

## Learning for a sustainable society

### Introduction

The area sustainable society is a multidisciplinary concept and it can be hard for students to embrace. Sustainable development can be explained like this: "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". Sustainable society embraces ecological, economical and social dimensions. We can work with these questions every day and every choice we make from small to big things.

In this paper we want to share a selection of examples, questions and ideas that can be a start or an input for your work with your students. These ideas have been a part of the PENCIL project. You can read more about the project in the Xplora webpage [www.xplora.org](http://www.xplora.org).

In this project Teknikens Hus and Universeum worked with several schools over a long time period to see how the science centre can support and inspire teachers and pupils in their schoolwork to learn for a sustainable society. We have worked with all classes and teachers from eight month 1.5 year and all classes have done different things. We have tried to be resource for them under the project time. Many classes have spent a lot of time in our exhibition area and those parts are not so easily done in schools. But from different visits in our science centres we have tried to get the essence out of discussions, workshops and work done in classrooms before and after their visits to write a manuscript that maybe can inspire you.

Sustainable development is a cross curriculum theme and we have encouraged all schools to work with all subjects in school. Many practical exercises in this paper focus on nature and technology science but hopefully all different kinds of teachers can be inspired of this paper. We have chosen seven areas that we describe a practical experiment or role play more in detail and after that ideas, examples and comments from teacher from how they have continued their work in school.

### Inspirational areas

Forrest	Role play, consumption and medicines
Recycling	Handmade paper The pile of trash
Water	Acidification Water circulation Capture small animal from river and lakes
Energy	Debate discharge of carbon dioxide Housing in the future Future scenario transports/Energy

Space	The Spaceship
Food	The Manna exhibit
Communication	Future scenario and discussion

## The Forrest

### Consumption

#### Method exercises

We tend to think that we live separated from people in other continents for instance Brazil. Of course this is not the case. We influence these people more than we think by the way we do our shopping for instance. And the way we live influences the rainforest, which can make a big difference to most of us. According to experts, around 17 per cent of the natural vegetation in the Brazilian Amazon has already been devastated by development, logging and farming (September 2006). There are many reasons to preserve the forest; its rich biodiversity is one of them. [www.wwf.se](http://www.wwf.se)

To grasp the problem and why the deforestation seems to be so hard to stop it has proven successful to take on different roles of the characters playing a role in this problem. A roleplay can be followed by a discussion on how to preserve the rainforest and what can be done on an individual level to help.

#### Role play

The different roles:

Consumer – wants to buy for instance soy as a major protein source. The Consumer wants to get most worth of his/her money so that money is left for other products.

Businessman – makes use of consumers demand to make money. To maximize the profit the soya is bought from Brazil where it is cheap.

Land owner – notices that the demand for soy is high/big and cuts down forest to grow a lot of soy to make money

Farmer – needs to make a living, soy is a safe card

Indian - has to move away from land, since area is needed to produce for instance soy instead. Ends up being the consumer.

Representative from government in Brazil – the country needs money for developing.

Scientist – only 1 % of the living creatures in the rainforest has been characterized. It is believed that future medicines can be made from substances found here.

Let the different groups of characters do research. Then meet, let all role characters present their view and let class make suggestions to how to make the development sustainable.

Another angle when working on preserving the rainforest could be medicines.

### **Future scenario**

You work for a pharmaceutical company and see this as an opportunity to help solve the serious health problems in the world. The company focuses on cardiovascular diseases. It wants to prevent and cure a serious illness that getting more and more common. Since this illness does not exist in Yanomami in Amazonas you suspect that there are active substances in their medicines or food. You get support from the company to lead a group of scientists going to Amazonas to look for active substances. You are given the opportunity to work with a Yanomamischaman. You observe Yanomamis use of plants and animals and collect extensive material for chemical analysis in Sweden. It is a sensation when it is found a very active substance in a unusual liana. After extensive testing on animals and healthy people the company decides to work for a new medicine which consists of the substance you discovered thanks to Yanomami, your own work with the support of the company. The company makes a profit on the new medicine and many people get a new possibility to enhance their quality of living.

