

ICT Tools in School – a Practical Guide

ICT Tools for Inquiry Based Science Education –
Practical Ideas for Tools and Implementation

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1. Introduction

ICT tools like apps, programs and web2.0 applications are part of our modern society. Schools all over Europe are adopting this essential trend, but in many countries this adoption is happening at a rather slow pace. This has many reasons, from missing infrastructure to security concerns to teachers not being familiar enough with using ICT in regular classes. To encourage teachers to think about an increased use of ICT tools in teaching, and to inspire them on where and how to use these tools is the main idea of this ICT Guide. We need well-educated students with profound ICT skills – in terms of operation as well as media literacy – to become active members of our knowledge society which is built on the foundation of ICT in most areas these days.

The aim of this guide is to practically support teachers in using ICT tools in class. A special focus is laid on integrating various tools in inquiry-based science education (IBSE): on the one hand, this type of teaching allows for a multitude of different opportunities for integrating ICT, on the other hand, it is one of the foci of the EU project IRRESISTIBLE in which this guide was developed.

This guide is an updated and considerably improved version of the Web2.0 / App Guide published in an early phase of the IRRESISTIBLE project (March 2014). While the first guide mainly focused on listing selected tools that could be integrated in IBSE teaching, this guide goes a step further by analyzing the application of tools in the IRRESISTIBLE teaching modules and offering many examples of practical integration of ICT tools in teaching.

The guide itself is divided in three main sections:

The first section (chapter 2) offers an overview on the spread of mobile devices, including numbers on the smartphone penetration in the relevant age group (students), the distribution of different operating systems, and the apps available for the different systems. Further the section includes a discussion of the challenges when using ICT in the classroom, mainly based on the experiences with implementation of ICT-supported teaching modules within the IRRESISTIBLE project. As a result of the experience gained in analyzing examples and discussions in two workshops, a list of factors determining a decent use of an ICT tool in teaching was extracted. This list was then used as a base for the revision of section two and the development of section three.

Section two (chapters 3 and 4) focuses on the ICT tools itself: Although in many schools traditional personal computers are the tool of choice when working with ICT in class, there's an increasing number of so-called 'tablet-classes', and with more and more students carrying a smartphone anyway, the opportunity to work with these devices in class gains momentum.

In total, there are almost four million apps available, plus an uncounted number of programs for traditional computers - so the problem is not that the app / program you are searching for is not out there, the challenge is to find it. Everybody using a smartphone will know that apps have very different qualities and prices. Our goal for this guide was to find useful apps and programs for different tasks in IBSE, e.g. task like organizing a project, measuring or simulating data, collaborative work, or presenting information. A full list of tasks and tools can be found on page 14.

For each task, helpful tools were searched that satisfied a set of criteria we had defined beforehand:

- The tool should work
- The tool should be available on both major operating systems (or at least a similar app should be available)¹, so a mixed set of handhelds could be used in the classroom. Another option would be a web-

¹ Some apps with the same name, even from the same author, have greatly varying functionality in the version for different operating systems. Teachers should consider this when setting up the tasks for their students.

based tool, being accessible with any device's web browser, so either on computers in the classroom or computer room, on a classroom set of tablets or on students' own smartphones.

- The tool should be free (although apps usually are not really expensive, we feared that having to pay for an app to be used on students' smartphones would discourage some teachers, students or even parents)
- The tool should not be cluttered with annoying or even inappropriate advertisements. Although we understand that programmers need some revenue to live on, it should not interfere with using the app. Thus there are several apps showing ads in our list, but they do so in a decent way.

E-learning platforms are gaining a huge momentum right now all over Europe. Taking this into account as well as their ideal usability when teaching IBSE, we did not only list several examples in the App Catalogue, but also included a step-by-step instruction on how to use them (using the example of the open source platform Mahara).

The third section of this ICT Guide (chapters 5 and 6) is dedicated to presenting examples of the integration of ICT tools in teaching. Chapter 5 lists examples of teaching units which contain one or several ICT tools that students need to use in order to fulfill different learning tasks. Chapter 6 is a collection of best practice examples drawn from the IRRESISTIBLE project – ICT tools that worked exceptionally well when used in a given IBSE setting.

Since the pace of the ICT market is incredibly fast, especially in the area of smartphone apps, this guide is only to be seen as a snap-shot from mid-2016. Some tools will stay on the market for quite some time while others might disappear in a few months. And new, better ones will show up. But in general, as this guide points out that there is a certain tool for a particular purpose, it might then be easier in the future to find a suitable replacement.

2. ICT at School

Smartphone Market Share and Penetration

Due to the growing number of ‘tablet classes’ at schools and with an increasing number of students owning a smartphone even in lower grades, the relevance of smartphone and tablet apps to be used in teaching increases. To give a brief overview of this trend, the following section lists some facts and figures on mobile devices and the use and distribution in the relevant age group.

Smartphone sales

In 2015, more than 1.4 billion smartphones were sold, a growth of 14.2 percent from 2014. Android (Google) is by far the most widely used operating system with over 80 percent, followed by iOS (Apple) with almost 18 percent and Windows Phone (Microsoft) with slightly above 1 percent.²

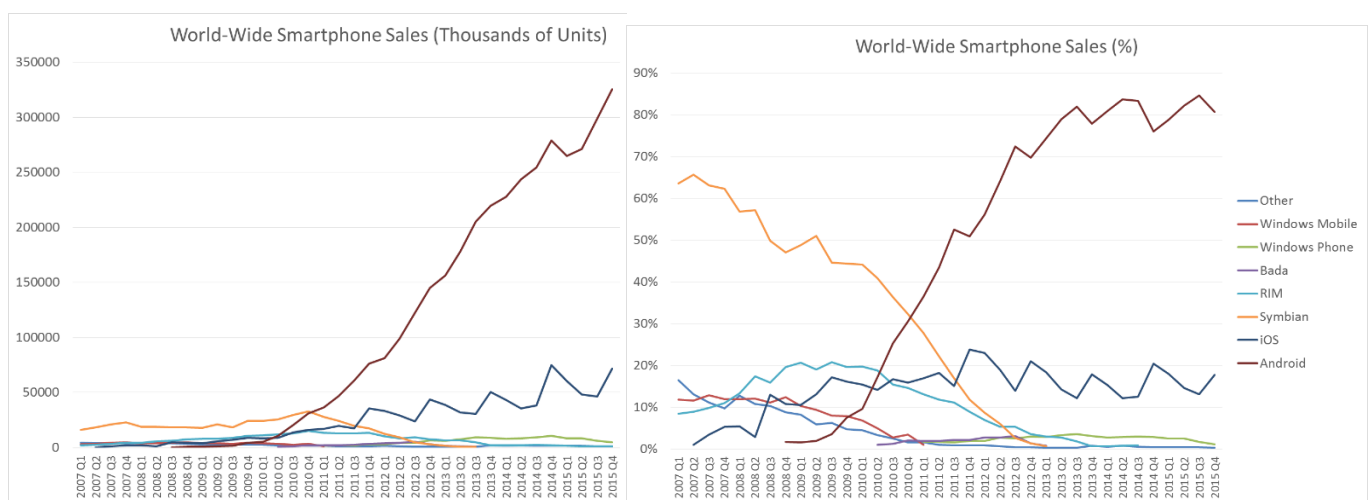


Fig. 1: Worldwide smartphone sales in thousands of units and in percent.

Although the rapid growth of the early 2010s with growth rates around 50 percent per annum is now levelling off, the numbers of devices sold is still remarkable: In the last quarter of 2015, 325 million Android smartphones and almost 72 million iOS devices were sold. Windows Phone didn't really catch up with the two big players and is still in the range of low 1-3 percent with about 4.4 million units sold.³

The tablet market is in a somewhat similar situation of saturation: with about 214 million tablet computers sold in 2015 (whole year), sales even slightly declined in comparison to 2014⁴. Android has a share of roughly 68 percent, iOS about 22 percent, and Windows about 10 percent.

Smartphones in use

Looking at smartphones in use today, the operating systems' shares are generally arranged in the same order as sales, but differ significantly between the US and Europe. In the US, the share is divided almost half and half between Apple's iOS and Google's Android, whereas in Europe there's more than 2/3 of phones using Android, and only less than 20% using iOS.

² Source: Gartner research, <http://www.gartner.com/newsroom/>

³ Source: Data: Gartner research via Wikipedia; Graph: own work

⁴ Source: Gartner research, <http://www.gartner.com/newsroom/id/3088221>

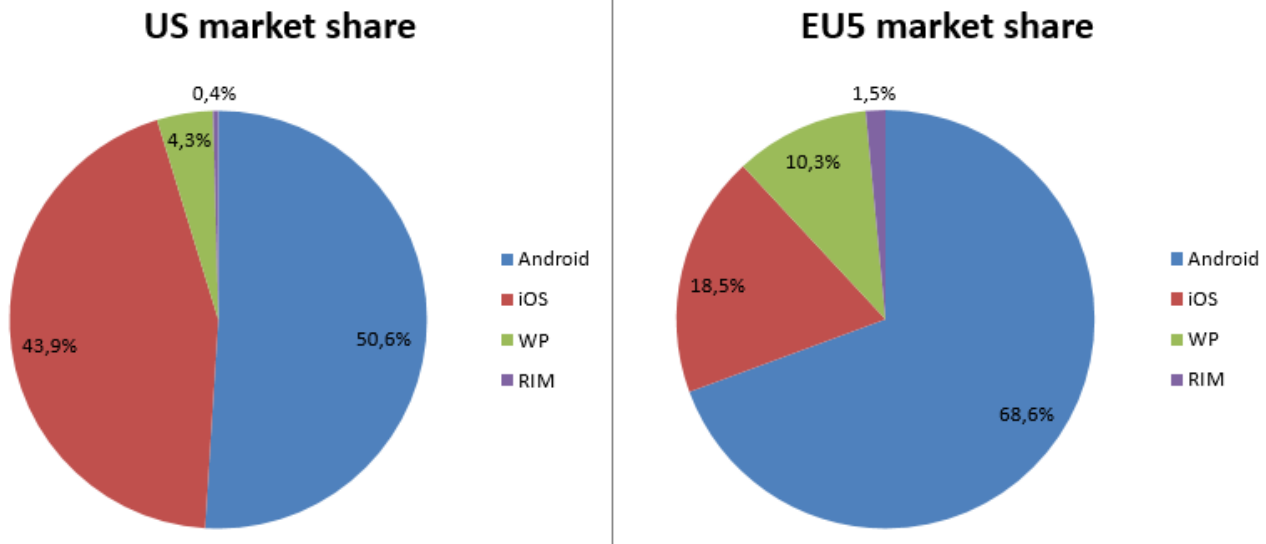


Fig. 2: Smartphone OS market share in quarter 4, 2013; EU5 includes: France, Germany, Italy, Spain, and United Kingdom; Source of data: Kantar Worldpanel: ComTech Smartphone OS market share (% of smartphones) Region

Number of apps offered for the different OS

Almost four million apps are accessible through the official app stores. By far, most apps are available for the main operating systems Android (Google Play – 1.6 Mio. apps) and iOS (Apple App Store – 1.5 Mio. apps). The Amazon App Store – originally founded for Amazon’s Fire Tablets – is open to all Android devices and offers only apps that are quality-checked by Amazon. With 340.000 apps for Windows Phone and 130.000 apps for BlackBerry, the app stores of the two other main operating systems are far behind the global players.

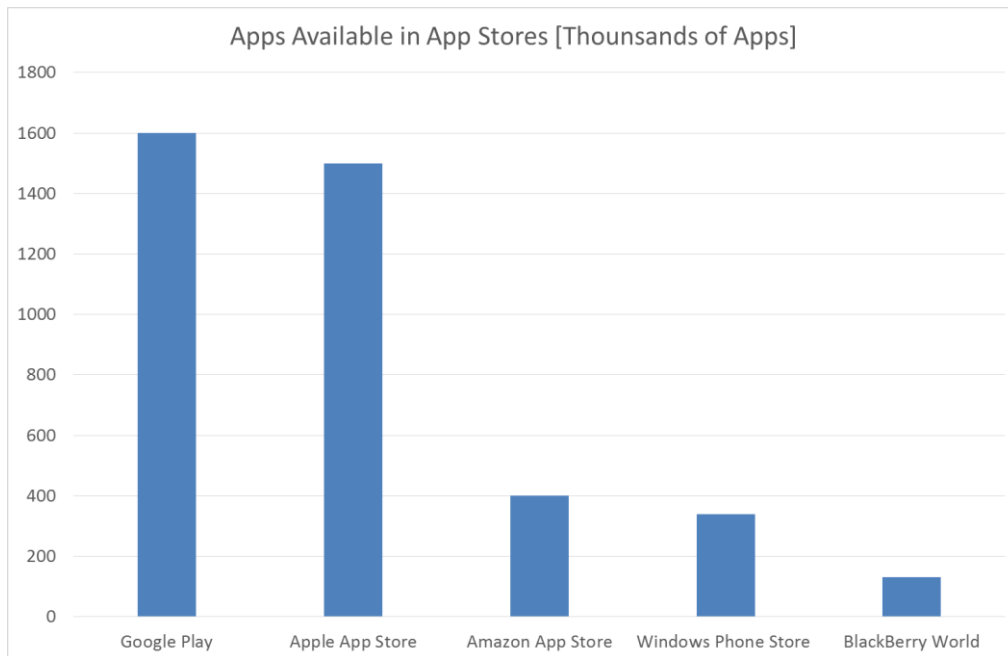


Fig. 3: Apps offered in the official stores Google Play (Android), Apple App Store (iOS), Amazon App Store (Android/Kindle Fire), Windows Phone Store (WP), and Blackberry World (RIM). Data of July 2015; Source: Statista.

