Examples of using ICT in a learning unit

Additional ideas of how the tools could be integrated in the IBSE modules

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Content

Introduction

In addition to the Web2.0 / App Guide that is available on the IRRISISTIBLE website[1] and to the workshop held in Kiel in March 2014, this document contains several examples of how ICT tools could be integrated into the teaching units developed within the IRRESISTBLE project.

Whereas the Web2.0 / App Guide's aim is to present the large variety of tools available on the marked and to spark ideas of what could be used in general, the goal of this document is to give examples of how some of the tools could be integrated in a module. It presents three fictive illustrations on different topic areas: using an e-learning platform for collecting basic knowledge on plastics, employing different apps to optimize solar power, and a unit on calculating and comparing CO_2 footprints for food and travel. The examples have an illustrative character and are focused on including ICT tools rather than giving full content teaching units.

To support the integration of ICT in the teaching modules developed within the IRRESISTIBLE project, the examples illustrate the core topics of the project, namely Responsible Research and Innovation (RRI), Inquiry Based Science Education (IBSE), gender issues and exhibitions. Table 1 gives a brief overview on the main aspects represented in the different examples.

In addition to these examples shown in this document, another use case on working with different app tools and integrating the results on the e-learning platform Mahara is documented in the Deliverable to the workshop, D4.2[2].

Further reading: Science on Stage Deutschland e.V. recently published a comprehensive collection of ICT tools and examples. These can be found in the booklet "iStage 2 – Smartphones in Science Teaching" that is available on their website[3] (pdf version and print copy to order, both free of charge).

[1] http://www.irresistible-project.eu/index.php/en/resources
[2] http://www.irresistible-project.eu/index.php/en/resources/deliverables
[3] http://www.science-on-stage.de/page/display/en/7/7/0/unterrichtsmaterialien//

Table 1: Indicating the core topics of the IRRESISTIBLE project being present in the following examples.

Unit	Responsible Research and Innovation (RRI)	Inquiry Based Science Education (IBSE)	gender issues	exhibitions
Unit on Plastics: Introduction to Plastics using Mahara	Discussion on environmental issues of plastic, sustainability, bio-friendly alternatives, …	-	-	Presentation of the results gathered in the unit on the school website
Unit on Solar Energy: Defining the Best Position for a Solar Cell using different ICT Tools	-	Student groups are working on research tasks to find the best conditions for obtaining solar energy	-	-
Unit on CO_2 Footprints: Calculating and Comparing CO_2 Footprints for Food and Travel	The topic of CO_2 footprints instantly offers many starting points for RRI, e.g.: Knowing how they are calculate ('Science Education'), Regulations on CO_2 emissions ('Governance'), contributors to the problem ('Engagement'), …	Tracking individuals CO_2 footprint travelling to school for one week, comparing and discussing results	Comparison and discussion of the CO2e footprint of female/male eating behavior (group work2)	Presentation of core results as a poster

Unit on Plastics:

Introduction to Plastics using Mahara

This example illustrates a teaching sequence on plastics. It starts with a reference to plastic as part of our daily environment and then introduces the basics about the production and use of plastic materials. Towards the end, it raises questions about substituting plastics and other ways to reduce the immense problems it creates today. During the whole unit, students work and document their results on the e-learning platform Mahara. At the end, the results collected during the teaching unit are presented on the school website. Mahara is just an example tool to be used here, there are comparable tools around that could be used in a similar way (e.g. Edmondo[4]).

Activity sequence

1. Introduction to Mahara

Introduction of the students into the e-learning system Mahara, creating user accounts for the learners. (A brief introduction to the e-learning platform Mahara in included in the IRRESISTIBLE Web2.0 / App Guide[1], pp. 23-33.)

2. Entry task: everyday reference

The students get the task, to photograph at home three different objects made of plastic. The objects should be as different as possible. Afterwards these images should be uploaded to the *content* section of their individual Mahara account (in Mahara jargon they are then called *artifacts*). This can be either done by using their own smartphone and the Mahara app, or done in a classical way by using a digital camera and upload the images via the browser interface.

In the following lesson, a joint Mahara *group* for the project is established and the images are collected in a common *portfolio*. The pupils are asked to find categories themselves by which to sort the plastic pictures (this could be e.g. color, hard/soft, use cases, …). If several classifications occur, multiple portfolios can be created and filled. In the following, the different sorting criteria are discussed by the learners, either face-to-face in class or digital within a Mahara *forum*.