#### **Questions and comments supporting this scenario:**

Is this scenario credible? What can we find in the rainforest? Which discoveries have been done and what do we expect from the future? Why do some plants and animals produce substances that can be used for medicine? How do native people find their medicines? Is it right to intrude on the Native American way of life? Which medicines come from the rainforest? Is it right to use the Native Americans knowledge? Is it right to patent substances that are found in plants and animals? What is a fair compensation to the native people for their knowledge? What is the prize of knowledge?

## **Recycling**

### **Practical exercises**

#### **Make your own handmade paper**

This is a good way to show how we can save our natural resources and what happens with the paper that we leave for recycling. And it is a very fun to make paper.

It is good to be in a room with a floor drain or outside when the weather s nice.

#### **Preparations**

To make paper you need a mold and a deckle

#### **Material**

4 wood 20\*2 cm pieces and 4 wood 15\*2 cm pieces

1 fine meshed net (nylon)

Hammer and nails

Stapler

Arrange the pieces in a rectangle. You will be making 2 frames, but only one will have netting. Nail together two frames (as you can se in the picture)

One of the frames is going to be the deckle. Tense the net over one of the frames and join the net on the form with the stapler

**Note:** You can also use picture frames that are the same size

Now you can decide what kind of paper you want to make.

The most important thing is to choose a paper where the fibers easily loose up from each other like cheap paper towels, paper napkins and cellulose tissue

Material:

Paper

Bucket

Water

1. Tear the paper into small pieces. Let the pupil try to rip the paper both on length and breadth. It is much easier to rip the paper in once of the directions. When you rip the paper length the fibers the stripes becomes long and straight
2. If using recycled paper, be sure to remove all traces of glue and take out all staples.
3. Put water and the paper pieces into a bucket. Let the paper soak over the night.

Making a sheet of paper

Material

Deckle and a mold

A big tub

Electric mixer

A bowl

2 wood or laminated board ex cutting boards

Kitchen cloths

(Screw clamps)

1. Put batches of the paper into the bowl and add some water. Mix the paper with the electric mixer and pore the paper pulp into the big tub. Add water to the tub until the mixture contains approximately 10 times more water than pulp. The amount of the pulp in the water will determine the thickness of the sheet of paper.
2. Give the pulp a good stir and place the mold so that the mesh is face up, and put the deckle on the top. Grip the two firmly.
3. Catch a layer of pulp
4. Keeping the mold and deckle level, pull them straight up out of the liquid. Hold the mold and deckle level--the water will drain back through the mesh. Take away the deckle from the mold.
5. Tip over the paper on one kitchen cloths that are placed on one of the wood or laminated boards and put one more kitchen cloth over the paper. You can easily press several sheets a time; just put cloths between the sheets.
6. Finally put the other board and press the sheets together so the water is being pressed out.
7. Lose the sheets from the cloths. It should keep together! Put it to dry.

Comments:

What other things do we recycle?  
How many times can a paper be recycled?  
Where does metal come from?  
Where does plastic come from?

### **A pile of trash**

One very popular exercise we conducted with several classes was to expose them to a big pile of trash. They were challenged to invent one new thing from the trash. We made a minixhibit from the recycled material and followed up on a discussion about modern consumption and what we need and not need. What we easily could do without, and what would be harder.

## **Water**

### **Lab work**

#### **Cleaning water**

We started this day with lab work for the pupils  
The water in the river is a little bit dirty with things from nature like sticks, leaves, soil and like that. How can we clean water that is a little bit dirty with thing from nature? The dirt was small sticks, some soil and humus. The pupils got their task: Clean the water with help from simple lab material, sand, gravel, filters and active carbon.

Material and lab work

Cleaning water

The pupils can work in groups with 2-3 pupils in each group.

Material (per lab group)

3 types of clean sand (different size on the sand)

Clean gravel

Cups

Coffee filters

Funnel

Fine meshed net

Every group takes some of the water that is a little bit dirty and their task is to clean the water with help from the material. In the end compare all groups' water.

Do the see any differences?

Every group tells how they did.

Would you like to drink it?

In the water purifications plant they add chlorine that kills all bacteria's before it goes out in the pipes.

Comments

In our city Luleå we take our drinking water from the Luleå River. And many of the pupils do not know that and those we have to take care of our water recourses. So one question from the teachers were if we could do some thing together about water from the river home to the children and back to the cleaning station and finally back to the river again. After that we went out to the exhibitions and looked at our water purification plant and our sewage

treatment work at the sc and some classes also went out on visiting tour the real cleaning station.