Smartphone users

With currently 1.86 billion smartphone users worldwide and a total population of about 7.4 billion, the global smartphone penetration is around 25 percent⁵. Europe has an average general smartphone penetration of about 50 percent, but in the age group closest to that relevant for our project the penetration is around 60 percent, i.e. at least every other student owns a smartphone. The penetration rate varies among countries, age groups and gender. Here are two graphs made from Google's Our Mobile Planet report⁶, all dated 2013.

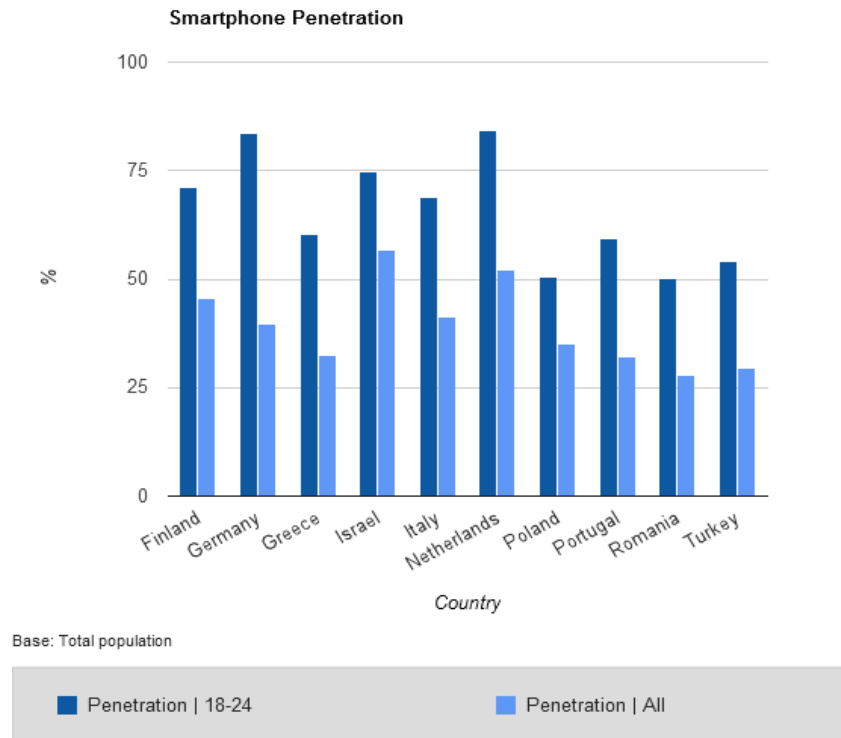


Fig. 4: Smartphone penetration in selected European countries: comparing the penetrating in the age group 18-24 with the penetration in the total population (Data: Google's Our Mobile Planet report).

⁵ <http://www.statista.com/statistics/330695/number-of-smartphone-users-worldwide/>

⁶ <http://think.withgoogle.com/mobileplanet/en/> (website no longer available, data retrieved 2014)

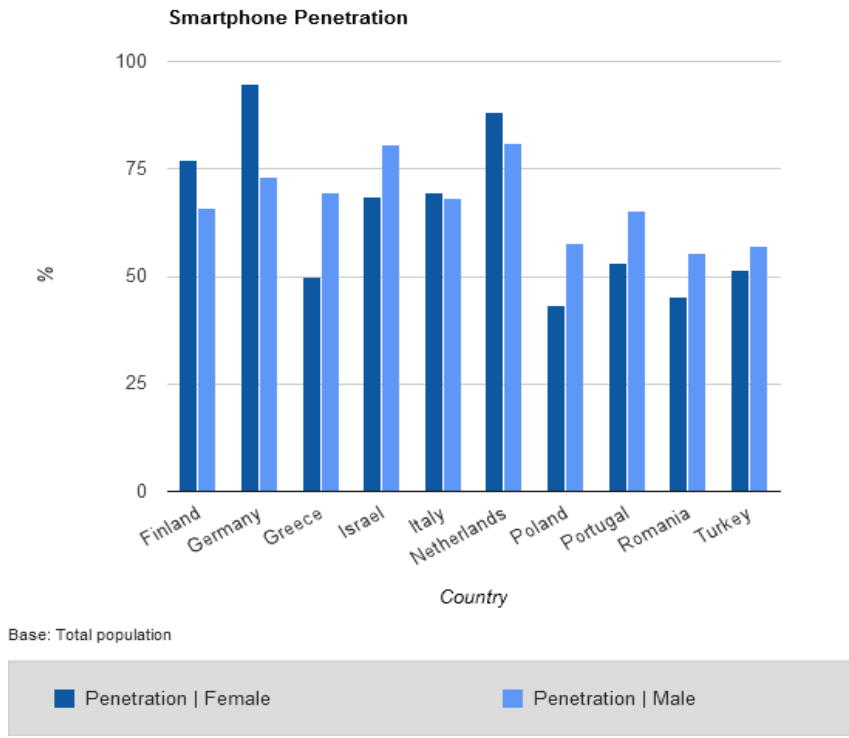


Fig. 5: Smartphone penetration in selected European countries: gender differences in the age group 18-24. (Data: Google’s Our Mobile Planet report).

To estimate the smartphone penetration in a more detailed way in the age group below 18 (which is most relevant for school applications of smartphones), there are no Europe-wide numbers available. For Germany the JIM study⁷ revealed some figures in 2013, with might be comparable to other EU countries: Of the children age 12-14, 57 % own a smartphone; for those age 15-16, the number increases to 73 %; 78 % of children age 16-17 and 80 % of the 18-19 year-olds have their own smartphone. The overall smartphone penetration does not vary among Germany’s different types of schools.

⁷ <http://www.mpfs.de/fileadmin/JIM-pdf13/JIMStudie2013.pdf>

Challenges When Using ICT at School

There are a lot of challenges when integrating ICT tools in teaching, ranging from a meaningful educational incorporation to questions regarding technical parameters and infrastructure to teachers' own ICT qualification. One demand within the IRRESISTIBLE project was the inclusion of Web2.0, Apps and ICT tools into the teaching modules that were developed. This process was used to characterize typical problems of ICT use in teaching. During the evaluation of the modules, the partners developing the modules were asked about the challenges the teachers in their country faced with the implementation. The results of the survey are shown below, with three points standing out:

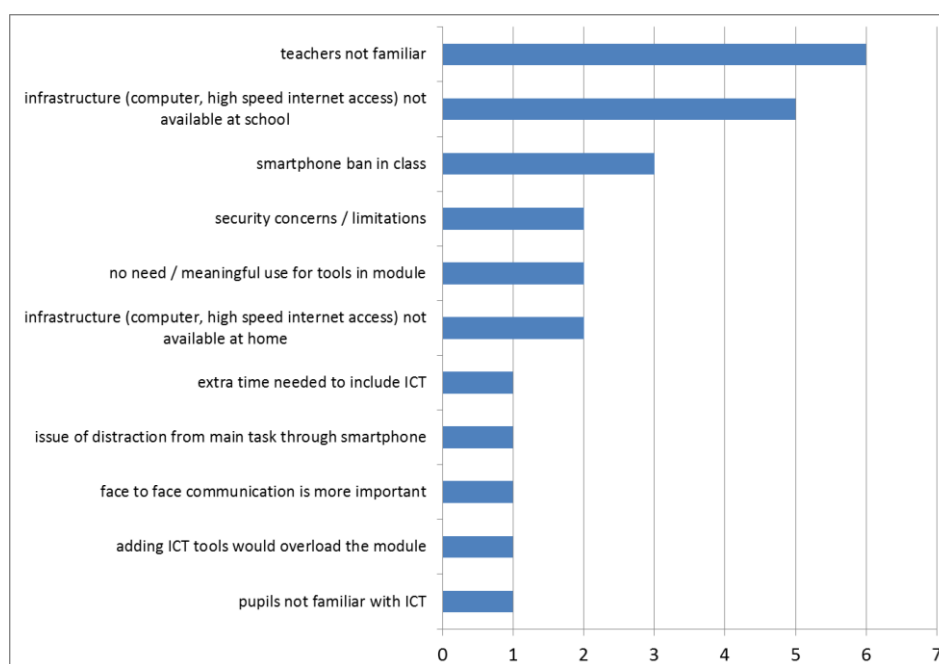


Fig. 6: Reasons that impede the implementation of ICT tools in the teaching modules, answers from 10 developing groups in nine countries.

By far the issue most often mentioned (60%) is that teachers are not familiar enough with using ICT tools. In half of the countries, a solid hardware infrastructure is not available at schools thus hindering the general use of appropriate tools in class. Security concerns of the teachers as well as a general student smartphone ban in class are relevant issues as well. Drawing conclusions from the survey and the two workshops held within the IRRESISTIBLE project, there are two main points to work on in the future:

Empower teachers to use ICT tools

The reason most often named to hinder a better implementation of ICT tools in the modules is the unfamiliarity of teachers with ICT. So the idea of this and future projects must be to empower teachers in using various tools on different IT platforms, but also to gain a better understanding of security and legal issues.

For raising awareness to use ICT in teaching, this ICT Guide seems a good starter: Discussing ICT tools with a lot of teachers on many occasions during the last two years, we realized a constant interest in the topic, not only from younger teachers, but more or less from all age groups. But knowing about the tools is just the first step. Before teachers start using these in class, they need to become familiar with the tools themselves – not only to be ahead of (or at least on the same level of knowledge as) their students, but also to be effective in training their students and delivering support – both important points in order to use tools effectively and not to waste too much time with getting it to run. Since not every user is a born self-educator, teacher trainings on ICT tools might be a good option to become familiar with new tools (at the same time offering room to discuss implementation). Another way that has been adopted by several partners within the IRRESISTIBLE project is to use relevant tools with the

teachers during the development of the teaching modules, giving them the opportunity to learn by productively using it themselves.

The next step towards using ICT in class is a meaningful implementation into teaching. Knowing about the possibilities (and limitations) of a tool and connecting it to relevant tasks in teaching is key to creating benefits for learning. The chapters Examples of Using ICT in a Learning Unit (page 50) and the Collection of Best Practice Examples (page 61) included in this guide might offer additional ideas for implementation.

Another reason that prevents teachers from using ICT tools is the uncertainty about security and legal issues. Since regulations in different countries vary greatly, it is very difficult to give general advice. Within the IRRESISTIBLE project the range of regulations differed between countries in which using Facebook for teaching and sharing tasks for homework is common and those countries in which all tools that store or send data outside the own country are not allowed at school (which excludes a huge amount of tools, including all major cloud storage providers), just to name the extreme positions.

Sure enough, the easiest way to solve these issues would be to not use ICT tools and ban smartphones from class. But this would withhold a huge learning opportunity from students and counteract any improvement regarding their media literacy. Providing teachers with the necessary background knowledge and giving them time in class to address these problems seems to be a much better way. Banning smartphones is the quick solution to reduce distraction – engaging students to make use of the technology at their hands and simultaneously training them to use it in a decent way and prioritize tasks would be much more helpful for their future. Security concerns are a broad field of challenges, from copyright issues to secure data storage in cloud space. Again, not using tools like student-developed (public) websites and cloud space is the simple solution – making students adhere to copyright regulations and finding ways to work with open content on their website or to discuss security issues when saving data on cloud space, such as finding solutions to encrypt these data as well as working with anonymous/fake accounts prepares students much better for their future. But this calls for teachers being highly qualified in using ICT, staying up-to-date during their teaching life, as well as investing some extra time in their lessons to address and discuss these challenges.

Improvement of Infrastructure

Many of the tools need a decent internet connection for working properly which seems to be problematic in many schools. Using stationary personal computers in a computer room or in the classroom is quite common, whereas using student smartphones with a Wireless LAN connection at school is definitely not the standard yet.

The studies mentioned above as well as various discussions on the workshops and with teachers reveal that many schools in the participating countries have a weak IT infrastructure. For a seamless integration of ICT tools in teaching, e.g. in form of an e-learning platform, permanent access to the tools is necessary. If teachers – as it is common practice in many countries today – have to move with their class to a separate computer room (which probably is not even available for all lessons) it is hard to realize a continuous, ICT accompanied project flow. This is much easier put into practice by either using computers in the classroom, or students' own smartphones – with the latter giving the chance to propagate the project across the boundaries of classroom and school. Especially the approach using students' smartphones requires a more comprehensive IT infrastructure than is available in many schools today.