3. Topic plastics

In the following lesson(s) the students are introduced to the topic of plastic. The introduction unit to plastics could incorporate e.g. structure, fabrication (polyreactions), properties, labelling ... From this knowledge, new criteria arise to sort the plastic in different categories.

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[4] https://www.edmodo.com/

When the new categories are developed, a new Mahara *portfolio* is created. As introduction to each category the nature, structure and main properties are briefly described. The students try to find out which plastic the photographed objects are made of and sort the images into the new categories.

4. Topic recycling

Short teaching unit on plastic: “Problems with Production and Recycling”. Assessment of different plastics with respect to their sustainability (considered over the entire life span). Adding the results to the new plastic *portfolio*.

Subsequently, the task to research bio friendly alternatives to the plastics shown in the portfolio is assigned to the students. The alternatives should have similar characteristics and thus should be able to serve as a direct substitute for the original plastics. If appropriate, other groups with secondary tasks are formed, for example, how recycling can be further improved or how the construction of products can be optimized to reduce the use of plastic and to ease recycling (reduced quantity of conventional plastic, composite materials, recycling friendly construction ...). The research results of the groups are collected on further Mahara *portfolios*, the (digital) discussion can be handled within topic-related Mahara *forums*.

5. Presentation

Each group prepares a final *portfolio* page or a small series of *blog* entries within Mahara, which summarizes the main findings of their group work in a multimedia format. These contents are first presented to the class, then released as a public Mahara *portfolio* and embedded in the school website.

