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LEARNING & CREATIVITY PLAN (L&C PLAN): Chair Design

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1. Overview

Title	Chair Design
Driving Question or Topic	Engineering Design process- Building chair prototype
Ages, Grades, …	Ages: 12-15 Grade: 7-9
Duration, Timeline, Activities	5h Five to Seven 60minutes class periods 1 Activity
Curriculum Alignment	Science and Technology
Contributors, Partners	
Abstract - Synopsis	Students become familiar with the engineering design process as they design, build, and test chair prototypes. The miniature chairs must be study and functional enough to hold a wooden, hinged artist model or a floppy stuffed animal. They use prototypes to assess design strengths and weaknesses.
References, Acknowledgements	TeachEngineering https://www.teachengineering.org/activities/view/chair_design This engineering curriculum aligns to Next Generation Science Standards (NGSS).

2. STEAME Framework*

Teachers' Cooperation	1st Teacher: Physicist 2nd Teacher: Mechanical Engineer (the two teachers can work together during all the activity period) Engineers build prototypes for their creations before starting actual production. Prototypes enable engineers to assess design strengths and weaknesses through testing and so they can redesign to achieve successful end products.
Action Plan Formulation	**Action Plan Overview:** **STAGE I:** Preparation steps for gathering prototype information. **STAGE II:** Lesson 1 and associated activity Plan formulation **STAGE III:** Lesson 2 and associated activity Plan formulation

3. Objectives and Methodologies

Learning Goals and Objectives	After this activity, students should be able to: 1. Describe and follow the steps of the engineering design process. 2. Assess prototypes for strengths and weaknesses.
Learning Outcomes and expected Results	Once the plan is completed, students will have designed, built and tested their chair prototypes.
Prior Knowledge and Prerequisites	Background: Before beginning the activity, lead a discussion with the class about engineering and what engineers do. Students should know that engineers follow the steps of

	the engineering design process as they work. The basic steps are asking to identify the problem, research, imagine possible solutions, plan, create a prototype, test, and improve.
Motivation, Methodology, Strategies, Scaffolds	Engineers are responsible for designing everything in the human-made world. What might this include? (Have students name a few items.) Yes, they design airplanes, bridges, cars, computers, computer keyboards, etc. It's obvious that you would need someone to design these things. Engineers are also responsible for designing the less obvious products. How about boxes? Teams of engineers are responsible for designing cardboard boxes to serve very specific purposes. What types of things do you think they consider as they design boxes? • What will the box be holding? • Will the box be shipped? • Is the cargo delicate? • Can it spoil? • How high will the boxes be stored? How much weight must each box need to hold? • What could happen if the boxes are not tested before being used? What could happen if the box is not sturdy enough for the cargo? • The cargo could become ruined. • The company shipping the cargo could lose money. • If liquid, the cargo could leak and pollute the surrounding environment. • If the cargo is ruined or unable to make the trip, trouble could arise for the person who ordered it. You can see that a lot of thought must go into each item that is designed. The design of the box changes depending on what is inside. You could have two items that require the same size box, but the box would need to be different because one box is for a bottle of liquid medicine and the other box is for pens. How do you think this would affect the box design? Think about a chair. It might be hard to imagine that engineers are still designing chairs considering how long they've been around but think of a baby's highchair vs. a chair in a doctor's office. What factors must engineers consider as they design chairs? • Where will the chair be located? (kitchen/doctor's office) • How often will the chair be used? (3 x day/all day) • Will people be doing anything else as they sit in the chair? (eating/reading) • Will this chair get dirty often? (yes/hopefully not) • Who will use the chair? What are the physical characteristics of the user(s)? (under 30 pounds/possibly hundreds of pounds) The answers to these questions help to dictate the design. For example, a chair in a doctor's office can be covered in fabric. But, this would be a bad idea for a baby's highchair since it gets so dirty every day. For the next few weeks, you will act as engineers. You will work in teams to design and build a chair prototype with the constraint of using only gauge wire within the allotted time. You will outline where your chair will be located, who will sit in it, etc. Then, you will design and build a prototype. As you work, you will follow the steps of the engineering design process and record your design process in an Engineer's Journal. You will use wire for your chair prototype but think about what kind of materials you would use when you turned your prototype into a real chair.

4. Preparation and Means

Preparation, Space Setting, *Troubleshooting Tips*	There will be 5-7 60-minute sessions, depending on how fast students work; These sessions can take up to 2 days for designing and building and approximately 3 days for testing and re-designing. Preparation steps: 1. Have examples of chairs of different designs.

Resources, Tools, Material, Attachments, Equipment	2. Gather materials and make copies of the My Chair Design Journal. **Materials List** Each group needs: 1. 10 meters of 18-gauge wire for each prototype (jewelry wire seems to be the least expensive, available at craft and bead stores or online) 2. My Chair Design Journal, one per student 3. To share with the entire class: 4. measuring tape 5. soldering iron (or wire finer than 18-gauge to secure main chair wire structure) wooden artist model or floppy stuffed animal Worksheets and Attachments Chair Design Matrix (pdf) My Chair Design Journal (pdf) Visit [www.teachengineering.org/activities/view/chair_design
Safety and Health	As necessary, train students on the safe use of soldering irons. Or else, have only teachers use the soldering gun.