Being aware that creating a sound infrastructure at school is a long term project, we want to mention just two approaches realized within the IRRESISTIBLE project to temporarily get around this challenge: As intermediate approach, it might be an option to install a temporary WLAN access point (cost < 100 EUR) in the class allowing the use of students' smartphones and thus working with ICT tools. Another possible approach is the use of ICT infrastructure and support offered by a third party such as a science center or student lab, as presented in the best practice example using Scratch (Greece 3, page 72).

Factors Determining a Rewarding Use of an ICT Tool in Teaching

Several factors that determine a good integration of an ICT tool in the teaching process were revealed through an analysis of the integration of ICT tools in the different teaching modules, through the analysis of the best practice examples (pages 61 - 75) as well as through discussion of the topic with education experts and teachers in the second workshop. These factors can be grouped in three larger areas: The tool itself, the integration into teaching, and the environment that influences the use.

Tool

- Easy to use for teachers and students: the tool should be easy to install/access and have clear user interface so the main functionality is directly approachable.
- Suitable for the purpose: the tool should match the task it is intended for in teaching.
- Free: using paid apps on student devices is not feasible (complicated payment processes, most often credit card needed).
- Problem with different operating systems: When using smartphones most likely different operating systems are present in class. In this App Guide, we usually name different options for both major operating systems. If working in groups, it might be helpful to make sure each group has at least one student working with the app the teacher is familiar with.

Integration

- Analyze points in teaching phases where ICT integration is helpful: When planning a teaching unit, find the spots where ICT tools support the progress and where enough time is available.
- Adding extra value: if the task can be fulfilled in the same manner with standard (e.g. paper-pencil) tools, there's little use in complicating it with using ICT. Gathering data from different teams or collecting information to share and work with creates extra value.
- Collaboration is pro: collaborative tools can support the group dynamic of a project and extend it over the lessons itself.
- Experience tool in class: when introducing ICT tools, a tutorial is not enough. Testing it and starting to work with it are key issues for ongoing use by students.
- Problems with battery life: the main purpose of students' own smartphone is their personal communication. Students might stop using the smartphone in class to save battery for their afternoon chat. To avoid this, students should be told in advance that there will be a 20 minute smartphone session in class, so that they could charge their phones or deliberately ration their battery time.

Environment

- Teacher ICT skills: the teacher needs to feel comfortable with using the ICT tool for a proper integration. Before starting the teaching sequence in class, the teacher should have spent some time trying out each tool.
- Combine science and ICT classes: the combination of the classes could strengthen the relevance and understanding for the students (e.g. learning the basics of the tools in ICT class and their use in science class).
- Students would prefer smart devices: students would prefer smartphones and tablets, although the integration into a teaching unit is more demanding than for standard (e.g. PC-based) tools
- Awareness of using devices in classroom: creating awareness of using ICT tools in class might animate colleagues to follow and thus gain a general ICT implementation at school.

Taking these factors into account when planning the use of ICT tools in teaching might help to keep the focus on the main task (teaching) and not to create too much distraction. The following section of this guide aims to support the teacher in selecting the appropriate tools for each teaching tasks, the sections Examples of using ICT (page 50ff) and Collection of Best Practice Examples (page 61ff) should help with the integration into the actual teaching process.

3. App Catalogue

Based on the experience with ICT tools that were used in the teaching modules developed within the IRRESISTIBLE project, the following section offers a wide selection of ICT tools fitting very different purposes. For each selected tool some core facts are listed: The title, the operating system, price, author, a brief description of what the tool's key feature is, and a screenshot to give an idea what the tool looks like. Where applicable, an alternative solution is named, sometimes with a different operating system, sometimes a different tool with a similar functionality. When looking for further options, visit the site of the tool in the relevant app store and have a look at the section of comparable tools that is proposed by the store.

A little hint for Android users: When searching the Google Play Store using your Android device, it'll only show the apps working on your device. If you search for tools in general, use a browser to get the full program.

Table 1: Overview of the tools presented in the app catalogue and indication of operating systems they could be used on.

Category	Program / App	Android	iOS	Browser	Program install.	page
Project Tools	Mindomo	X	X	X	-	15
	Popplet	-	X	X	-	15
	Groupboard	X	X	X	-	16
	Trello	X	X	X	-	16
	Evernote	X	X	X	X	17
	Squid	X	(X)	-	-	17
	Board Cam Pro	-	X	-	-	18
Image and Video Work	Lapse It	X	X	-	-	18
	1 Second Everyday	X	X	-	-	19
	Pics Art	X	X	X	-	19
	iMovie	(X)	X	(X)	-	20
Measuring	Photo Ruler ABC	(X)	X	-	-	20
	OSMTracker	X	(X)	-	-	21
	iMetalBox	(X)	X	-	-	21
	Accelerometer Analyzer	X	(X)	-	-	22
	Oscilloscope	X	(X)	-	-	22
	Signal Generator	X	(X)	-	-	23
	Light meter	X	(X)	-	-	23
Simulation	Changers CO ₂ Fit	X	X	(X)	-	24
	Scratch	(X)	(X)	X	-	24
	Algodoo	(X)	X	-	X	25
	Geogebra	X	X	X	-	25
	Sun Surveyor lite	X	X	-	-	26
	Sun Position and Sunrise	X	X	-	-	26
	VeggieTizer	X	-	-	-	27
Mobile Office	Eat Low Carb	-	-	X	-	27
	Prezi (Viewer)	X	X	X	-	28
	Google Docs, Sheets & Slides	X	X	X	X	28
Collaborative Work	CamScanner	X	X	-	-	29
	Skype	X	X	-	X	29
	Mind42	X	(X)	X	-	30
e-Learning System	Google Docs	X	X	X	X	30
	Mahara ePortfolio	X	X	X	-	31
	Edmodo	X	X	X	-	31
Knowledge	GoConqr	X	X	X	-	32
	Wikipedia Mobile	X	X	X	-	32
	Merck PTE	X	X	-	-	33
	Formulas Free	X	X	-	-	33
	Physics Formulas Free	X	X	-	-	34
	Khan Academy	X	X	X	-	34
Tools	Sky Map	X	X	-	-	35
	Quick Graph	(X)	X	-	-	35
	Universal Converter free	X	X	-	-	36
Exhibitions	i-nigma	X	X	-	-	36
	QR Code Generator	(X)	(X)	X	-	37
	Glogster	X	X	X	-	37
	Open Exhibits PLAYER	-	X	X	X	38
Add-on	Open Exhibits SDK	-	X	X	X	38
	SPARKvue	-	X	-	-	39

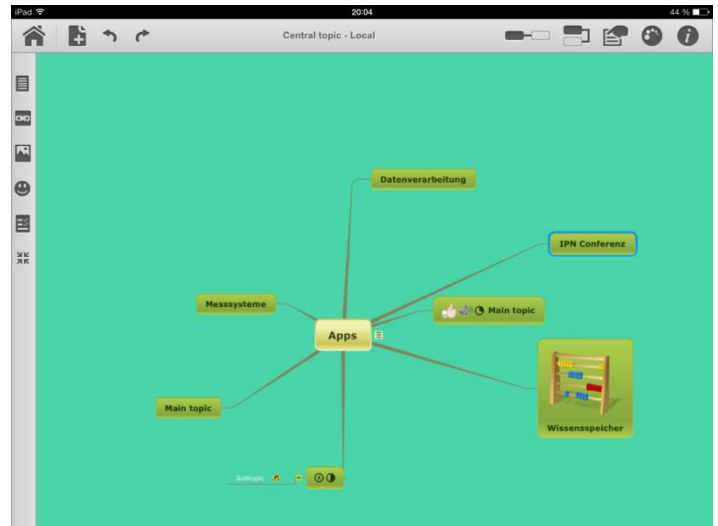


Mindomo
Mind mapping

Project Tools

Operating system(s): Android, iOS
 Language: English
 Price: free; Author: Expert Software Applications Srl
 Alternative solutions: NeuronalMind42 (Browser, Android) / Simple Mind + (iOS)

Collect all your thoughts (not only text, but also photos, URL's, audio etc.) in a mind map and share them with your friends. Mindomo is easy to use and versatile in the incorporation of different data formats. It also allows to do interactive presentations and to work together with others on the same map.



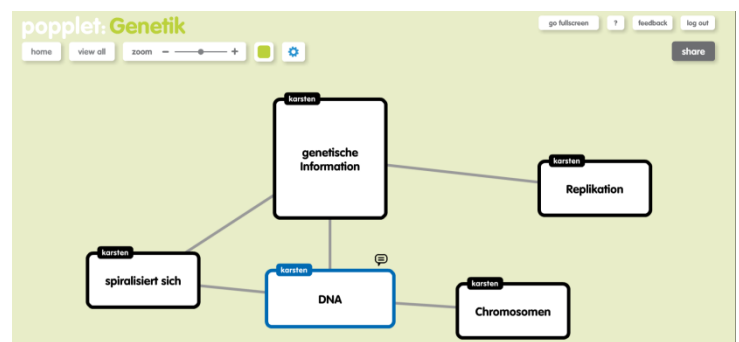
Popplet
Concept mapping

Project Tools

Operating system(s): Browser, iOS
 Language: English
 Price: free (lite Version, just one popplet; for more 4.99€); Author: Notion Inc.
 Alternative solutions: cmap (Browser)

Popplet is a tool that allows users to visualize ideas. Creating graphic organizers, timelines, and many other forms of visual organization supports structuring ideas and teaching. Popplet is a collaborative brainstorming tool and at the same time a presentation tool. It is available as an app for iPad, iPhone and has a browser interface.

(see Best Practice Examples, page 67)





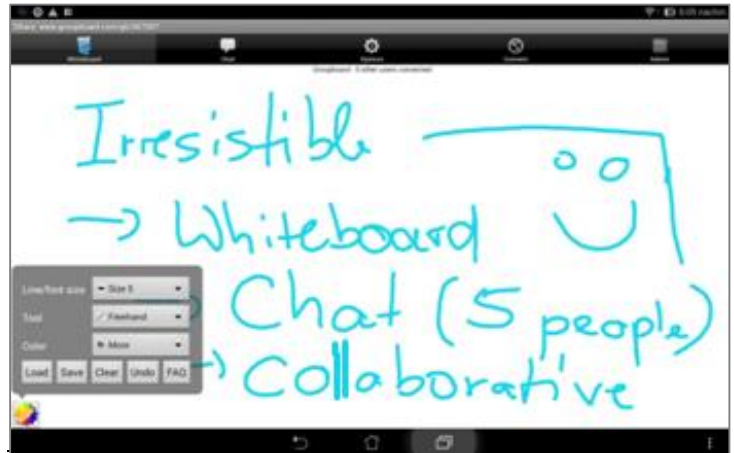
Groupboard

Interactive and collaborative whiteboard

Project Tools

Operating system(s): Android, iOS, Browser
 Language: English
 Price: free; Author: Yuansheng Chen
 Alternative solutions: Twiddla (Browser)

Groupboard is a tool for creating and sharing whiteboard content. You can create whiteboards containing sketches, text, and photos. Sharing them with other Groupboard users (up to 5) is easily done by creating an own (or guest) account. The chat-function is really helpful while collaboratively creating and discussing the content.



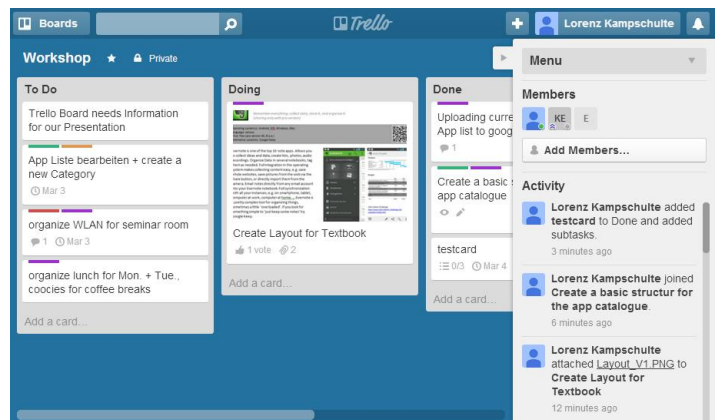
Trello

Organize a project, keep track of progress, work on tasks collaboratively

Project Tools

Operating system(s): Android, iOS, Browser
 Language: English
 Price: free; Author: Fog Creek Software
 Alternative solutions: Edmodo

Trello helps you to create the organizational structure of your project. Create lists, e.g. 'ToDo', 'Doing', 'Done', 'Things-to-remember' etc. Create single tasks (called cards), add photos, checklists, mark them with different colors, schedule them etc. Structure the cards in the lists, according to project progress. Invite coworkers to participate in the board, to create their own tasks, to comment tasks and mark project progress in the tasks.





