on any curricular topic or unit and you have an amazing platform to engage the future toy engineers in your classroom in a unique learning experience.

The entire project easily fits into the overall Engineering Design Process (EDP). Since this is designed for elementary and middle school students you can use either of the following EDP models. (Please note that we have had a number of high school teachers use a more in-depth version of this same project with great success. They sometimes add in things like a sound or a light that is triggered by a certain play of move. Some even have students 3D print game pieces. Some teachers have used this project as a mock-up prior to electronic game design projects.)



EDP Grades 3-8



EDP Grades K-2

Suggested supplies are listed at the end of this overview. Encouraging your students to recycle and repurpose items they may have at home will further minimize expenses. Provide groups folders or binders to be used to organize all forms, notes, and planning documents.

Time for project: Varies with grade level and complexity. Approximate Grade 6 timing for project as described is 10-12 class periods (50 minutes each).

Here are some simple guidelines to get started:

- **CHOOSE A TOPIC**

Choose your topic and decide how many concepts or ideas you want featured in the game.

For example, if your middle school students are learning about cells, you may want to provide a list of 15-20 key facts or terms and require that 10 should be featured in the game.

Here are some topic ideas:

- Any core science topic or unit
- Sets of math facts
- Shapes and geometry concepts
- Global issues such as types of renewable energy, plastics in the ocean, the water footprint of various products, the United Nations Sustainable Development Goals
- World language games can focus on key vocabulary, phrases, and cultural issues
- Games in ELA classes can revolve around characters and plots in stories and novels
- History games can be based on important dates and events; cultural and economic aspects of development

As you can see, the options are unlimited. Just be careful to start with a clear description of the content you want to see featured in the game. All groups can be focused on the same topic since they will all develop different games based on their own criteria and their research. Or you can maximize the exposure to different aspects of a topic by assigning different sub-topics to different groups.

- **DEVELOP CONSTRAINTS AND DESIGN REQUIREMENTS**

Provide some constraints for your students. You will probably want to give them an overall footprint (length x width) for their board and some guidelines for the size of their box. Making it smaller than the board requires some “engineering” in terms of how to

fold the board. Make sure they understand any requirements you may want to put in place for the materials and the format of the instructions. Remind them that the game should have a title that reflects there them.

- **CREATE GROUPS/ASSIGN JOBS**

Create groups based on your experience with the students or group work in your class. If you are working with very young students (grades K-3) you may want to scale both the project and the group size back. Don't forget to assign or to let students select jobs. See the Jobs Chart in this document for suggested jobs and responsibilities. You can adjust it to fit your project and needs.

- **GROUPS RESEARCH AND DEVELOP CRITERIA**

Once students are aware of the project and the constraints and requirements, give them time to "research" different types of games in order to develop criteria to define what they think is a good game. They should have 4 – 5 criteria once they are done. The Project Manager should create a list and put it in the group folder or binder.

- **GROUPS BRAINSTORM IDEAS**

Provide some time for the group to think divergently and creatively. Brainstorming should help them to generate ideas for the overall design, game pieces, name, theme, strategy. You may want to break this up into two sessions. Have students sketch or record their ideas on sticky notes or on chart and keep all of that in their folder or binder.

- **FINISH PLANNING**

Using the 4 forms and graphic organizers in this packet, have students check that have made enough plans to begin. Ideally, the Concepts, Board, and Packaging forms would be complete before students start building, but that may be challenging to some groups. In that case, walk them through key ideas you would like thought through before they build and remind that it all needs to be complete before they finish the project. These forms should also be kept in the group binder or folder.

- **BUILDING PHASE**

This is where having jobs is very helpful. There is a lot to do and group member will need to work on many tasks simultaneously. Use the job titles and responsibilities to keep students on track with a DAILY TASK list on your board. Many teachers find it is also helpful to indicate which job "backs up" each of the other position in case a student needs help or advice from other team members. Others simply let students sort out that collaborative function. Remind students of their planning forms to help them follow a process rather than simply making something. Students will be working on board and

playing piece design, content inclusion, packaging, and writing instructions. Everyone should be busy! This may take 5-6 class periods.

- **TESTING PHASE**

Toys and games are tested by having potential customers try them out. Have each group generate a 4-5 questions about how much fun the game is; how it looks; if instructions are clear; if players learned anything; is packaging easy to use, etc. They should have a 1-5 rating space for all questions. Bring another class in to test or have groups switch. Try to have a least two groups play each game for feedback and have each player fill in a survey. The design team can then average data and decide what can be improved.