5. Implementation

Instructional Activities, Procedures, Reflections	1. Guide students through the brainstorming process to learn about brainstorming and start thinking about what really makes a chair. Have students write additional brainstorming ideas in an engineering journal. The final chair must be sturdy enough to be dropped from ankle-height, support a stuffed animal or a hinged, wooden artists model, and appear to be comfortable. 2. Discuss the engineering design process with students. Explain that they will be designing a chair and building prototypes of the chair, following the steps of the engineering design process as they work. 3. Explain to students that engineers work in teams and that one of the team members practices "human factors" to help them as they design. Human factors experts help engineers to design products and devices that will work for many people. In this case, they help engineers design chairs that are functional for people of differing heights and weights. 4. Have students measure their heights and compare to the class mean. 5. Students should next design an uncomfortable chair. Draw the chair design in their engineering journals before they build. 6. Once they have designed an uncomfortable chair, have them build the chair with the wire. Use either a finer gauge wire to bind the wire or solder the wire. 7. After students have built their chairs, bring together the class so each student can present his/her design to the group. This exercise helps to facilitate a discussion about features that make the chairs uncomfortable, which, in turn, helps students focus on what makes chairs comfortable. 8. Next, have students redesign the chairs based on the knowledge they gained from their first prototypes. Test the chairs by placing the wooden model or floppy stuffed animal on them; a chair should be able to support the model/stuffed animal. 9. Conclude the activity by giving each student time to present his/her redesigned chairs to the class. Require that they describe their chair's strengths and what they would change in the next iteration (next version, for improvement) of the design.
Assessment - Evaluation	**Assessment** **Activity Embedded Assessment** Design Journal: As students progress through the activity, have them fill in the prompted questions and sketches in the attached My Chair Design Journal. Review their answers to gauge their comprehension of the subject. **Post-Activity Assessment**

Presentation - Reporting - Sharing *Extensions - Other Information*	Evaluation Rubric: Evaluate students using the attached Chair Design Matrix, which includes the criteria categories of brainstorming, imaging-planning-improving, creating, sharing and prototype design. Students present their prototypes to the class.

Resources for the development of the STEAME Learning and Creativity Plan Template

STEAME Prototype/Guide for Learning & Creativity Approach
Action Plan Formulation

Major steps in the STEAME learning approach:

STAGE I: Preparation by one or more teachers

1. Formulating initial thoughts on the thematic sectors/areas to be covered
2. Engaging the world of the wider environment / work / business / parents / society / environment/ ethics
3. Target Age Group of Students - Associating with the Official Curriculum - Setting Goals and Objectives
4. Organization of the tasks of the parties involved - Designation of Coordinator - Workplaces etc.

STAGE II: Action Plan Formulation (Steps 1-18)

Preparation (by teachers)

1. Relation to the Real World – Reflection
2. Incentive – Motivation
3. Formulation of a problem (possibly in stages or phases) resulting from the above

Development (by students) – Guidance & Evaluation (in 9-11, by teachers)

4. Background Creation - Search / Gather Information
5. Simplify the issue - Configure the problem with a limited number of requirements
6. Case Making - Designing - identifying materials for building / development / creation
7. Construction - Workflow - Implementation of projects
8. Observation-Experimentation - Initial Conclusions
9. Documentation - Searching Thematic Areas (STEAME fields) related to the subject under study – Explanation based on Existing Theories and / or Empirical Results
10. Gathering of results / information based on points 7, 8, 9
11. First group presentation by students

Configuration & Results (by students) – Guidance & Evaluation (by teachers)

12. Configure mathematics or other STEAME models to describe / represent / illustrate the results
13. Studying the results in 9 and drawing conclusions, using 12
14. Applications in Everyday Life - Suggestions for Developing 9 (Entrepreneurship - SIL Days)

Review (by teachers)

15. Review the problem and review it under more demanding conditions

Project Completion (by students) – Guidance& Evaluation (by teachers)

16. Repeat steps 5 through 11 with additional or new requirements as formulated in 15
17. Investigation - Case Studies - Expansion - New Theories - Testing New Conclusions
18. Presentation of Conclusions - Communication Tactics.

STAGE III: STEAME Actions and Cooperation in Creative Projects for school students

Title of STEAME Project : ________________________

Brief Description/Outline of Organizational Arrangements / Responsibilities for Action

STAGE	**Activities/Steps** Teacher 1(T1) Cooperation with T2 and student guidance	**Activities /Steps** **By Students** Age Group: ____	**Activities /Steps** Teacher 2 (T2) Cooperation with T1 and student guidance
A	Preparation of steps 1,2,3		Cooperation in step 3
B	Guidance in step 9	4,5,6,7,8,9,10	Support guidance in step 9
C	Creative Evaluation	11	Creative Evaluation
D	Guidance	12	Guidance
E	Guidance	13 (9+12)	Guidance
F	Organization (SIL) STEAME in Life	14 Meeting with Business representatives	Organization (SIL) STEAME in Life
G	Preparation of step 15		Cooperation in step 15
H	Guidance	16 (repetition 5-11)	Support Guidance
I	Guidance	17	Support Guidance
K	Creative Evaluation	18	Creative Evaluation