engineers
without borders
australia

Floating Houses

Workshop Guide

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What is this guide?

This guide provides an introduction to *humanitarian engineering*, centred on the Floating Houses module developed by Engineers Without Borders Australia. It contains a session plan and tips on running the Floating Houses module, as well as possible follow up activities which can be linked to humanitarian engineering.

What is *humanitarian engineering*?

Humanitarian engineering is about using technology to implement practical solutions which directly improve the wellbeing of marginalised or under-served communities. In humanitarian engineering, a strong emphasis is placed on the cultural emphasis of engineering activities.

Humanitarian engineering is not just about the most efficient or cost effective technical solution, but about which solution is appropriate for the community in which it is being implemented.

One practicing humanitarian engineering must be well versed in not only the technical aspects of engineering and science, but also history, politics, economics, sociology and language, particularly relating to the community which they are serving.

Who are Engineers Without Borders Australia?

Engineers Without Borders Australia are a non-profit organisation that works within Australia and the Asia-Pacific region to improve the quality of life through education and the implementation of sustainable engineering projects.

They do this by:

- Working in partnership to address a lack of access to basic human needs such as clean water, sanitation and hygiene, energy, basic infrastructure, waste systems, information communication technology and engineering education.
- Educating and training Australian students, engineers and the wider community on issues including sustainable development, appropriate technology, poverty and the power of humanitarian engineering.
- Leading a movement of like-minded people with strong values and a passion for humanitarian engineering within Australia and overseas.

For more information about EWB Australia's programs and history, visit their website at http://www.ewb.org.au/.

Who is this guide for?

This guide is for any teacher who wishes to support students' development of engineering concepts applied within a socially responsible context. The themes within the Floating Houses module cover a wide range of subject curriculum and as such this guide has been prepared to cater for each of these areas.

The connections between school curriculum and the workshop content are presented here, however it is up to the teachers to reinforce those concepts which are relevant to their

particular subject area or those which they consider to be more important for student development.

How should I use this guide?

Feel free to design new activities and remix the included activities. Of course, we'd love to learn about what you're doing, so I encourage you to document and share your experiences with the program at uts@ewb.org.au.

HSC Standards

The sessions and activities in this guide make connections to several different HSC curriculum objectives, including:

Subject	Relevant objective/outcome	Tie-in concept
Engineering studies	**H2.1** determines suitable properties, uses applications of materials, components and processes in engineering	Thinks critically about which materials would be best for the design of their floating house
	H6.1 applications of materials, components and processes in engineering	Students engage in constructing a floating house
	H4.3 applies understanding of social, environmental and cultural implications of technological change in engineering to the analysis of specific engineering problems	Students learn about the people living in the Tonlé Sap and incorporate their needs into the design of a structure
Earth and Environmental Studies	**H4** assesses the impact of applications of Earth and Environmental Science on society and the environment	Considers what steps are being taken in the Tonlé Sap to solve its environmental and social issues
	H6 evaluates the use of the Earth's resources	Gains insight into the produce of the Tonlé Sap region and considers the importance of this production
Geography	**H6** evaluates the impacts of, and responses of people to, environmental change	How the community is responding to the difficulties in the Tonlé Sap region
Physics	**H4** assesses the impacts of applications of physics on society and the environment	**Research task 3:** discovering what technology can be used to make houses float
	H5 identifies possible future directions of physics research	**Research task 3:** developing creative solutions that may not be technically possible at the moment
	H14 assesses the validity of conclusions from gathered data and information	Reflecting on floating house design and how well it worked/what could be improved for next time
	H16 justifies positive values about and attitude towards both the living and non-living components of the environment, ethical behaviour and a desire for critical evaluation of the consequences of the applications of science	Implicitly considering how science can best be used to improve the lives of people in the Tonlé Sap region
Senior Science	**H6** describes uses of the Earth's resources	**Research task 2:** Investigates how clean water can be supplied to a floating

		house Observes that houses do not just need to be built on land as we see generally in western society
	H14 assesses the validity of conclusions from gathered data and information	Reflecting on floating house design and how well it worked/what could be improved for next time
	H16 justifies positive values about and attitude towards both the living and non-living components of the environment, ethical behaviour and a desire for critical evaluation of the consequences of the applications of science	Implicitly considering how science can best be used to improve the lives of people in the Tonlé Sap region
Economics	**H7** evaluates the consequences of contemporary economic problems and issues on individuals, firms and governments	Faces time, budget and resource constraints in the construction of floating houses. Implicitly considering why these constraints are present for the Tonlé Sap region but not for developed countries.
Society and culture	**H3** accounts for cultural diversity and commonality within societies and cultures	Briefly examines the culture of people living in the Tonlé Sap region