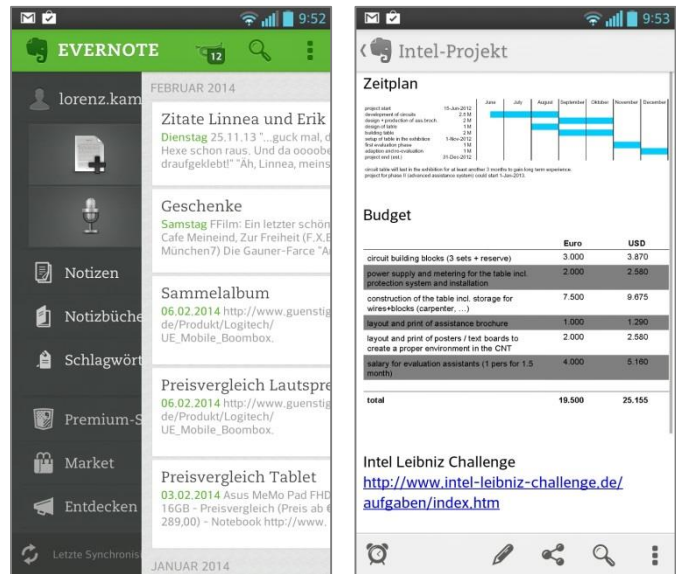
Evernote

Remember everything: collect data, store it, and organize it.

Project Tools

Operating system(s): Android, iOS, Browser; Program install
 Language: English
 Price: free; Author: Edmodo inc.
 Alternative solutions: Google Keep

Evernote is one of the top 10 note-taking apps. Allows you to collect ideas and data, create lists, photos, audio recordings. Organize Data in several notebooks, tag them as needed. Full integration in the operating system makes collecting content easy, e.g. save whole websites, save pictures from the web via the share button, or directly import them from the camera and share them with friends. This app allows for collaborative work. Email notes directly from any email account into your Evernote notebook. Full synchronization with all your devices, e.g. on smartphone, tablet, computer at work, computer at home etc. Evernote is a pretty complex tool for organizing things, sometimes a little 'overloaded'. If you look for something simple to 'just keep some notes' try Google Keep.



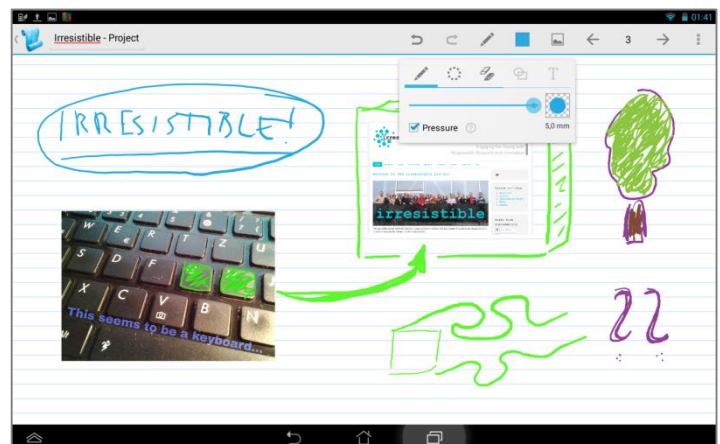
Squid

Sketchbook style note app with easy export

Project Tools

Operating system(s): Android
 Language: English
 Price: free; Author: Steadfast Innovation, LLC
 Alternative solutions: Smart Note (iOS)

Squid is an easy to use App for sketching and creating simple collages, include photos (+ cut, rotate etc.). Create different sketchbooks with several pages. Very acute finger / pen pressure recognition allows elegant sketching (depends also on the touchscreen of your device). Export single pages or the whole sketchbook in .pdf, .png or .jpg format.





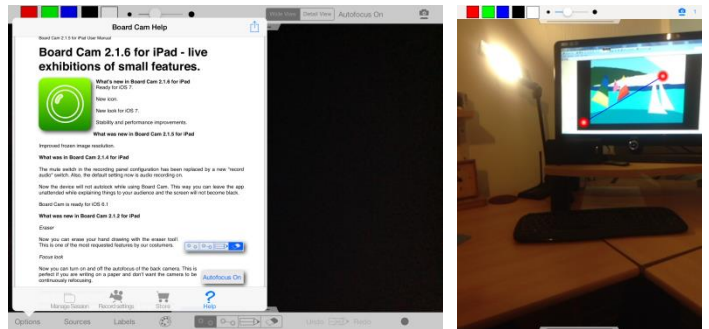
Board Cam Pro

Live notes as virtual 2nd layer on a running experiment

Project Tools

Operating system(s): iOS
 Language: English
 Price: 1.99€; Author: Juan Luis Herrera Cortijo
 Alternative solutions: -

Board Cam allows you to make notes directly on the video recorded by the camera. This allows for instance to do an experiment with a ball rolling down a slope and stopping at different positions at each run. You can mark the end position and see how they differ. The screen can be transferred to a projector, so students can follow even in a classroom.



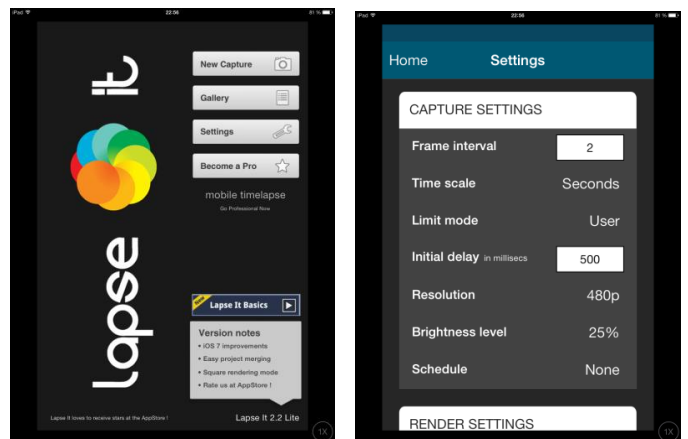
Lapse It

Time lapse & stop motion

Image Work

Operating system(s): Android, iOS
 Language: English
 Price: free; Author: Interactive Universe
 Alternative solutions: Droid Timelapse (Android)

Lapse It is a tool to create time lapse or stop motion movies. Take photos every few seconds, and render them to a movie. So you can follow a 1h sunrise in 3 minutes. Or you can investigate the movement of a sunflower head during a sunny day. Or, with lots of time (and an extra smartphone) follow seedlings growing. If you don't want to use your phone for longer term experiments, there's a lot of webcam based time lapse tools for your computer, or have a look at your photo camera, quite a few have a time lapse function integrated (see e.g. en.wikipedia.org/wiki/Time-lapse_photography for a start).





1 Second Everyday

Imagine a movie that includes every day of the rest of your life

Image Work

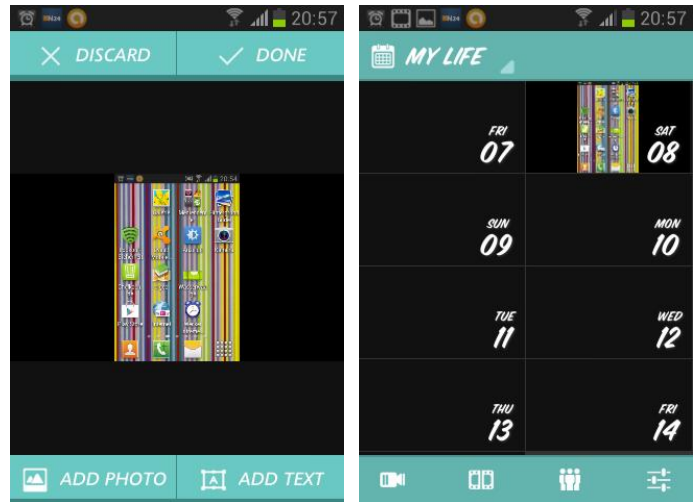
Operating system(s): Android, iOS

Language: English

Price: free (for 1 Month, then 0.89€); Author: Cesar Kuriyama

Alternative solutions: 1 Second Daily Cam (iOS)

Track processes over a longer period of time: Trees getting green in spring, or track the view out of your window over a full season. This App allows you to create multiple timelines in a Video that you can share and save via Google Drive.



PicsArt

All in one image processing app

Image Work

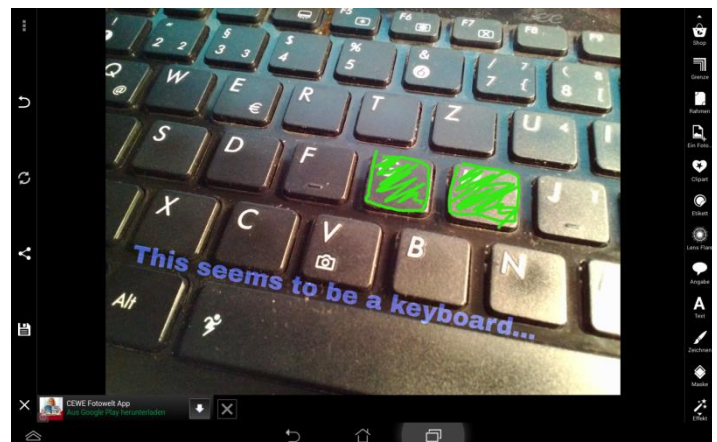
Operating system(s): Android, iOS

Language: various

Price: free; Author: PicsArt

Alternative solutions: Pixlr Express (Android/iOS)

PicsArt is one of the best photo-editing programs for smartphones and tablets, offering a large number of features. Create sketches from scratch, use a photo and rework it, include it in a collage. Share your work in various ways, inside the community or via Twitter and Facebook etc. The camera module included allows to record an interval series of photos, e.g. for tracking a chemical reaction on minute scale and comparing the different states.





iMovie
Intuitive tool for creating and playing movies

Video Work

Operating system(s): iOS
 Language: various
 Price: 4.99€; Author: Apple Inc.
 Alternative solutions: VideoShow Free (Android, free)

iMovie is a tool for creating professional style movies with an iPhone or iPad. It includes a variety of functions for cutting and editing, as well as templates for trailers with matching titles, transitions and music. Finalized movies can easily be uploaded and shared on YouTube, Facebook or Vimeo. The App for iPhone / iPad is compatible with iMovie for Mac allowing e.g. to start with several groups on smart devices and then join and finalize the collaborative movie on a standard computer.



<http://www.apple.com/de/mac/imovie/>

(see Best Practice Examples, page 69)

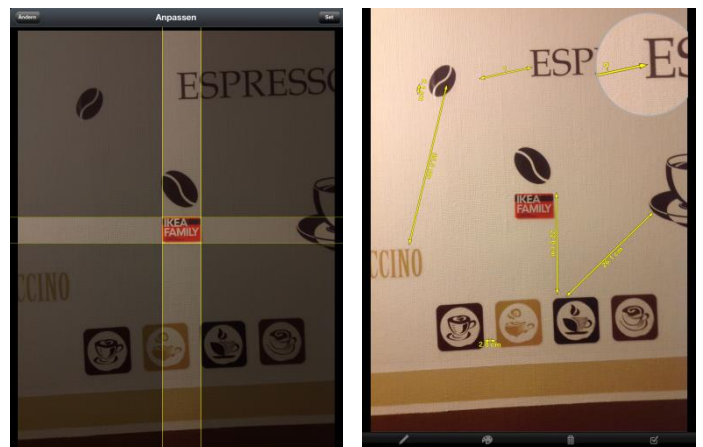


Photo Ruler ABC
Measure your surroundings

Measuring

Operating system(s): iOS
 Language: English
 Price: free; Author: QL Software
 Alternative solutions: Camera Ruler / ON 2D Measure (both Android)

With Photo Ruler ABC you can easily measure dimensions from mm to m scale. It works by including a reference object like a coin, a CD / DVD or DIN A4 paper, into the photo (on the image plane to be measured). The photograph is then referenced to that object and you can measure dimensions. Great for documenting different sized objects, e.g. beetles found on a field trip, or tracking the growth of plants.