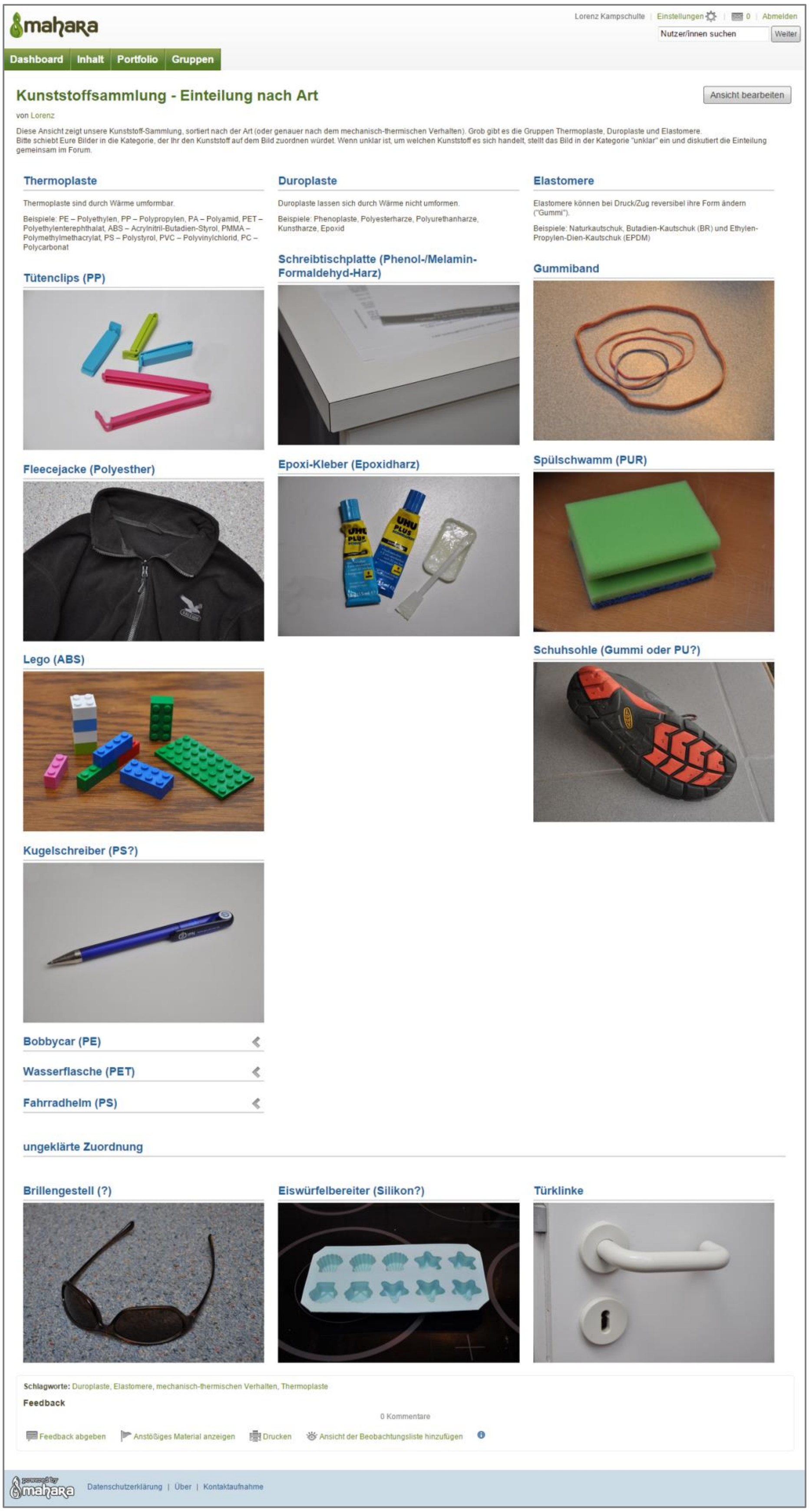

Figure 1: Example of a Mahara *portfolio* during the sorting process: The photographs of the students are grouped in four categories: thermoplast, duroplast, elastomer, unsettled.

Unit on Solar Energy:

Defining the Best Position for a Solar Cell using different ICT Tools

In this example, a teaching unit on solar energy is presented, especially looking on the influence of the solar panel position on the highest possible power generation. The class is divided in three groups looking at different aspects: the local position (e.g. influenced by houses, trees …), the regional position (e.g. influenced by topography, sunshine duration …), as well as the technical position (e.g. orientation, tilting angle …). During the units, the groups work with different ICT tools to fulfill their tasks, the tools are either smartphone or computer based. The tools are just examples that could be used, several other tools are available that could be used in a similar way.

Activity sequence

1. Introduction

Solar energy is a fundamental part of all scenarios to ensure the global energy supply in the future. Until the vision of a 'solar paint', that can be applied to almost all surfaces turning them into effective peripheral power generators comes true, we have quite a way to go. Today's state of the art technology is photovoltaic solar panels being based on polysilicon or thin films. These have two main drawbacks: they still are moderately expensive (so it's not possible to 'just cover' all available surfaces), and their efficiency is highly dependent on the orientation towards the light incidence. The latter effect should be investigated within this unit.

2. Group 1 – school yard

Task: Find the best spot to place a 2 m² photovoltaic solar panel on your school yard. Take factors as sun position during day, seasonal sun position, obstacles (houses, trees) into account. Use the App Sun Position[5] or Sun Surveyor[6] to work out the best place.

As a result, take (or draw) a map of you school yard and indicate your 1st and 2nd choice position. Draw a table and list the relevant factors for both positions.

[5] https://play.google.com/store/apps/details?id=com.andymstone.sunpositiondemo&hl=de