Suggestions on questions to work with afterwards

Where does our drinking water come from?

How much water in the world are sweet water and how much are salted?

How can we clean water?

What happens with the water that we flush down the toilets?

How much water do we consume every day?

How is it in other parts of the world?

Can we reduce our water consumption? How?

Clean water?

Acidification

Water circulation

Recourses in the oceans

Biodiversity

One school let their pupils try to carry so much water as they use everyday in buckets.

### **Excursion**

#### **Capture small animal from river and lakes**

Material

Landing net

Determine cloth for insects and small animals in lakes or rivers

Magnifying pots

White trays



In this elaborative work you can go out to a lake or river with your pupils to explore what kind of animals there is in water. Some classes worked with just exploring nature, some with ecology and biodiversity in polluted water and comparing results with more clean water.

Comments

Take some lake or river water and animals into an aquarium at school to see what happens. Some classes afterwards dissected fishes in their ecology work.

### **Lab work**

#### **Acidification**

One question from pupils was “What is acidification?”. This theme we started up with a lab work for the pupil. We started the work with ph value. The first thing we talked about was acid and bases and the ph scale. But how can you test whether a substance is an acid or base? In this experiment, we made our own pH indicator from red cabbage and use it to measure some liquids to see whether they are acids or bases.

The most striking property of both acids and bases is their ability to change the colour of certain vegetable materials. A common vegetable whose colour responds to acids and bases is red cabbage. The first step in this experiment is to prepare an extract of red cabbage, so you can investigate its colour changes.

Besides the lab work we looked at the water circulation to answer the question “how does the acidification come here?”

In addition, you will learn how chemists use the **pH scale** to describe acids and bases.

### Red cabbage

A head of red cabbage

stove

A pot

Water

Coffee filters

Solutions were you know pH from 1-14

Test tubes

Test tubes rack

Pipettes

Cups

Some test substances like lemon juice, machine washing powder, clear sports drink, lime soda, window cleaner, vinegar, toothpaste, soap, (it is good if you can solve ex the soap in water so get a clear solutions.)

Prepare an extract of red cabbage

Cut half of the cabbage head into small cubes. Put them in a pot and add water (1,5 l) and let it boil for some minutes.

Prepare comparable test tubes

Label the test tubes with marks form pH 1-14. Put solutions (were you know the pH) into each test tube. Then add the same amount of red cabbage extract into each test tube. Now the pupils can see that the colour changes with different pH.

Investigation pH

The pupils work in groups in 3.

Every group shall have like 3 test tubes and 1 test tube rack

Let the pupils catch red cabbage extract in a cup + 1 pipette

In the 3 test tubes the pupils choose 3 different solutions (do not mix)

Then the groups can start to investigate the solutions ph. They students can add red cabbage (like the teacher did) into each test tube and then compare with the marked once. Now they can make a table with the different solutions. When the groups have done 3 solutions the can wash the test tubes and get 3 more solutions and continue their investigations.

Example of table

Solution	Colour	pH	Acid/base/neutral

### Comments

The pupils also learnt how to measure pH with sticks. Now they were ready to continue their work with the river and lakes in their neighbourhoods. Several classes borrowed material to do further investigations with water. And worked with the questions

What other animals (besides fish) live in the river/lake?

What can we do so we don't get more acidification?

What will happen if there is more acidification?

## Energy

### Debate discharge of carbon dioxide

#### Method exercises

Divide the class in to two groups. One of the groups shall be for the suggestion and the other half is against the suggestion. The groups now have to have time to prepare them self for the debate. The debate can be about anything like: in 10 year all countries are only allowed to discharge half the amount of carbon dioxide than they do to day. The delegates in the debate can be anyone like a scientist, president from USA, worker from Russia, Red Cross worker from Africa etc.

While the pupils are preparing them self the educator puts the chairs in two lines in front of each other. Make it look like a TV-studio. The educator become the TV host and welcomes all the delegates to the debate. The educator sets the rules for the debate like:

Do not talk when someone else is talking

If you want to say something, wave with your hand

Let all students present them self's (in their characters) before the debate starts. In the end of the debate each group gets one minute to convince the not visible watchers that their cause is the right one.

### Comments

What can I do?

What alternatives are there today, in the future?