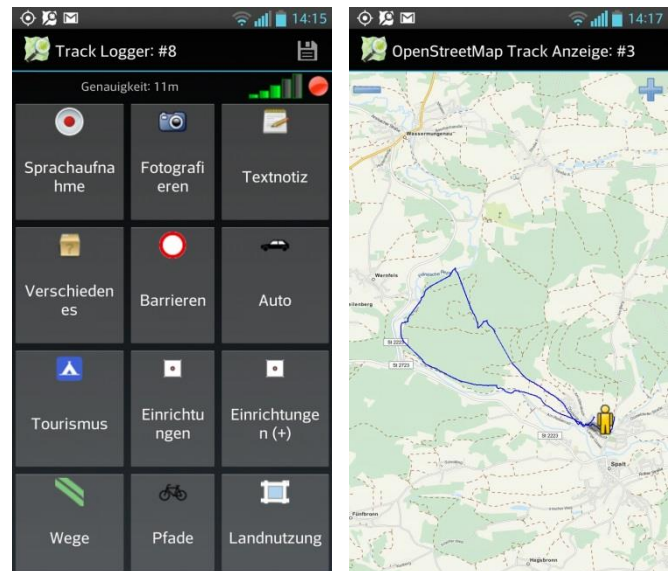
OSMTracker

Track your way

Measuring

Operating system(s): Android
 Language: English
 Price: free; Author: Nicolaus Guillaumin
 Alternative solutions: My Tracks / GPS-Tracks (both Android/iOS)

With OSMTracker you can log a route you have taken with GPS, e.g. while hiking, cycling, or on a scientific field trip. OSM tracker allows you to add points of interest (PoI) alongside the track, e.g. text messages, markers, photos, audio recordings etc. The recorded tracks can be shown in the app, or exported in .gpx format, allowing the further work on them with a multitude of programs (e.g. Google Maps, Google Earth, and many add-ons that build on them).



iMetalBox

Measurement tool box

Measuring

Operating system(s): iOS
 Language: English
 Price: free; Author: Tue Nguyen Minh
 Alternative solutions: Smart Tools (Android)

iMetalBox is a tool box including different measuring devices build on the sensors of your smartphone. iMetalBox includes a Flashlight, Stopwatch, Spirit Level, Ruler, Protractor, and a Compass. Smart Tools for Android is a comparable collection (the full collection is a pay app, but you can download all tools as stand alone measures for free). Be aware that the measuring results are highly influenced by the type of smartphone you use (i.e. the sensors and electronics therein).





Accelerometer Analyzer

Use the internal acceleration sensors of your smart device

Measuring

Operating system(s): Android,
 Language: English
 Price: free; Author: Sora Takayama
 Alternative solutions: Sensor Kinetics / Sparkvue (both Android/iOS)

Accelerometer Analyzer is a tool to log the signals of the accelerometers built in your smartphone. Accelerometer reads out the accelerations in all three spatial directions (x,y,z in m/s^2), shows them in different ways on the screen and writes them alongside with a time stamp to a simple text file on the phone. With this app you could e.g. track the maximum acceleration of elevators, vibrations of a car on different roads, or your walking frequency. The App Sensor Kinetics shows more results derived from the accelerometer and other sensors in your phone, like gyroscope, magnetometer, rotation, and light sensor. Data export is possible with Pro version only (0,76€). Sparkvue is usually meant to be used with external sensors, but works with internal sensors as well (iOS is free).



Oscilloscope

Dual channel oscilloscope w/o extra hardware

Measuring

Operating system(s): Android
 Language: English
 Price: free; Author: UberApp
 Alternative solutions: iMSO Oscium (iOS, needs additional hardware, ~ 270 €)

This App is a simple dual channel storage oscilloscope. It uses either the internal microphone or some device (microphone) connected to the headphone/mic plug as input. Combine it with a function generator (e.g. the app FuncGen Signal Generator (Crescendo)) and / or a Fourier spectrum analyzer (e.g. the app FFT Spectrum Analyzer (UberApp)) and you'll have an easy set up for simple sound experiments. But be aware that smartphone speakers and microphones are far from perfect tools, especially due to signal transformations built-in to increase speech quality etc.





Signal-Generator

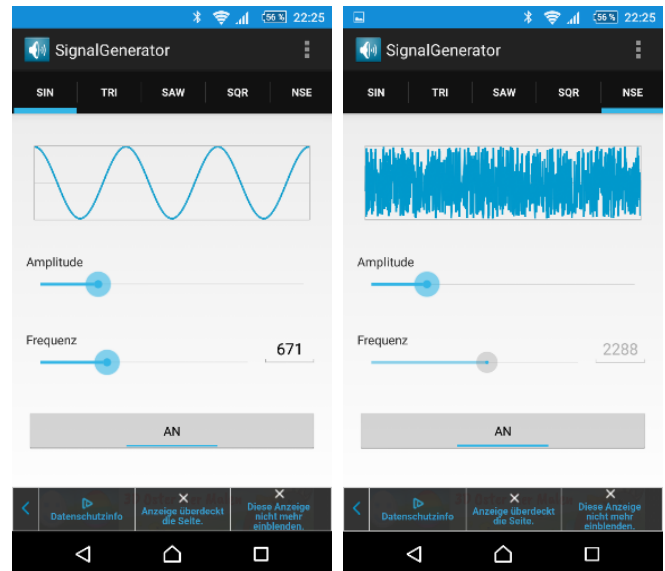
Signal Generator to create reference tones for sound frequency experiments

Measuring

Operating system(s): Android
 Language: English
 Price: free; Author: XYZ-Apps
 Alternative solutions: Signal Generator (iOS)

Signal Generator is an audio tool that creates tones and artificial noise for sound frequency research projects and general audio tests.

The app allows the user to create sine waves, triangle waves, sawtooth waves and square waves with variable frequency and amplitude. Additionally a white noise signal can be generated, e.g. to include an artificial disturbance in your experimental setup.



Light Meter

Measuring the light intensity

Measuring

Operating system(s): Android
 Language: English
 Price: free; Author: Keuwlsoft
 Alternative solutions: my LightMeter free (iOS)

This app measures the intensity of light that shines on your device, using the built-in light sensor. Since the sensors have a relatively small viewing angle, it is not only possible to measure the light intensity, but also to check the intensity of a point light source in relation to the incident angle, e.g. when determining the best position for solar cells. In the lower area, the app tracks the intensity over time, which helps finding intensity maxima or minima.

(see ICT Examples, page 56)





Changers CO₂ Fit

Track how much CO₂ you can reduce and collect ReCoins.

Measuring

Operating system(s): Android, iOS

Language: various

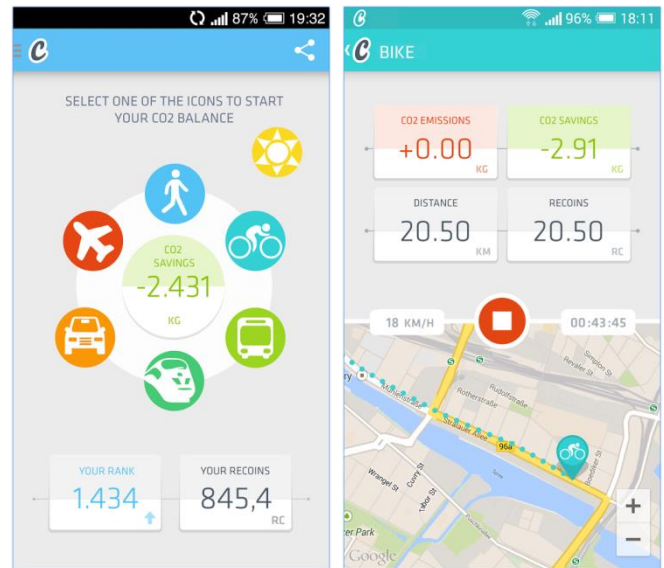
Price: free; Author: BlackSquared

Alternative solutions: -

The app is made for tracking personal travel and calculating the CO₂ used for that. When starting a tour, you just tap a mode of transportation, and the app will calculate the CO₂ footprint using GPS signals.

A social community attached to the app allows you to compete with others. It is also possible to collect rewards for a sustainable way of travelling: green bonus points called ReCoins can be collected and traded in for “CO₂-neutral” travels.

(see ICT Examples, page 58)



Scratch

Create stories, games, and animations

Simulation

Operating system(s): Android, iOS, Browser

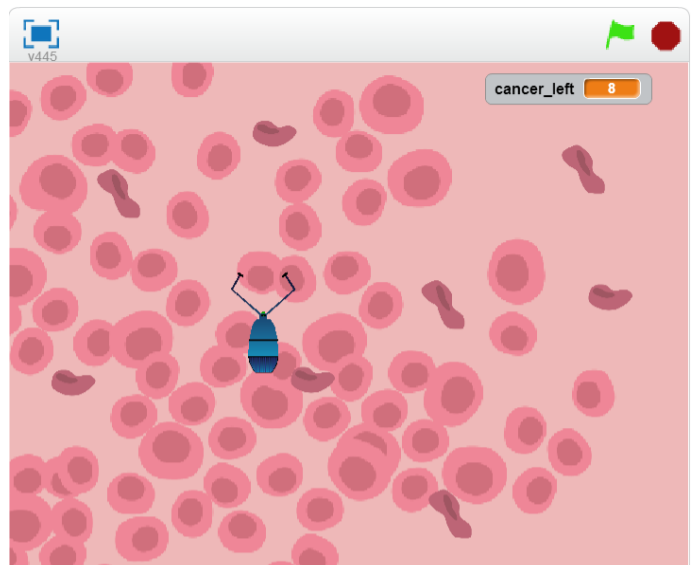
Language: various

Price: free; Author: Scratch Foundation

Alternative solutions: -

Scratch is a programming language and an online community where you can program and share interactive media such as stories, games, and animation with people from all over the world. The graphical programming language based on functional building blocks that are ‘snapped’ to each other was developed at the MIT for the age group 8 to 16 years.

(see Best Practice Examples, page 72)





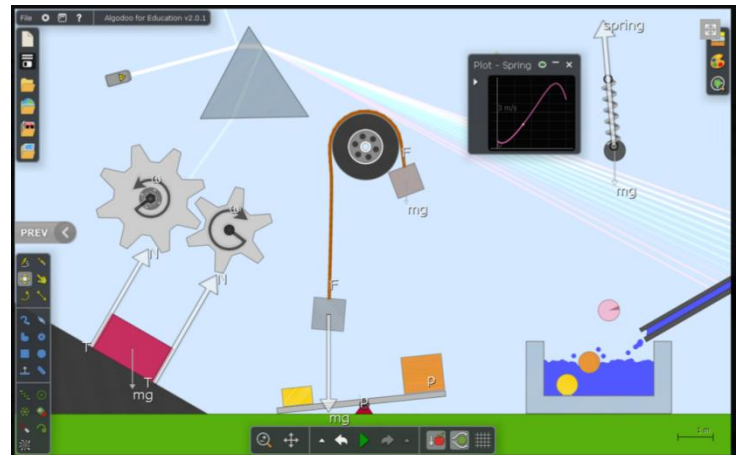
Algodoo

Physics 2-D Simulation

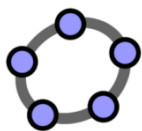
Simulation

Operating system(s): Windows, Mac, iOS
 Language: English
 Price: free (iOS-Version 4.99€); Author: Algorix Simulation AB.
 Alternative solutions: Physics Sandbox Free (Android)

Algodoo is a 2D simulation software allowing a low-threshold and playful approach to engage with physics. From creating mechanical systems with ramps, gears and stimuli to filling water basins and testing if the created objects are swimming or sinking, to playing with light and optical tools – with Algodoo it is possible to simulate very different systems. The range of application in school is wide, from clearly assigned tasks to playful sessions of mechanical construction.



<http://www.algodoo.com/what-is-it/>



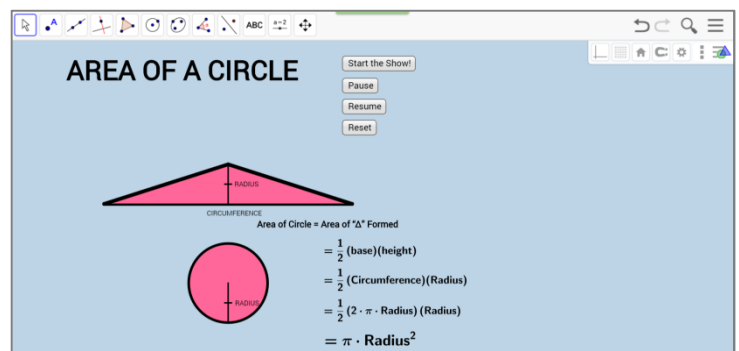
Geogebra

See, touch and experience math.

Simulation

Operating system(s): Android, iOS, Browser
 Language: English
 Price: free; Author: International GeoGebra Institute.
 Alternative solutions: -

Geogebra is dynamic mathematics software for geometry, algebra, tables, statistics and analysis. It could be seen as a link between geometry and algebra. Interactive learning, teaching, and practice materials created with GeoGebra can be exchanged and shared freely on www.geogebra.org. Students can see, touch and experience mathematics.