[6] https://play.google.com/store/apps/details?id=com.ratana.sunsurveyor&hl=de

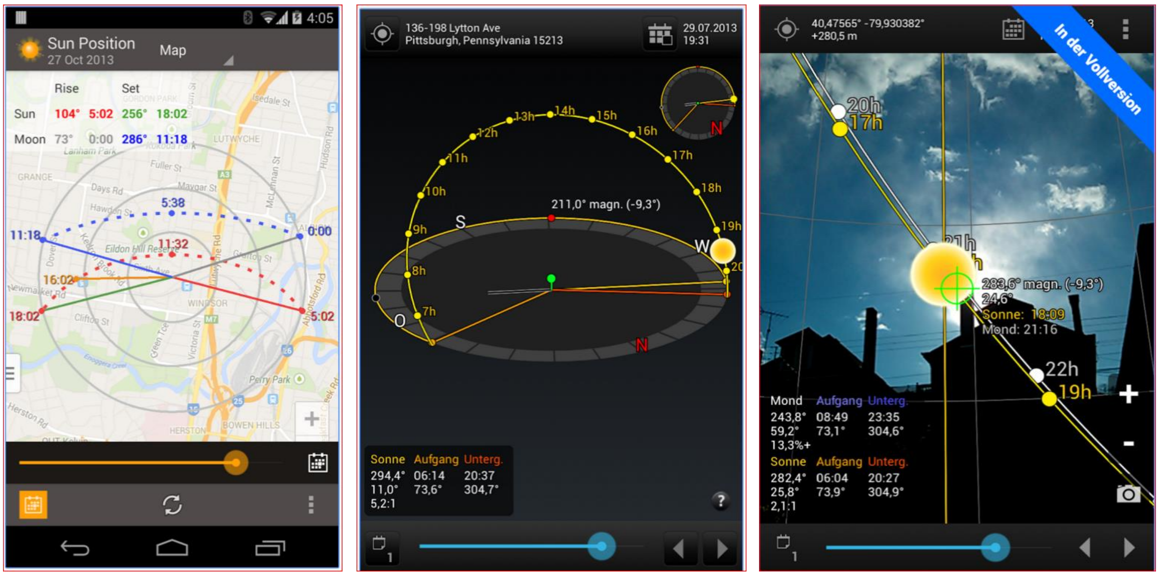

Figure 2: Screenshots of the apps Sun Position (left) and Sun Surveyor (middle and right) to determine the best position for a solar panel (screenshots: [5],[6]).

3. Group 2 – regional position

Task: Find the best spot for a small communal solar power plant (200 m² base area, photovoltaic) within a radius of 50km from your school location. Take factors as local sunshine duration, topography, sites (buildings, grassland, large roofs …) into account. Use Tools like Google Earth[7] (topography, site options), sunshine duration maps[8], or tools to analyze the course of the sun for a specific place[9] …

As a result, take a map of the area under investigation and indicate your 1st and 2nd choice position. Draw a table and list the relevant factors for both positions.

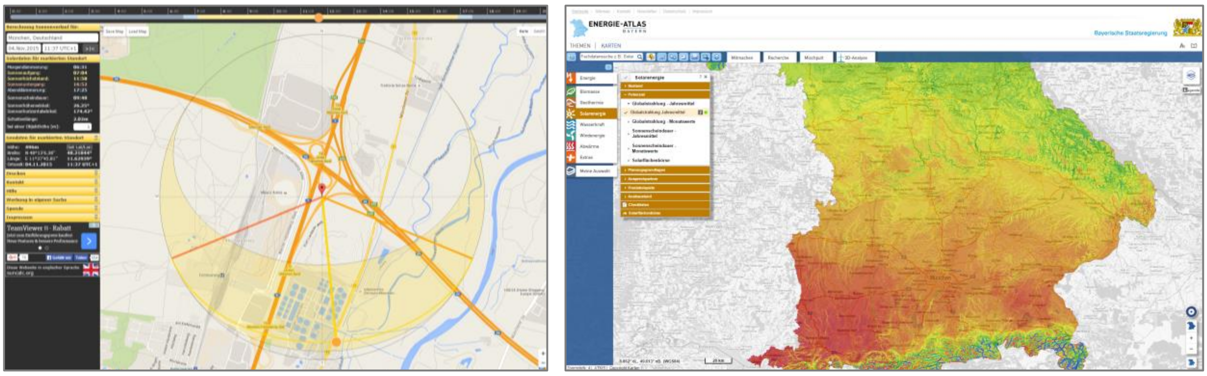

Figure 3: Course of the sun simulated on sonnenverlauf.de[9], map of global radiation for southern Bavaria[8].

[7] https://earth.google.com/

[8] http://geoportal.bayern.de/energieatlas-karten (similar maps should exist for most regions)