Different energy sources

Locally produced food

**Housing in the future** – a way to get teenagers interested in the concept of energy.

The project is developed at Konsument Göteborg. [www.konsument.goteborg.se](http://www.konsument.goteborg.se).



Foto: Ylva Lundin



In the project Framtidens boende, a method is developed to get young people interested in learning more about energy and the effect energy has in daily lives. Young people about thirteen or fifteen are seldom very eager to learn about the concept of energy. This has

however, become possible with a method called storyline. The method “storyline” originates from Scotland. The pedagogy is well known in Sweden, though has not been used in this subject before. The aim has been that the knowledge of energy should remain in the minds of the people educated for life. In a fictive society they built their own houses and handled all the consumption of energy. One of the main objectives was to find out how to reduce the consumption of energy and at the same time find a level of sustainable living. A consultant in the “storyline” was engaged and the teachers had guidance during the work. Konsument Göteborg and the consultant also maintained a manual in “storyline”, particularly about energy, to make the job easier for the teachers and the youth.

The used the science centre building as an inspiration for housing in the future. Universeum is developed from an environmental perspective. The energy comes from solar cells for electricity and solar collector for hot water. The ventilation system is made without energy consuming fan system. The toilet separates the urine and parts of it are used in a cleaning process to make a biological chain that takes care of salts and cleans the water from bacteria. Algae are grown in cylinders and feeds water fleas that are eaten by fish. The cleaned water is recycled and mixed with new urine.

## Future scenario Energy

In 20 years the government has decided that every citizen under his/her lifetime will get 100 energy units, EU. All citizens get to choose among the following EU:

### ENERGY menu

Every citizen gets to choose among the following for his/her transports during life:

1. Use fossils fuel/car/MC 5000 km/yr	2 EE/år
2. Use fossils fuel/car/MC 10 000 km/yr	4 EE/år
3. Bicycling	0 EE
4. Go by airplane 5000 km	2EE/trip
5. Go by bus/train	0 EE
5. Eat imported food	2 EE/5 year
6. Eat food produced nearby	0 EE
7. Motorboat	2 EE/year
8. Sailboat	0 EE
9. Imported clothes and electronics	2EE/5 years
10. Clothes and electronics produced nearby	0 EE

Now to the question: How to distribute your 100 EE?

## Space

<http://www.envisions.nu/tidigare/e2001/program/g3b.htm>

The assignment: to equip a spaceship for a trip 6000 years into the future. There is a limit of 100 people that can be onboard at any time. How would the spaceship look like? What to bring? Who would go? (One didn't have to worry about the size or operation that was taken care of by engineers from abroad) After a while the questions were many for the pupils. The initial joy to decide by themselves, getting their wishes, drawing the places to sleep, TV room,

gymns did carry worries that the pupils didn't think about in the beginning. The pupils go through different faces. It is interesting to see how the pupils calculate the amount of water they think they need when a normal person uses 400 l/day (x 100 people x 365 days x 6000 years) There are many open questions a teacher can raise to make the pupils think again, develop their thoughts.

How do we deal with inbreeding?

Shall we have money?

How to share the food?

How do we prepare the food?

What do we do if something stops working?

How to move the knowledge from generation to generation?

Shall anyone decide?

Are we to have laws?

Which standard of living is reasonable?

### **Description of how a class worked with the theme Space.**

Sustainable development on earth.

The overriding problem was Sustainable development. "What does it take to move our way of life to another planet?" During the work it was always commented on how vulnerable we are to the conditions on earth.

As a start the knowledge on earth was increased. It was then possible to compare to other planets. Started reading on how earth was built and how the conditions for life arose. At the same time one can work on the theme "LIFE" in science class.

One can consider the earth's outer and inner forces and how these influence our planet and the different life forms that exist. Many questions have risen after the Tsunami regarding earthquakes and volcanoes.

The earth and the other planets in our solar systems Position and conditions

#### 1. Solarsystem in scale

This area can be introduced with an exercise to give the pupils an idea about size and scale in our solar system. Let the pupils make the different planets, and the sun and the moon in paper. The sun is 35 cm in diameter, the earth is 3 mm and Jupiter 3,5 cm. Then the pupils were challenged to stand in the right position relative to the sun. All pupils stood in the class room to begin with. The right distance according to sizes of the planets was that Mercury's closest to the sun was 14,5 meters away and Pluto 1400 meters away. (The closest star would then be 11000 km away.)