Sun Surveyor

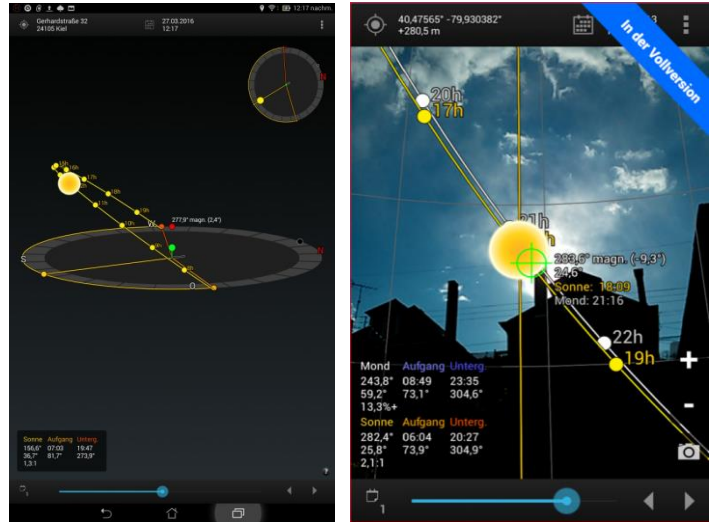
Follow the path of the sun

Simulation

Operating system(s): Android, iOS
 Language: English
 Price: free; Author: Adam Ratana
 Alternative solutions: Sun position and sunrise (Android)

Sun Surveyor Lite predicts and visualizes sun, sunrise and sunset positions and times with a 3D Compass. Sun Surveyor Lite is thus useful for locating of venues for film and photography, for the orientation of solar panels, in architecture, horticulture, real estate, for geography geeks and more.

(see ICT Examples, page 53)



Sun Position and Sunrise

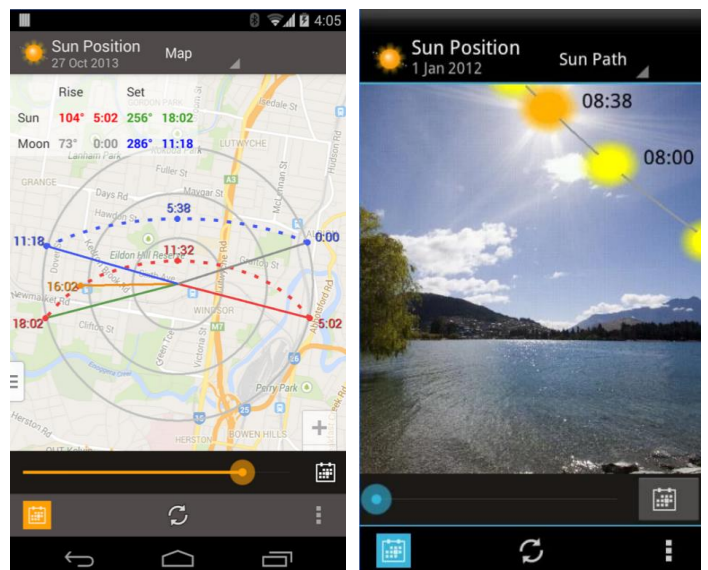
The universe in your pocket

Simulation

Operating system(s): Android, iOS
 Language: English
 Price: free; Author: Stonekick
 Alternative solutions: Sun Surveyor

Sun Position shows you sunrise and sunset and the solar path on an augmented reality camera view for each day of the year at your current location. Your handy screen also gives you other useful information including golden hour and twilight times.

(see ICT Examples, page 53)





Veggietizer

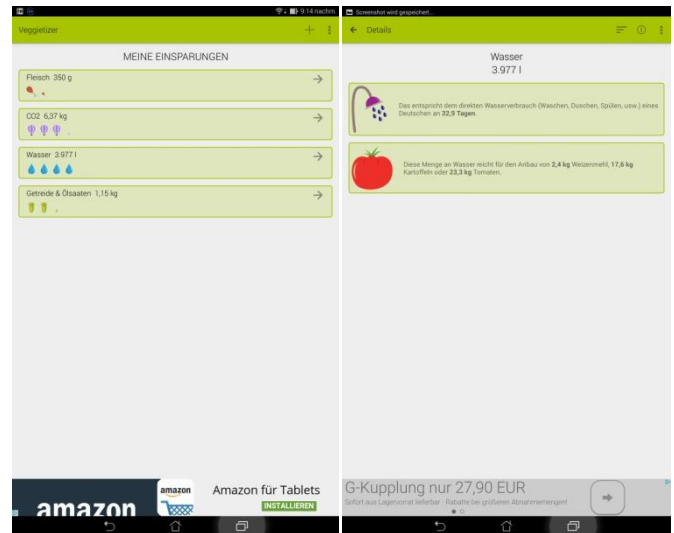
It is hard for you to resist meat, but have a look how much CO₂ you can save by being a vegetarian.

Simulation

Operating system(s): Android,
Language: various
Price: free; Author: FreeRunning Apps
Alternative solutions: -

See how much CO₂, water and feeding stuff you can save. Have a look at all savings using practical examples and do some simple statistics. Read some carefully researched background information and unlock 18 funny dates with interesting facts.

(see ICT Examples, page 59)



Eat Low Carbon

Food choices to reduce climate change

Simulation

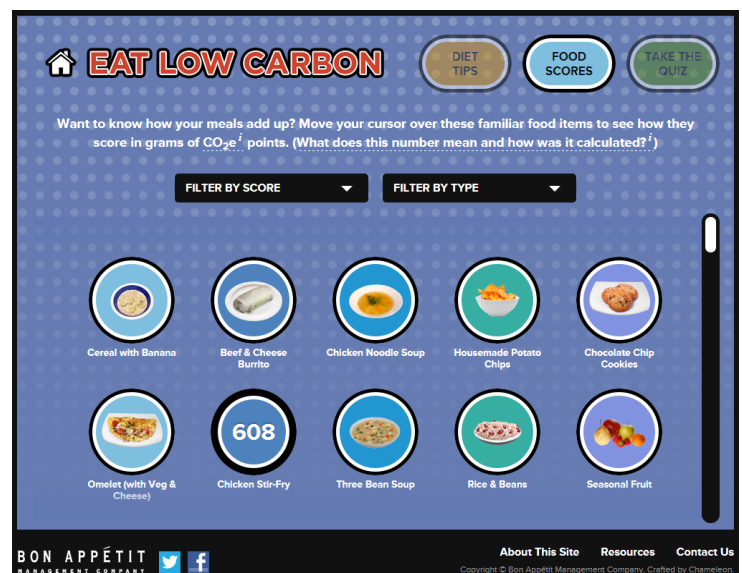
Operating system(s): Browser
Language: English
Price: free; Author: Bon Appétit Management
Alternative solutions: -

Each food item you can find on this website represents a specific amount of the greenhouse gas carbon dioxide. Choose your menu and explore how much CO₂ is released by eating it – or try to minimize your CO₂ footprint and choose a low carbon menu.

The calculation includes the energy that is needed for production, transportation, processing and cooking.

You can also calculate an average CO₂ footprint for your daily food ration.

(see ICT Examples, page 59)



<http://www.eatlowcarbon.org/food-scores/>

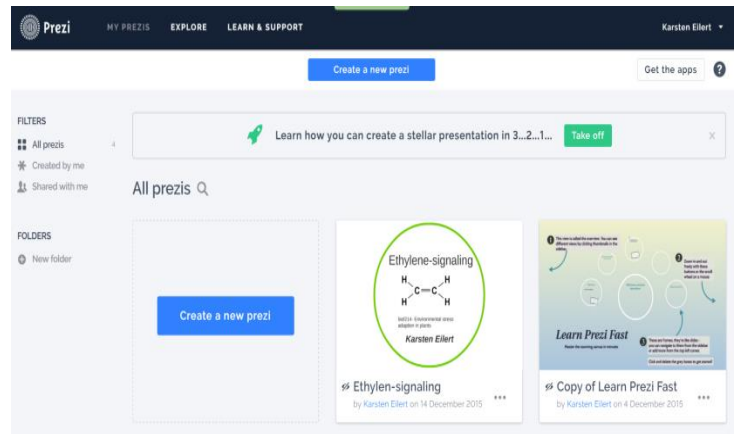


Prezi
visual storytelling, not just a presentation

Mobile Office

Operating system(s): Android (Viewer), iOS (Viewer) & Browser
 Language: varios
 Price: free; Author: Prezi Inc.
 Alternative solutions: Google Slides

Prezi is a visual storytelling program for presentations. It allows the user to create a quick and attractive access to all kinds of content. The presentations can easily be adapted to different audiences by using a variable depth of information – e.g. by giving a brief overview and digging deeper in topics that are more relevant for the target group.



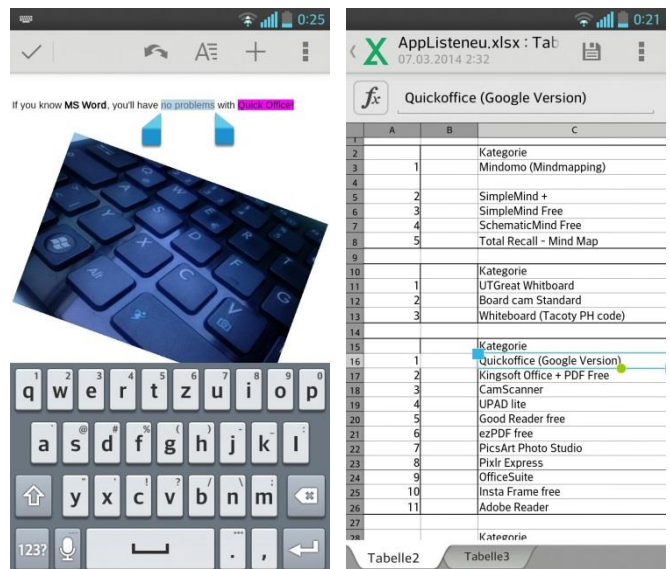
Google Docs, Sheets and Slides

A free mobile office solution that works

Mobile Office

Operating system(s): Android, iOS; Browser
 Language: various
 Price: free; Author: Google Inc
 Alternative solutions: Office Suite (Android/iOS)

A free, simple and working office solution for smartphones and tablets. Although more special functionalities of Microsoft Office are not supported, it allows you to work with general documents and shows standard formatted tables, text and slides mostly correct (which many mobile office versions don't do). Easy sharing and collaborating due to synchronization and sharing functions of Google Drive.





CamScanner – Phone PDF Creator

Smart and intelligent document administrator

Mobile Office

Operating system(s): Android, iOS

Language: various

Price: free (pro version 4,49 € per month); Author: IntSig Information Co.,Ltd

Alternative solutions: Foxit PDF Camera + Foxit MobilePDF (Android)

Scan documents, whiteboards, blackboards, pictures etc. with your smartphone camera and directly create .pdfs out of it. Nice tool for cutting the page area and increasing readability. The free version can export/share as .jpg without, or as .pdf with a watermark on the lower end of the page. The OCR function allows to search the scanned .pdfs, although not perfect. Automatic upload to different Cloud spaces, multiple ways of sharing the documents and comments, with the possibility of others commenting on the shared documents in the same document.



Skype

Video communication made simple

Collaborative work

Operating system(s): Browser, Android, iOS

Language: English

Price: free; Author: Microsoft Inc.

Alternative solutions: Google Hangout, Apple Facetime

You can use Skype to conduct teleconferences with experts, friends or family far away. Take collaboration to another level. Share screens and create new ideas together. Send photos and files of any size and keep the ideas flowing. With the newer versions of Skype videoconferences with a group of people are possible.

(see Best Practice Examples, page 65).



<https://www.skype.com/de/>

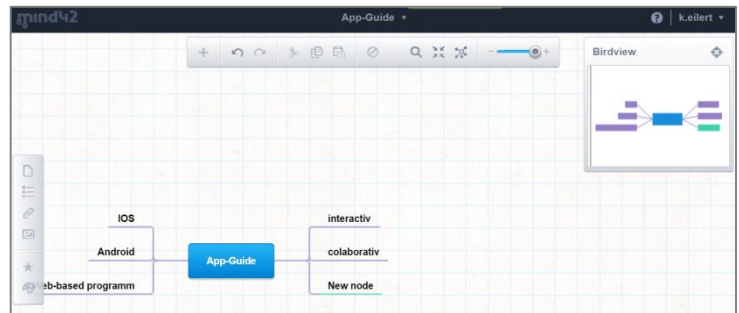


Collaborative work

Operating system(s): Browser, Android (NeuronalMind42)
 Language: English
 Price: free; Author: Stefan Schuster & IRIAN Solutions GmbH
 Alternative solutions: Mindmeister (also Browser, Android, IOS)

Mind42 is a free web application for collaborative mind mapping. One specialty of the program is that you can share your map with other users and also work in groups on the same map, at the same time. All editors can add a new topic to a mind map, or deepen existing thoughts, while seeing the changes of others.

You just have to start your browser or the app on your smart device (Android: NeuronalMind42).



Free registration at mind42 is needed.

