Ship Design

Intermediate Version

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Stimulate problem solving	**Platinum**	**Stimulate entrepreneurship**	**Bronze**
Stimulate creativity	**Gold**	**Informal learning enviro.**	**Silver**
Stimulate critical thinking	**Gold**	**Technology use**	**Silver**
Stimulate group work	**Gold**		

Practicalities

Preparation: 15min

Group size range: 25-30

Ideal sub-group size: 3-4

Duration: 2hrs

Workshop made for: 12-16 years old
Easily transferable to workshops for ages between: -12/+16

Material needs:

- Water-tank and bottles of water
- aluminum foil, baking paper, skewers or drinking straws

Environment FabLab necessary: No

Educational area:
* Engineering
* Science

Precognition

Knowledge about buoyancy, weight, mass, density.

(see box ‘content links’ below)

Preparation

Fill a water-tank or large container of size at least 50x50cm. This is where student teams will test the vessels they build.

Collect and sort building materials. Each student team should have the following materials:

A roll of aluminum foil
A roll of baking paper
A packet of wooden skewers or plastic drinking straws
A bottle of water of 500ml=500gr. This is the payload that the vessel must be able to carry without sinking.

Workshop Guidelines

Phase 1: Orientation and Instruction Phase

Material needs:
Optional: pictures of various vessels, container-ships, tankers, ferries, boats etc.

Goals:
Skill Goals (**Blue**)
(S1) Optional To look up information independently
(S2) To be able to model

Content Goals (**Green**)
(C1) Understand and acquire content knowledge of subjects like buoyancy, weight, forces, mass, volume, density

Background story:

The natural resources are limited and so we must find or invent optimal solutions to protect our environment and minimize unnecessary waste of materials or resources. Each student team is challenged to build a water-tight, strong, stable, streamlined vessel to carry a payload using only certain materials. As an extra challenge or as a competition they are asked to use the minimal possible materials available i.e. the winning team is the one who builds the lighter vessel able to carry 500gr of payload.

Goals	Activities	Duration
S1	Ask students to look up for information about how big the vessels shown in the pictures are, how much they weight and how much payload they can carry. How they can float.	To be chosen
S2	Ask students to draw on paper or make a simple model of a ship	10min
C1	Let students to experiment with various materials at hand (e.g. pens, pencils, erasers, keys etc.) by dropping them in the water tank. Do they sink or float? Why.	Max: 10’

Phase 2: Design Phase

Material needs:

Essential: aluminum foil, baking paper, wooden skewers or plastic drinking straws, pair of scissors

Goals:

Skill Goals (**Blue**)

(S1) Abstraction of an idea to a 3-dimensional prototype object or model

Content Goals (**Green**)

(C1) Experiment, identify and understand the strengths and weaknesses of different materials

(C2) Balancing/optimizing between having a structure with extra strength or a lighter one with less weight and less material to use

Goals	Activities	Duration
S1, C1, C2	Student teams build initial prototype vessels and test them in the water tank. They try to understand the properties of each material and what is best for. By doing so they try to devise an optimal design, change and adapt it to achieve their goal.	20 min

Phase 3: Making Phase

Material needs:

Essential: aluminum foil, baking paper, wooden skewers or plastic drinking straws, pair of scissors

Goals:

Skill Goals (**Blue**)

(S1) Working in group

(S2) Working under constraints (time pressure, limited materials, compete with others)

Content Goals (**Green**)

(C1) Experiment, identify and understand the strengths and weaknesses of different materials

Goals	Activities	Duration
S1, S2, C1	After the experimentation and trials during the previous design phase now student teams build their final vessels within the allowed time interval	40 min

Phase 4: Operational Phase

Material needs:

Essential: *water-tank or container, weighing scale*

Goals:

Skill Goals (**Blue**)
(S1) Trial and error / Deal with failure
(S2) Competing with others

Content Goals (**Green**)
(C1) Balancing the role of structural strength, overall weight and buoyancy
(C2) Understanding the strengths and weaknesses of different materials

Goals	Activities	Duration
S1, S2, C1, C2	In the first round all vessels made by the student teams are weighted with a weighing scale. Each value is recorded in a table. Teams are ordered form lighter to heavier.	10 min
S1, S2, C1, C2	Each team in order puts its vessel (without payload) in the water tank. The vessel should stay afloat for at least 1min. If it sinks, then the team is disqualified from the next round of final evaluation. Optionally if time permits then teams can make adaptations and have a second trial.	10 min

Phase 5: Evaluation Phase

Material needs:

Essential: *water-tank or container, bottles of 500ml water*

Goals:

Skill Goals (**Blue**)
(S1) Deal with failure
(S2) Competing with others

Content Goals (**Green**)
(C1) Understanding the role of structural strength, overall weight and buoyancy, optimal design
(C2) Understanding the strengths and weaknesses of different materials

Goals	Activities	Duration
S1, S2, C1, C2	Each team in order puts its vessel (with payload) in the water tank. The vessel should stay afloat for at least 1min. If it sinks, then the team is disqualified. Optionally if time permits then teams can make adaptations and have a second trial. The final winning team is the one with the lighter vessel which succeeds to stay afloat with payload.	20 min

Pedagogical tips

The workshop can be from a start a one-off competition among student teams or multiple rounds of design-make-evaluate so that teams can try multiple ideas, have the possibility to alter and adapt their initial solution, and practice and understand better the cycle of design, development and optimization which what is is actual applied in everyday work of scientist and engineers.

How to transfer to (non-)Fablab environment

Transfer to non-fablab environment is very feasible, as long as the necessary building materials are provided. The essential materials used for the construction of vessels are low-cost, every-day kitchen materials.

Evaluation of achievements

At the end of the workshop you can award different teams depending on achievements.
For example, award for:

- The most stable vessel
- The most light-weight vessel
- The vessel with the most outrageous use of materials
- The most beautiful vessel
- ...

Content links

The workshop can be enhanced with various online educational resources, virtual labs or interactive simulations, such as the **PHET INTERACTIVE SIMULATIONS FOR SCIENCE AND MATH** which are available in various languages

Density: https://phet.colorado.edu/en/simulation/density

Buoyancy: https://phet.colorado.edu/en/simulation/buoyancy