- **MODIFICATION AND OPTIMIZATION**

Once they have collected and analyzed the feedback data, teams should be allowed to make a few modifications. They should be able to connect their modifications to their testing information. You can create a very simple Modification Form for this. It needs to ask what the modification is and why it is being done. Limit modifications or the game will look completely new and any evidence of planning and a design process will be lost. Two or three modifications are generally enough.

- **FINAL “PITCH”**

Since this is a consumer product, a marketing pitch or ad campaign works well and eliminates the opportunity for a rote and boring presentation. Limit time and give students a list of a few things that should be in their “pitch”. Have the students in the audience rate or rank the pitches, just for fun. (Most teachers do not use this group rating as a significant part of assessment. It is generally more about bragging rights.)

ASSESSMENT CONSIDERATIONS:

Teachers use a wide range of assessment components for this project because it can be so customized. Please try to follow a few key pointers:

- The process should be as or more valuable than the product. A great deal of learning takes place in managing a multi-faceted project over multiple days. If you fail to weight the process enough, the project can be more “making” than “Engineering”. The binder or folder provides documentation of the process along with your ongoing observations.

- You may want to spell out key components of a success product. There are multiple parts such as the board, packaging, concepts, instructions, etc. It would be helpful for students to have prompts in terms of what will be assessed.
- This is a group project, and depending on grade level, that should be reflected in assessment. In general, the group component of the grade should be equal to or higher than the individual grade. That is sometimes determined by school or teacher policy. There should always be some individual component in order for students to feel more in control. The idea of jobs helps with individual assessment. Other useful tools are a simple teacher checklist of who is on task every day and an opportunity for peer assessment. Some teachers give a short quiz related to the concepts in the game as part of the individual grade.

MATERIALS/SUPPLIES

This is a suggested list. Most teachers find actual material cost are low since they already have most items.

- ✓ Chart or Kraft paper for planning
- ✓ Foam core (for pieces)
- ✓ Cardboard (recycled, for boxes and boards)
- ✓ Card stock (various colors)
- ✓ Buttons, pom poms, pipe cleaners, etc. (for playing pieces, decorations)
- ✓ Scissors
- ✓ Scotch tape
- ✓ Duct tape (various colors)
- ✓ White or craft glue
- ✓ Hot glue guns and glue (optional)
- ✓ Student supplied materials (recycled, not new; with teacher approval)

Some helpful resources on real toy engineers and the value of games as learning tools can be found here.

<http://www.graduatingengineer.com/articles/20000117/Toying-With-Education>

[https://www.thegeniusofplay.org/App Themes/tgop/pdfs/research/smithsonian-panel-report.pdf](https://www.thegeniusofplay.org/App%20Themes/tgop/pdfs/research/smithsonian-panel-report.pdf)



<https://news.stanford.edu/2013/03/01/games-education-tool-030113/>

<https://www.treehugger.com/climate-change/can-role-playing-game-teach-millions-farmers-cope-climate-change-video.html>

DESIGN TEAM JOBS FOR BOARD GAME DESIGN PROJECT

JOB TITLE	RESPONSIBILITIES
Project Manager	<ul style="list-style-type: none"> • Checks with each team member about that day's focus • Manages the project checking that by forms to document process are completed • Develops and writes the instructions and rules of the game
Design Engineer*	<ul style="list-style-type: none"> • Develops overall layout of game board • Manages development and construction of prototype with assistance from all team members • Verifies that the design is meeting constraints and criteria • Oversees modification based on testing
Materials Engineer*	<ul style="list-style-type: none"> • Identifies needed materials for game board, pieces, and packaging. • Develops packaging • Establishes testing procedure • Works with Project Manager to develop instructions
Marketing Manager	<ul style="list-style-type: none"> • Develops packaging for the game • Works on commercial communication of product (i.e. instruction manual, and user information) • Develops market survey and customer feedback forms • Develops and coordinates marketing pitch.

*If there are more than 4 team members, one of these jobs can be duplicated. If there are only 3 team members, eliminate one of the jobs and equally distribute Responsibilities to remaining team members.