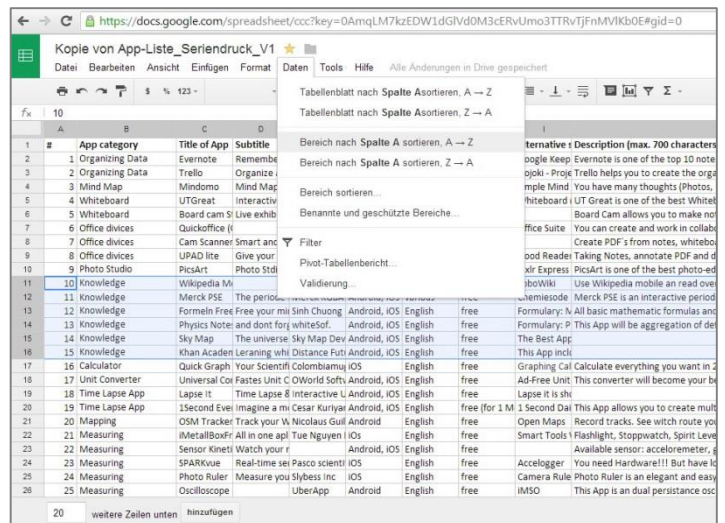


Google Docs
Simultaneously working on the same (web-)documents

Collaborative work

Operating system(s): Browser
 Language: various
 Price: free; Author: Google Inc.
 Alternative solutions: Zoho Office Suite (www.zoho.com)

Easy to use office applications accessible via web browser (Chrome works best). Good integration and accessibility from mobile systems, simple sharing, 15Gb of free Cloudspace. With Google Forms it's easy to create (online) questionnaires and analyze them. Teams can collaboratively work on the same document at the same time. Gmail account is needed.





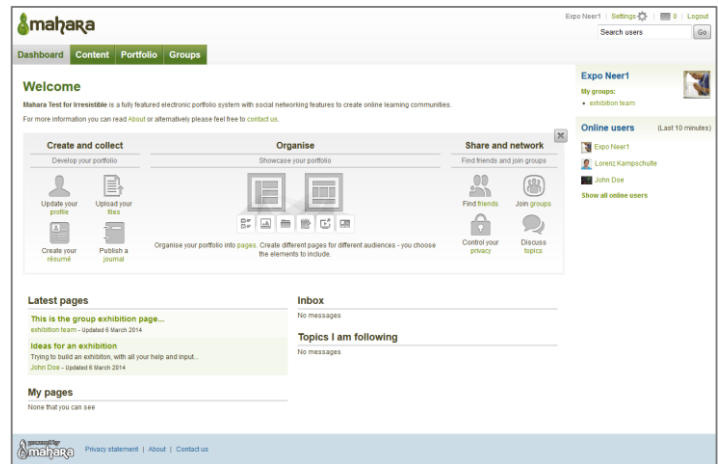
Mahara ePortfolio

Web2.0 in a nutshell: ePortfolio system plus safe social network

e-learning Systems

Operating system(s): Browser, Upload tools for Android (MaharaDroid) and iOS (PortfolioUP!)
 Language: various
 Price: free; Author: Mahara Open Source Community
 Alternative solutions: Edmodo, Google Classroom

Mahara is an ePortfolio system that is explicitly developed as a learner centered system to form a Personal Learning Environment (in contrast to Learning Management System (LMS) like Moodle). It offers a dazzling array of functions, with the core being an ePortfolio system and a shielded social network with tools such as journals (private / internal), a blogging tool, easy to program (drag-and-drop) web pages (privat / internal / external), collaborative work pages, a resume builder etc. Mahara can be used as stand-alone system or be integrated in a larger network, e.g. with it's 'sister' application Moodle. It usually needs a Linux Server (Ubuntu, Debian), but can also be run on most shared webhosting and Windows systems.



Edmodo

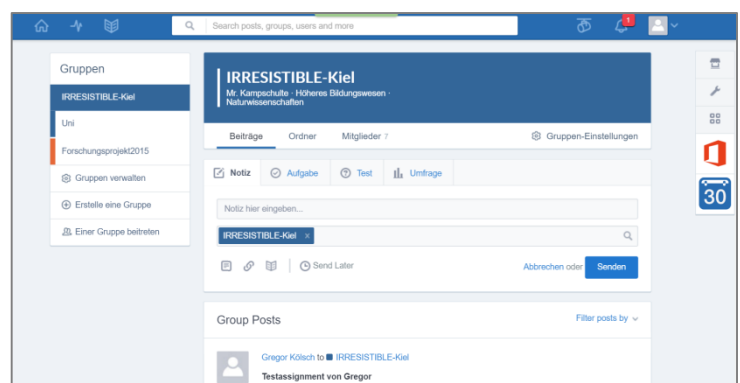
Create secure groups that take learning beyond the classroom

e-learning Systems

Operating system(s): Android, iOS, Browser
 Language: English
 Price: free; Author: Edmodo inc.
 Alternative solutions: Mahara, Google Classroom

Edmodo is a social learning network that takes learning beyond the classroom by providing a safe place for teachers and students to connect and collaborate – anytime, anywhere. You can create a group for your students, where they find worksheets, presentations or homework. It is also possible to assign tasks with a due date and to create short quizzes. Your students will find everything they need for the next exam, homework or group work.

(see Best Practice Examples, page 62ff)



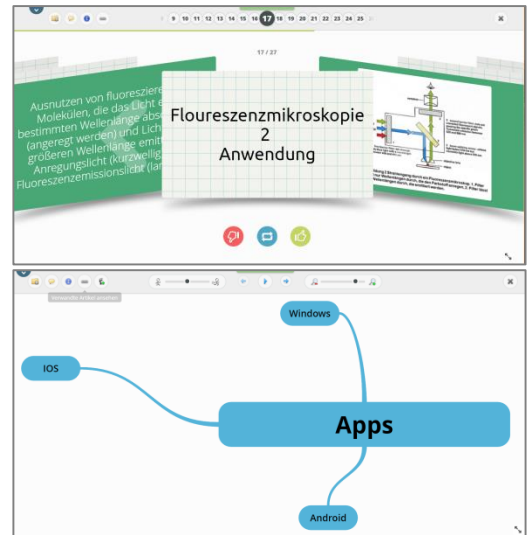


GoConqr
Interactive and collaborative whiteboard

e-learning Systems

Operating system(s): Android, iOS, Browser
 Language: English
 Price: free; Author: ExamTime
 Alternative solutions: Edmodo, Mahara, Google Classroom

GoCondr is a platform that turns learning into an active and entertaining process. Teachers can create a connected and digital classroom for learning including resources, tests, homework and quizzes. Students can organize their learning in mind maps, flashcards, slide sets and notes and share it with classmates or friends. They can track their learning progress, create a study-planer and start discussions for a collaborative learning process.

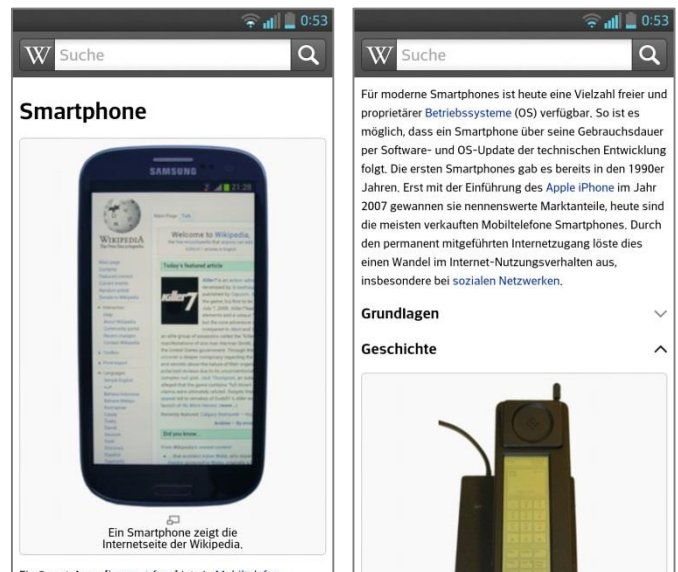


Wikipedia Mobile
Wikipedia easily accessible in your pocket

Knowledge

Operating system(s): Android, iOS
 Language: various
 Price: free; Author: Wikimedia Foundation
 Alternative solutions: LoboWiki (Android)

Use Wikipedia mobile and read over 20 million articles. Save articles to read later offline, search related articles. Share articles (links) in various ways. On aged phones, the app is much faster than using a browser.





Merck PTE

The periodic table, presented in a nice way

Knowledge

Operating system(s): Android, iOS
 Language: various
 Price: free; Author: Merck KGaA
 Alternative solutions: Chemisode (iOS)

Merck PTE is an interactive periodic table with a clean and friendly design. Besides all relevant information usually part of a periodic table, the app includes element features, images, history of discovery, melting and boiling point – you even have a view of the PSE indicating the state of matter of each element at a given temperature. Further the app offers an integrated molar mass calculator. All content is stored within the app, after download no internet connection necessary (due to legal restrictions this app is named EMD PTE in North America).



Formulas Free

All math fomulas in your pocket

Knowledge

Operating system(s): Android, iOS
 Language: English
 Price: free; Author: NSC Co.
 Alternative solutions: Formulary: Math Free (Android/iOS)

The app Formulas Free contains all basic mathematic formulas and many helpful gadgets like calculating the surface area or solving roots / equations. It also includes a simple unit converter. You can share every formula with friends via email, message or facebook.



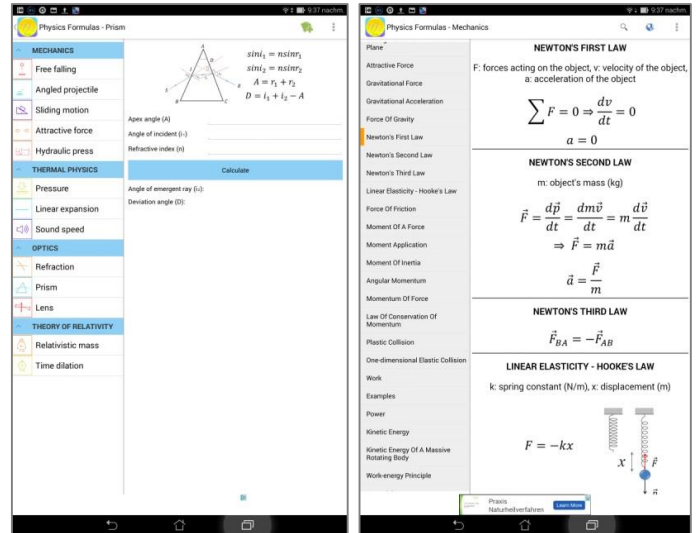
Physics Formulas Free

Physics formulary

Knowledge

Operating system(s): Android, iOS
 Language: English
 Price: free; Author: NSC Co.
 Alternative solutions: Formulary: Physics Free (iOS)

This app is an aggregation of definitions and formulas in basic physics knowledge, somewhere between fomulary and text book. It contains e.g. electricity, magnetism, electromagnetic waves, ray optics etc.



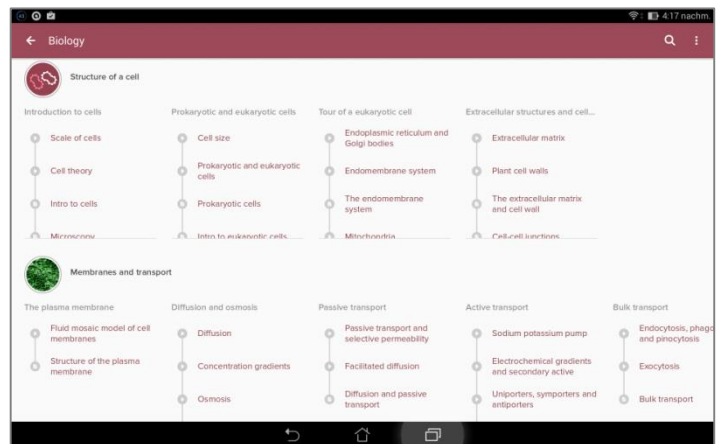
Khan Academy

Learning while watching

Knowledge

Operating system(s): Android, iOS
 Language: English
 Price: free; Author: Distance Future
 Alternative solutions: -

This app offers a huge collection of video lectures. Topics are e.g. mathematics, science, economics, humanities etc. Most lectures include experiments, notes, and pictures.





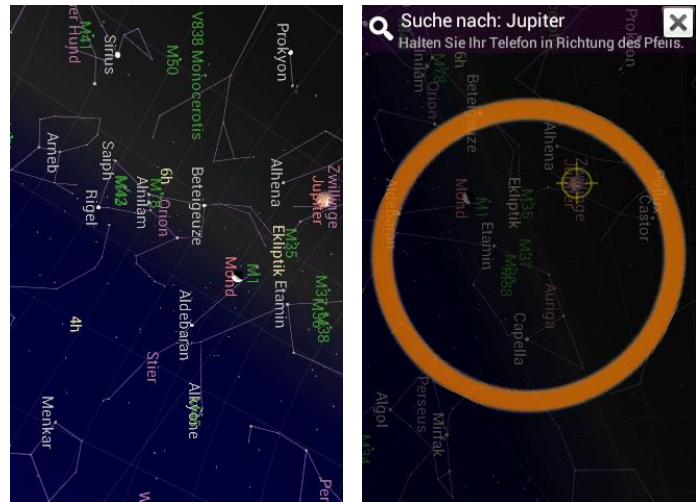
Sky Map

The universe in your pocket

Knowledge

Operating system(s): Android, iOS
 Language: English
 Price: free; Author: Android: Sky Map Devs, iOS: Mobius Entertainment
 Alternative solutions: -

The app offers you navigation through the night sky. It works in two modes: Point your phone to any star or constellation, and it will offer you the solution on the screen. Or search for a star or constellation in the menu, and let it guide you to the object of desire.