## Food

### Manna - Food in a New Light (<http://www.mannautstallningen.nu>)



How many insects does it take to make a hamburger? How do you fit hundreds of litres of water into one bottle of beer? What do researchers really say about the environmental benefits of organic farming? Can we eat our way to sustainable development? All of this – and much more – is taken up in Manna, a different exhibition about food, the environment and our hidden dependence on nature. The exhibit has been touring for the last two years and from autumn 2006 can be seen in Stockholm.

### Background

Manna is based on the latest trans-disciplinary environmental research and focuses on current and “urban” food, like hamburgers and sushi. The goal is to show how the foods we eat originate from nature by using a visual, pedagogic approach to describe the food production system and the global trade system that we are all a part of.

For example, the exhibition displays a hamburger and shows that almost all of its ingredients - the tomatoes, cucumber, mustard, lettuce and the fodder plants for the beef - are pollinated by insects. The visitors are also guided back in the production chains in order to show how many hundreds of litres of water are needed to produce a single bottle of beer.

## Communication

The development of technology is fast and scientific studies do not follow and consumers have a hard time following the debate. The ignorance of people is believed to be taken advantage of by the government for a long time.

Recently the journalist of Göteborg Post has worked under cover in the government and reveals an advanced surveillance system coupled to mobile phones. The mobile phone has a transmitter that sends signals to satellites and that in its turn sends information to those that can receive information. Still it is not known who is involved and how the transmitters could get into the telephones. One suspects that the Swedish government has cooperated with other European countries and an extensive register of people, first and foremost criminals but even politically active and sick people. By the help of the register one could easily locate whoever is interesting at any time. There is even evidence that the next step would be to directly by birth operate a microscopic nano transmitter – without the consent of the parents.

GP has had no luck in getting hold of comments from the prime minister. Metro april 18<sup>th</sup> 2016

Is this a possible scenario? Can it happen? Why/Why not?

**Questions to discuss:**

How does this influence me and my family?  
Do I want to always be reached and traceable?

What is the good side of being traceable?  
What is the bad side of being traceable?

Who should the information in the chip?  
Who has the right to programme the chip?

Do we have a right to register what people do?  
Is it OK for parents to control what their teenagers do?  
Is it OK to control old people that have lost their way?

Will it be cheaper/more expensive for society if everyone has a chip under the skin?  
Is there a health risk associated with this?

**Other good ideas for working with a sustainable society**

Examples on how science centres can work with representatives from society and schools to learn more on sustainable society.

**The Future Day**

The Young Minds project

Aims to increase teenagers interest in future science and technology in a changing world. The method was co-jointly developed by six Swedish museums and science centres by sharing their expertise, experience and other resources.

The science centre serves as an arena for debates, discussions, pupils exhibits. The arena invites scientists, politicians, businesswomen to one day for meeting across the borders.

This is an occasion for the pupils to develop their discussion skills and take part in other peoples opinions and experiences. And for representatives from society to meet opinionated young people. For more information on this work:

[http://www.ungaspekularar.nu/om\\_us/Final\\_eng.pdf](http://www.ungaspekularar.nu/om_us/Final_eng.pdf)

**City of Göteborg International Environment Prize**

[http://www.goteborg.se/prod/sk/goteborg.nsf/1/english.environment.city\\_of\\_goteborg\\_international\\_environment\\_prize](http://www.goteborg.se/prod/sk/goteborg.nsf/1/english.environment.city_of_goteborg_international_environment_prize)

In 2005 this award was awarded The Maraba Cooperative, Abahuzamubambi in Rwanda has for its pioneering work to produce coffee in a sustainable way from social, environmental, as well as economic aspects.

Pupils were invited to discuss with the guests. This is an occasion to discuss and get the global perspective on sustainable society. And a valuable occasion to train English language.

### Summary

The cooperation between schools and Teknikens Hus and Universeum has been a part of the PENCIL project. The 12 schools that have worked with us under the project time are Bergviksskolan, Tunaskolan, Råneskolan, Munkebergsskolan, Ängsskolan, Kristinaskolan, Hertsöskolan in the Luleå area and Buråsskolan, Karl Johan skolan, Utmarksskolan, Stensbo skola and Hjällboskolan in the Gothenburg area.

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