[9] http://www.sonnenverlauf.de/#/48.2184,11.6294,15/2015.11.04/07:24/1

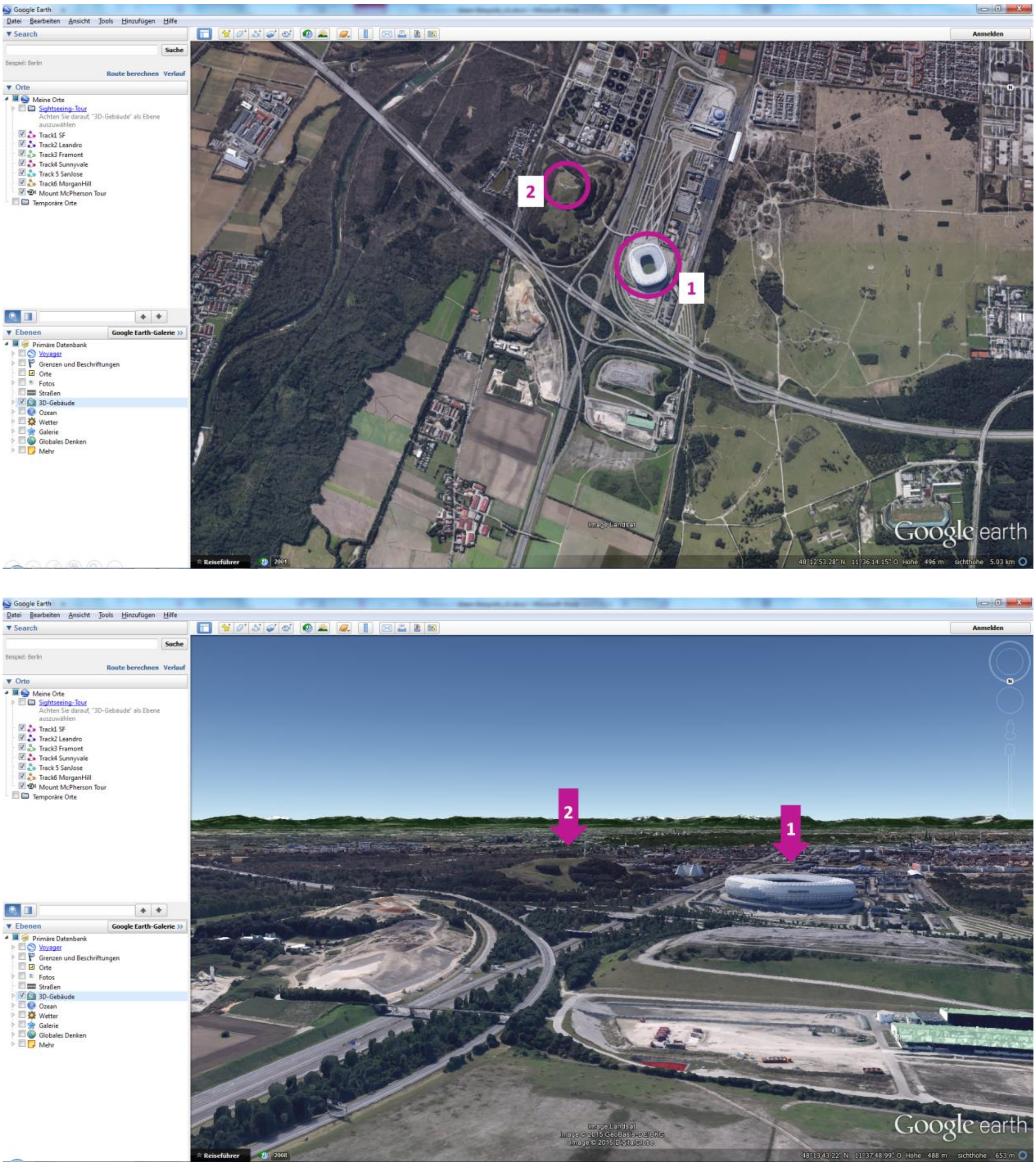

Figure 4: Two possible positons for a small PV solar power plant, visualized in Google Earth[7]: (1) on the roof of a football stadium, (2) on the top of a small hill close by.

4. Group 3 – optimal position to the sun

Photovoltaic solar cells are most effective, when the sun hits perpendicular onto the solar panel. Tilting to panel +/- 20° off the optimal position results in ~17% power loss, when tilting it to +/- 50° only 10% of the maximum power is left.

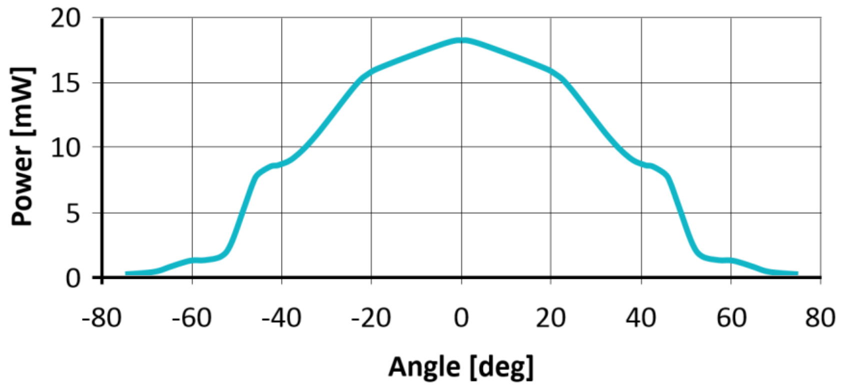

Figure 5: Angle dependent power of a typical solar cell.[10]

Task: Find out the optimal orientation of a solar panel towards the sun under the current situation. Search for a sunny spot on your school yard. Draw a compass rose with the four cardinal points on a sheet of paper. Use a smartphone to determine the north direction, align your compass rose and tape it to the ground. Now use the App Light Meter[11] (or a similar one) and systematically try to find the orientation with the highest light intensity, alternating optimizing East-West orientation and tilting angle. When the optimum point is reached, note down the maximum light intensity (in Lux), the East-West orientation and the tilting angle in a small table. You can either use a set square and a compass, or smartphone apps like Smart Level[12] and Smart Compass[13]. Since these values are highly dependent on the current situation, note down exact location (GPS), date and time as well.