ENGINEERING A GAME

Key Concepts and Information

Group Members:

Please list at least 10 concepts, facts, or statistics that your game will help people learn about. If you would like to include more, use a second copy of this form.

Possible Game Name:	
SDG:	
Concept, Fact, or Statistic	Check if Included
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	
9.	
10.	



ENGINEERING A GAME

Board Layout and Component Plan

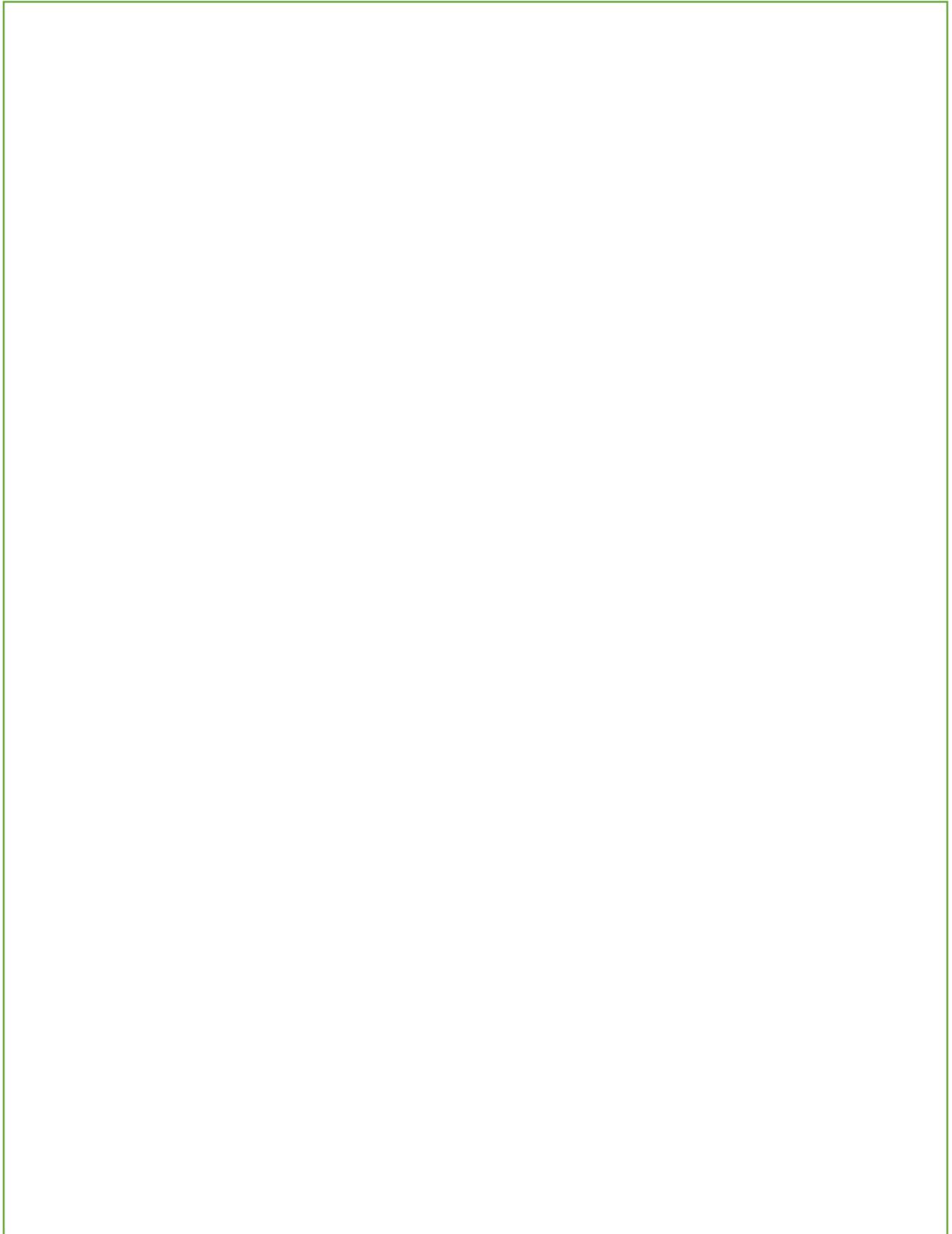
Group Members:

Name of Game:

Please complete the following Checklist in order to help you plan your game. Provide sketches of your board, cards, and pieces on the next pages as needed. Add any additional parts that you will use.