‘Floating Houses’ session plan

Description

In this session, students will participate in the Floating Houses activity in which they will learn briefly about a region in Cambodia and then attempt to build a structure which will float in water using minimal resources and a confined budget.

Objectives

The students should:

- Develop an appreciation for how people in other countries live
- Develop their intuitive understanding of basic fluid mechanics
- Apply concepts with the practical constraints of time/budget/resources

Activities summary

- **Introduction**: Case study overview
- **Planning**: Designing the houses
- **Construction**: Constructing the houses
- **Implementing**: Testing designs
- **Reflecting**: Improvements and summing up

Resources

- Floating Houses PowerPoint presentation
- Equipment for the ‘houses’ to be made:
    - Packet of foam/plastic cups
    - Packet of balloons
    - Pieces of cardboard
    - Brown paper bags
    - Packet of straws
    - Paddle pop sticks
    - Rubber bands
    - Roll of sticky tape
    - Roll of cling wrap
    - Roll of aluminium foil
- A large container to fill up with water for testing
- Computer and projector: for displaying the PowerPoint presentation

Approx. mins	Activity

10-15	**Case study overview**
	• What are engineers?
	  ○ Get students’ opinions on this and then reveal **slide 2**
	  ○ Can students give some more examples for each of the disciplines listed?
	• What are basic human needs?
	  ○ Get students’ opinions on this and then reveal **slide 3**
	  ○ Ask the students if they think everyone has these basic needs

- Show some examples of different housing in developing countries (**slides 4-6**)
    - Get students to think about the region in which each house was constructed
    - Do they think those houses are the best for the conditions?
    - Here we subtly hint at 'suitable' technology
    - Ask the questions on the slide briefly
- Apply these concepts by presenting different environments (**slides 7-9**)
    - Stress that the solutions presented in the presentation are by no means the only ones
- Overview of the Tonlé Sap region in Cambodia (**slides 10-15**)
    - Produces around 300,000 tonnes of fish every year
    - Lake increases in size by four-fold in monsoon season
    - Home to more than 3 million people
    - Region is currently in trouble though
    - Most people in the region live in floating villages
        - Go through the examples on **slides 14 & 15** showing some different ways residences stay above water
- Floatation methods (**slide 16**)
    - Ask the students:
        - Why does something float?
        - What sort of objects could you use to help things float?
- Issues with floating houses (**slide 17**)
    - Ask the students:
        - How do we keep the house from tipping? (stability)
        - How do we get clean water and dispose of waste?
        - How do we supply the homes with energy?
        - How do we supply food to someone who is in the middle of a lake?
- Basic fluid mechanics with examples in the Tonlé Sap region (**slide 18**)
    - Buoyant force is equal to the weight of water displaced
    - Ask the students to think what factors shape whether an object sinks or floats (answers are: **density and geometry/shape**)
    - Use the example of a rescue ring in the water: think about how it works
- Construction brief (**slide 19**)
    - Run through the content on this slide to ensure students are aware of what is required of them for the task
    - Form them into teams of four or five (depending on the number of students and resources available)

15-20 **Designing the houses**

- Give the students some pencils, erasers and blank pieces of paper and get them to start planning the design for their house
- Allow them to look at the available equipment to get an idea for what will work best
- Have teachers/facilitators walk around and discuss students' designs with them, asking them why they are taking the approach they are taking

15-20 **Constructing the houses**

- Allow students to 'purchase' resources to construct their houses
- Students will now put together their plans
- Facilitators continue to walk around and provide guidance
    - **Key point**: the students are the ones designing and constructing the solution, not the facilitators, let them make the big decisions