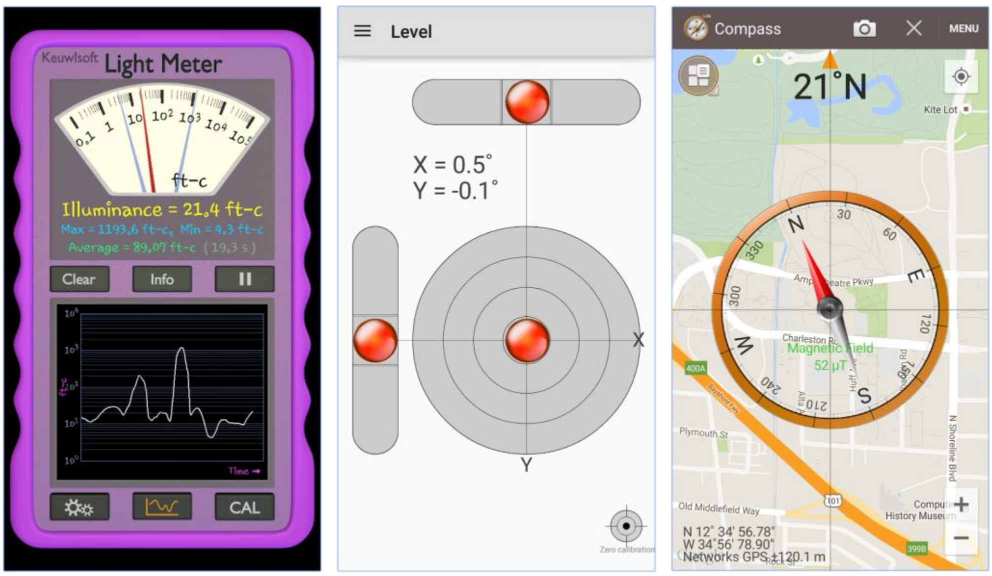

Figure 6: Screenshots of the apps Light Meter, Smart Level, Smart Compass (screenshots: [11],[12],[13]).

[10] source of data: http://www.drollinger-wds.de/benjamin/study/docs/et_solar.pdf
[11] https://play.google.com/store/apps/details?id=com.keuwl.lightmeter&hl=en
[12] https://play.google.com/store/apps/details?id=kr.sira.level&hl=de
[13] https://play.google.com/store/apps/details?id=kr.sira.compass&hl=de

Now tilt the smartphone 20° off the optimal position. Roughly, how much is the “power” (aka light intensity) reduced as compared to the maximum “power”? (You most probably will measure a different decrease than mentioned in the example above, since your smartphone sensor is not a real solar cell, and the angle is also dependent on how the sensor is mounted in the smartphone – nevertheless a significant decrease should be measurable.)

5. Summary

Each of the three groups presents their findings in a brief PowerPoint presentation. Discuss how you can optimize your solar power plant including all findings (especially group 2 and 3). From the results of group 3 it can be concluded that following the sun with the solar panel would be a good option to increase the overall power output. But that is done very seldom – why?

Unit on CO_2 Footprints:

Calculating and Comparing CO_2 Footprints for Food and Travel

This example illustrates a teaching unit on carbon footprints. Carbon footprints are “a measure of the total amount of carbon dioxide (CO_2) and methane (CH_4) emissions of a defined population, system or activity, considering all relevant sources, sinks and storage within the spatial and temporal boundary of the population, system or activity of interest. Calculated as carbon dioxide equivalent (CO_2e) using the relevant 100-year global warming potential (GWP100).”[14] Working with and reflecting these measures, students should get an idea on the dimension of CO_2 emissions and how the individual can influence climate change by controlling their own behavior. In the teaching unit, several apps and websites are used to explore, compare and track the individual carbon footprint.

The teaching module on Climate Change developed by Finland within the IRRESISTIBLE project includes several aspects on CO_2 and Carbon footprints[15].