Part	Number	Description	Materials Needed
Board			
Players' pieces			
Fake money			
Cards			
Spinner or Dice			

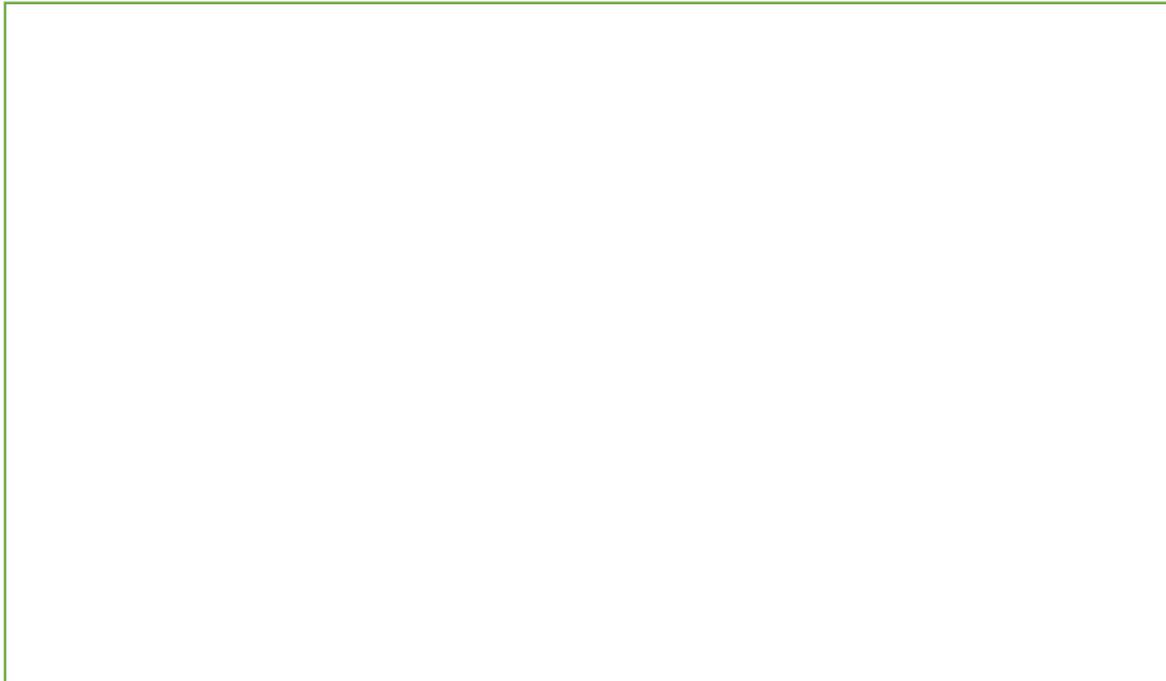
Sketch of Board:



Sketch of Player Piece (s):



Sketch of cards and/or money:





ENGINEERING A GAME

Packaging Design Plan

Group Members:

Possible Names for Game:

1.

2.

3.

Type of Game (circle one): **CARD** **BOARD** **OTHER**

Overall Shape of Box or Outer Packaging (please include a sketch on next page):

Any Additional Storage Components:

Materials you will need:

Please sketch your planned game box or package here.



Game Procedure and Rules Form

Telling someone how to play a game and making sure that they know all of the rules can be challenging. Once you have completed this form, you should be able to write instructions to include with your game. You should always have some “customers” try to follow your instructions and then modify them to make them as clear as possible. Use this form as a guide to help you think about all the things that need to be part of your game’s instructions.

Name of the Game:

Overall Goal of the Game (How do you win?):

How do you know someone has won the game?

How many people can play and what should their age be?

What do you need to start out with?

How do you set the game up to begin?

Who goes first and how do you decide the order of turns?



Procedure: These are the steps players follow to play the game. List them in order and try to decide if they make sense. Add more on a separate piece of paper if you need to.

STEP	ACTION
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

Points and Penalties: Some games have penalties and ways to earn more points, money, or move more spaces. List these if you will make this part of your game.

POINTS OR PENALTY	ACTION THAT CAUSES IT

Rules: Describe anything that you are not allowed to do.

- 1.
- 2.
- 3.

You should have enough information to complete the instructions that will go with your game. It may help to have someone outside of your group look this over before you complete your instructions. They might notice if you left something out.