	• Students may test their designs in the water without marbles if they wish

10-15	**Testing designs**
	• Gather students to test the designs under the load of marbles
	• Be sure to reward creative and innovative designs, even if they did not hold a great number of marbles
	• Provide recognition not only for the designs that hold the most marbles, but also:
	  ○ Innovative/creative designs
	  ○ Simple/efficient designs

10-15	**Improvements and summing up**
	• Some questions to ask students:
	  ○ What went well with your designs?
	  ○ What didn't work so well?
	  ○ What would you change next time around?
	• Linking to real-world applications
	  ○ Many constraints placed on projects
	  ○ You can hardly ever implement something 'perfectly' like you did in the laboratory
	  ○ Shelter is a basic human need – a practical solution that exists is better than a perfect one that doesn't!

Notes

One of the goals of this session is to get students to think creatively about problem solving with constrained conditions. Students should be encouraged to try out concepts they think might work well, even if the facilitator knows the concept probably won't be successful. It is then important to get the student to reflect on this failure. Their failures should be celebrated as they have learnt that their particular method doesn't work very well!

Suggested follow-up activities

The following research tasks are suggested as an expansion on some of the concepts presented in the Floating Houses module.

These tasks all have the core concepts from the Floating Houses module but are not related to each other. See the task briefings for an idea of which subject areas they favour.

- Research Task 1: Problems in the Tonlé Sap region
- Research Task 2: Water: how the people of Tonlé Sap obtain it
- Research task 3: Floating Houses Master class: The best possible design?

1. Problems in the Tonlé Sap region

Focus subjects

- Geography
- Earth and environmental sciences
- Economics
- Society and culture

Task summary

The Tonlé Sap region is a vital part of the Cambodian economy, producing some 300,000 tonnes of fish annually. It is also home to more than 3 million Cambodians. There have been some issues with unsustainable human activities in the area putting the region's forests and fish production at risk.

It is the student's job to investigate the environmental threats in the Tonlé Sap region. Once these threats have been identified, students should develop potential solutions to the issues. They will then prepare a presentation for their peers on their findings.

Objectives

The students should:

- Develop critical thinking skills within a humanitarian context
- Develop an understanding of global issues
- Develop presentation skills

Teacher resources

Some quick introduction links to the region can be found here:

- A Push to Save Cambodia's Tonle Sap Lake – The New York Times
- Tonle Sap Lake: Conserving Cambodia's Fish Factory, Conservation.org
- Tonlé Sap, Wikipedia.org

2. Water: How do you get it to a floating house?

Focus subjects

- Society and culture
- Physics
- Earth and environmental sciences
- Engineering studies

Task summary

Access to clean water is one of the fundamental needs for human life. Even though the people living in the Tonlé Sap are surrounded by water, this water is not suitable for drinking!

Students are required to research how people in floating houses like those who live in the Tonlé Sap gain access to clean drinking water. Students are expected to research a particular method of water supply and then write a report about how this method works and the advantages/disadvantages of this approach.

Objectives

The students should:

- Develop an appreciation for the logistics and effort involved in providing a basic amenity, water
- Develop communication skills through writing a report
- Develop research skills

Teacher resources

- Floating homes – 2 types, Inspiration Green.com
- Floating houses, inhabitat.com
- Could icebergs be used as a source for drinking water?

3. ‘Floating Houses’ master class: The best possible design?

Focus subjects

- Physics
- Senior science
- Engineering studies

Task summary

In this task, students revisit the core brief of the Floating Houses workshop. This is a research project. The task for the students is to determine what the best design is for a floating house in the Tonlé Sap region.

Students may select from any material known to design their house, however appropriate justification for their selection must be made.

Students are to complete the following as part of the task:

- A design report outlining why their particular design was chosen
- Drawings showing their design
- Construction of either: a) a physical model of the house, or b) a proof of concept component of the house which actually works

Objectives

The students should:

- Develop their application skills of the scientific method
- Develop technical drawing skills
- Develop critical thinking through justifying designs

Teacher resources

- FLOATEC project develops new floating house technology for low-lying countries
- Floating homes, Tréndir
- 10 Floating Homes Of The Future