Activity sequence

1. Introduction

Starting the introduction with a more general approach to climate change and the role of CO2 and other greenhouse gases. Basic introduction to the concept of carbon footprints, illustrating their role in terms of direct emission (e.g. transportation) and indirect emission (e.g. food, textiles …) with the latter having a special look on lifecycle analysis.

2. Determining the CO_2 emission of getting to school for one week

Introduce students to using the app Changers CO2 Fit[16]. The app allows to track all travelling, calculates the CO2 saved, and rewards the user with green bonus points called ReCoins.

Let the students track their way to school (or all travelling) for one week, collect, compare and discuss the results.

[14] Wright, L.; Kemp, S.; Williams, I. (2011). "'Carbon footprinting': towards a universally accepted definition". Carbon Management 2 (1): 61–72. doi:10.4155/CMT.10.39.
[15] http://www.irresistible-project.eu/index.php/en/topics
[16] https://play.google.com/store/apps/details?id=com.blacksquared.changers&hl=de

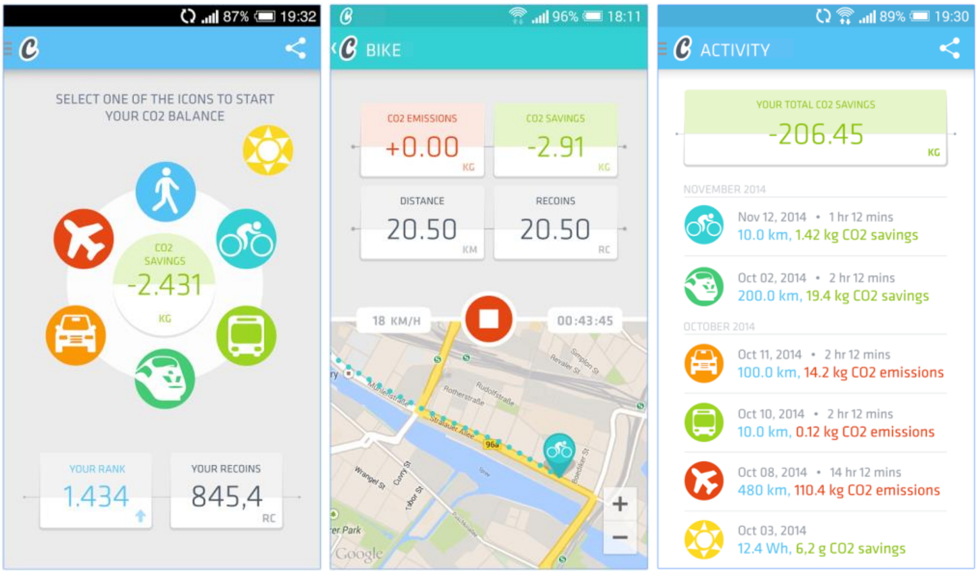

Figure 7: Screenshots of the app Changers CO2 Fit: start screen, travel screen, list of travel activities (screenshots [16]).

3. CO_2 emission caused by food

Calculating the CO_2 footprint of food is quite complicated, since many factors influence the footprint: production conditions, production itself, wrapping, transport, storage, retail system, transport to household … Discuss these factors and their potential share in the total footprint of the food product. Also take the contribution of other greenhouse gases into account (e.g. Methane (CH_4) when producing meat), which are far more dangerous than CO_2. Introduce the Global-warming potential (GWP) of greenhouse gases and the concept of carbon dioxide equivalents (CO_2e)

Group work1: Students explore the different food and respective carbon dioxide equivalents (CO_2e) on the webpage Eat Low Carbon[17]. Let them write down three food ingredients that they presume to have a very low CO_2 emission, and three food ingredients that have a very high emission. Discuss the findings.

Group work2: The class is separated in female-only and male-only groups. Each group gets the task to choose the food for each person and day, based on the meals they like best. Then students calculate an average CO_2e footprint for the daily food ration within their group. Compare the results between the groups. Is there a difference between female and male groups? Discuss the results in terms of worldwide eating behavior and world population.

[17] http://www.eatlowcarbon.org/food-scores/

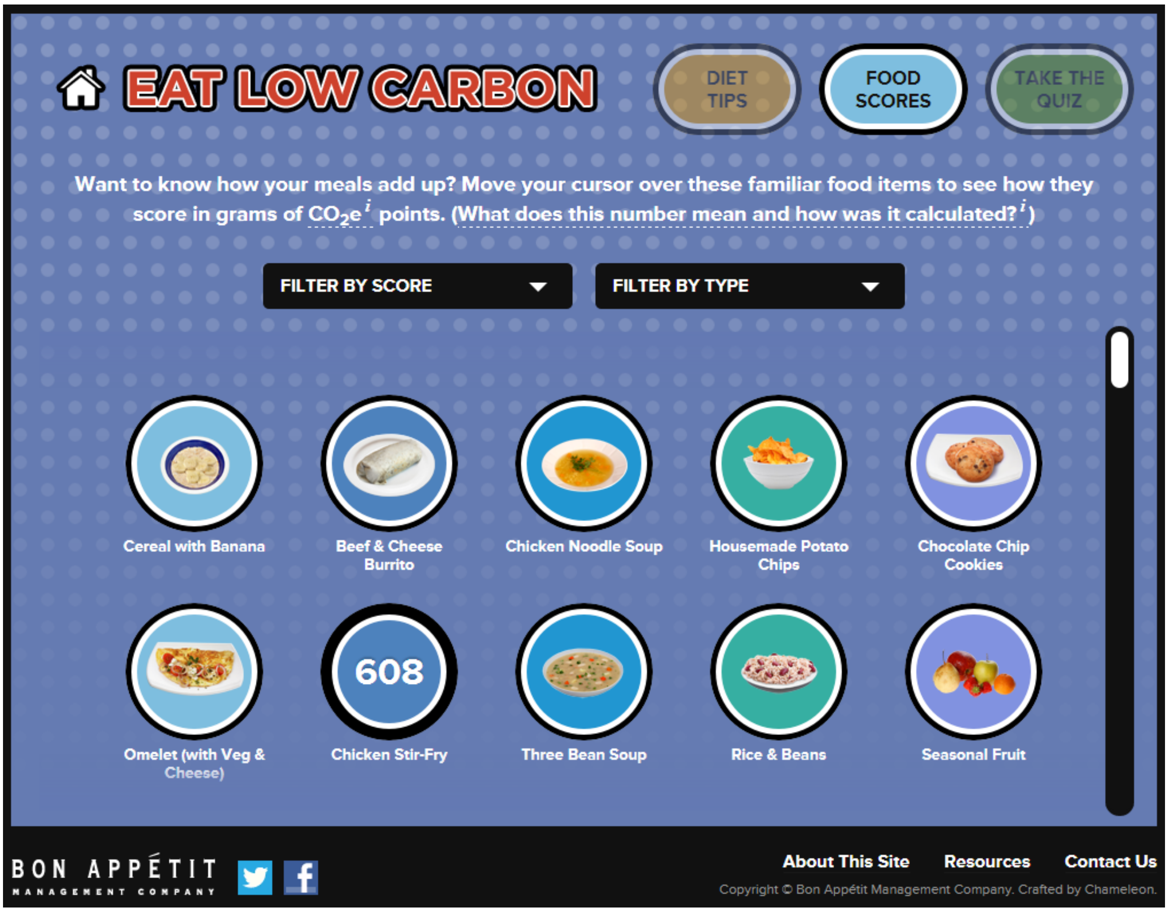

Figure 8: Screenshot of the website Eat Low Carbon. The page contains a huge variety of food and meals, hovering over the photo with the mouse indicates the grams of CO_2e (screenshot [17]).

Note: some nice examples of professional CO_2e calculation are listed on the website of CleanMetrics[18] (right column).

Note for an extended project: With the app Veggietizer[19] one can easily calculate how much CO_2, water and crops can be saved by banning meat from your meal.

4. *Summary*

Discuss the findings on CO2 emissions from food and travel. For consolidating the results of the unit, let the students make a joint poster which could have three parts:

- Introduction, explaining CO2 problem and concept of carbon footprints and carbon dioxide equivalents (CO_2e)
- Catching examples to present: compare travelling a specified distance by plane, by train, by bus, by car and by bicycle and/or compare meat: beef from Argentina, local beef, local poultry

[18] http://cleanmetrics.com/html/foodcarbonscope.htm
[19] https://play.google.com/store/apps/details?id=freerunningapps.veggietizer&hl=en (currently only a German version available)

- Students research the CO_2e for ten different kinds of food (e.g. 100g of pasta, 100g soy milk, 100g beef, …) and calculate how far you could travel with a car producing the same CO_2 emission (for a graphic inspiration look at the illustration of the CO_2e of different products published by the meateatersguide[20]).

Hang up the poster in a frequented spot in the school building to spark discussion between students.

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[20] http://static.ewg.org/reports/2011/meateaters/images/eatsmart_twenty.gif