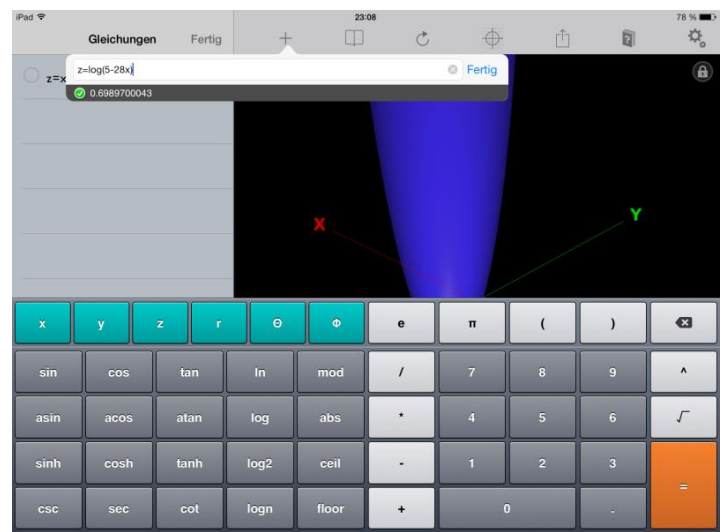
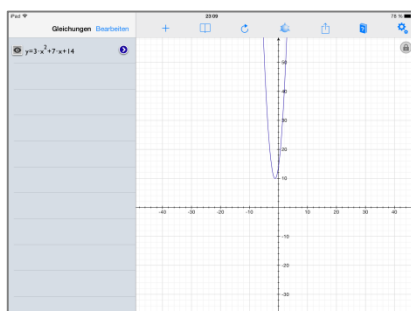
Quick Graph

Capable scientific graphing calculator

Tools

Operating system(s): iOS
 Language: English
 Price: free; Author: Colombiamug
 Alternative solutions: Graphing Calculator (Android)

This scientific graphing calculator offers 2D and 3D equation plotting with wireframe and solid visualization. Supports cartesian, polar, cylindrical and spherical coordinate systems. Includes a library for commonly used equations.





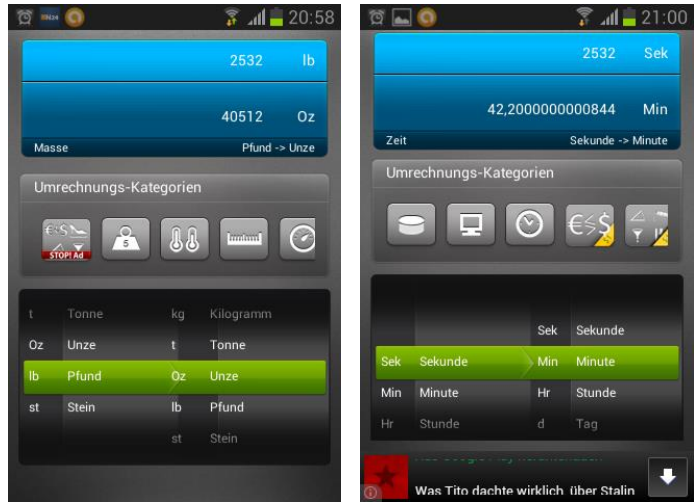
Universal Converter free

Easy-to-use unit converter

Tools

Operating system(s): Android, iOS
 Language: English
 Price: free; Author: OWorld Software
 Alternative solutions: Ad-Free Unit-Converter (iOS)

Universal Converter free is a clearly designed and easy to use app for converting various units. The free app includes e.g. mass, speed, volume, distance, time, temperature.



i-nigma

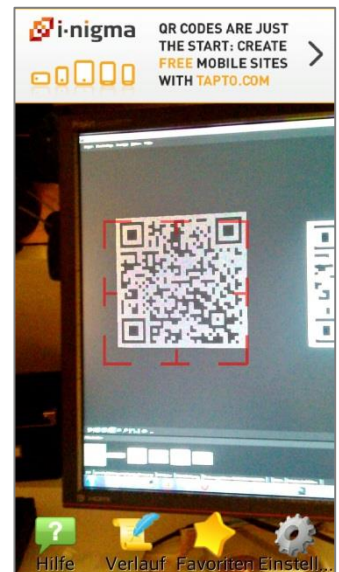
The most widely used mobile barcode reader in the world

Tools

Operating system(s): Android, iOS
 Language: English
 Price: free; Author: 3GVision
 Alternative solutions: Barcode Scanner (Android)

Barcode reader for various code formats, e.g. 1D and 2D codes like QR, DataMatrix, EAN 13 and UPC . Works fast and also pretty well when codes are in bad condition or at low light.

[referring to the ad shown here: Tapto.com offers a system that allows you to easily create simple mobile sites accessible through QR codes for free. This might also be a solution for use in your exhibition project. For details visit www.tapto.com.]



QR Code Generator



Create various QR-codes (www.goqr.me)

Exhibition

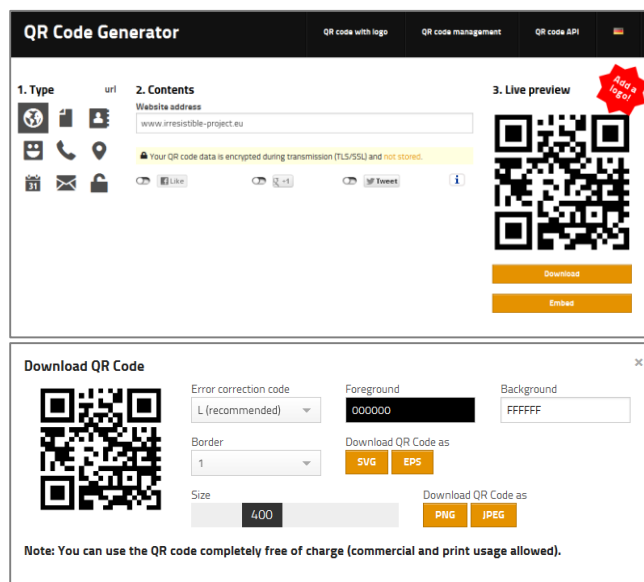
Operating system(s): Browser

Language: English

Price: free; Author: ARSAVA GmbH & Foundata GmbH GbR

Alternative solutions: www.i-nigma.com/CreateBarcodes.html

Create 2D barcodes online. Offers different content formats, e.g. text, URL, vcard, telephone, geolocation, WLAN access data etc. Create codes with a resolution of up to 1000x1000 Pixel, download as .png, .jpg, .svg, .eps files. Different colors are possible, unlimited use, no ads.




Glogster

An interactive poster-session

Exhibition

Operating system(s): Browser, Android, iOS

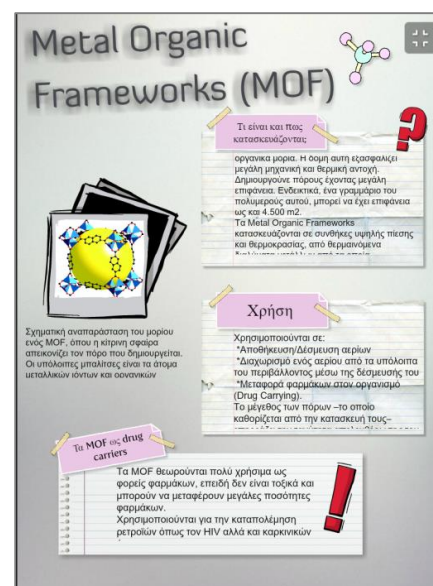
Language: varios

Price: free; Author: Glogster Inc.

Alternative solutions: -

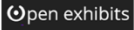
Glogster is a Web 2.0 tool that allows users to create virtual posters combining text, audio, video, images, and hyperlinks and to share them with others electronically.

(see Best Practice Examples, page 74)



Open Exhibits PLAYER

Exhibition



Author/Edit multitouch, multi-user exhibits in CML, GML and CSS
(www.openexhibits.org)

Operating system(s): Windows, Mac OS
Language: English
Price: free; Author: Ideum
Alternative solutions: -

Edit and adapt a multitouch surface without deeper programming skills. The OE Player works comparable to a web browser interpreting XML-based mark-up language and cascading style sheets (CSS). By changing the XML files you can adapt the content, by adjusting the CSS files you can change the look. (OE Player requires Adobe AIR and Windows OS)

Open Exhibits Player 1.1

The Open Exhibits Player allows you to develop exhibits without programming. Like a web browser, the OE player can read XML-based mark-up (CML) and cascading style sheets. Simply edit and load CML files through the player.

The Open Exhibits Player requires [Adobe AIR](#) and Windows OS.

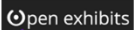


Authors / Editors

[Download OE Player \(PC & Mac\) 1.1](#)

Open Exhibits SDK

Exhibition



Develop multitouch, multi-user exhibits and components
(www.openexhibits.org)

Operating system(s): Windows, Mac OS
Language: English
Price: free; Author: Ideum
Alternative solutions: -

The OpenExhibits Software Development Kit (SDK) allows you to easily program your own multitouch application. The Kit is written in ActionScript. Adobe Flash and Adobe AIR are supported. The OE SDK allows you to develop in the IDE of your choice, but Open Exhibits officially supports the following IDEs: Flash Professional CS5+, FlashDevelop, Flash Builder.

Open Exhibits SDK 3.1

The Open Exhibits Software Development Kit is written in ActionScript. It supports both [Adobe Flash](#) and [Adobe AIR](#).

The Open Exhibits SDK allows you to develop in the IDE of your choice, but Open Exhibits officially supports the following IDEs (Flash Professional CS5+, FlashDevelop, Flash Builder).



Developers

[Download OE SDK \(PC\) 3.1](#)

[Download OE SDK \(Mac\) 3.1](#)



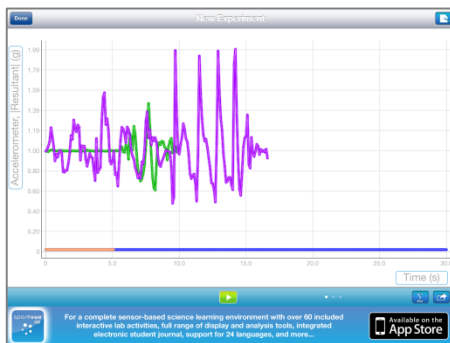
SPARKvue

Real-time sensor-based data collection

Add-On / Measuring

Operating system(s): iOS
 Language: English
 Price: free; Author: Pasco scientific
 Alternative solutions: -

Internal sensors right away, lots of external sensors for measuring various variables. Have a look at: <http://www.youtube.com/watch?v=rnhKwUVJmKw>.



4. Example of an E-Learning Platform

Learner centered e-learning platforms are increasingly becoming an integral part of teaching. Although the idea is not new, in recent years quite a few new platforms have showed up and are competing for the favor of schools and teachers, e.g. Mahara, Edmodo, GoCondr and Google Classroom to name just a few. The following short introduction to the open source platform Mahara will give an overview what an e-learning platform is capable of and how it can be used in teaching.

Short Introduction to the E-Learning Platform Mahara

This really should just be a very brief introduction to give a rough idea of the basic use and capabilities. All information you need you'll find on www.mahara.org. Also, there are many national groups supporting the system and offering tutorials in your language. And you can find a lot of detailed video tutorials on YouTube.

What is Mahara?

Mahara is an ePortfolio system that is explicitly developed as a learner centered system to form a Personal Learning Environment (in contrast to Learning Management System (LMS) like Moodle). It offers a dazzling array of functions: The core components are an ePortfolio system to present, share and exchange information, including a full file repository with upload possibilities from mobile devices. The second large part is a shielded social network with tools such as journals (private/internal), blogs, forums, easy to build web pages (private / internal / external), collaborative work pages, a resume builder, and many more. All the content is easily placed on the pages by drag-and-drop, combining internal (Mahara portfolio) and external (web) content on the same pages. Even external blogs can be embedded on internal pages using RSS feeds. Mahara scales nicely on different systems, so you can work on the web interface from your personal computer, laptop, tablet, and smartphone.

Mahara can be used as stand-alone system or be integrated in a larger network, e.g. with its 'sister' application Moodle. It nicely integrates in Moodle, you can e.g. use the same login accounts and manage them in Moodle, and you can directly link from Moodle pages to Mahara pages.

The System Requirements are not immense, but have in mind that traffic and thus machines load scales with the numbers of users. The Mahara standard setup is to run it on an Apache web server installed on a Linux system (e.g. Ubuntu, Debian), it also needs a database (Postgres or MySQL) installed for managing user data and content. Running it on a separate machine will give you the best performance. But it also works on shared webhosting, and on Windows and MAC operating systems. There are also several hosting companies offering a serviced platform ready to start. See Mahara.org for details. The design of the user interface can be widely customized.

Names and Definitions

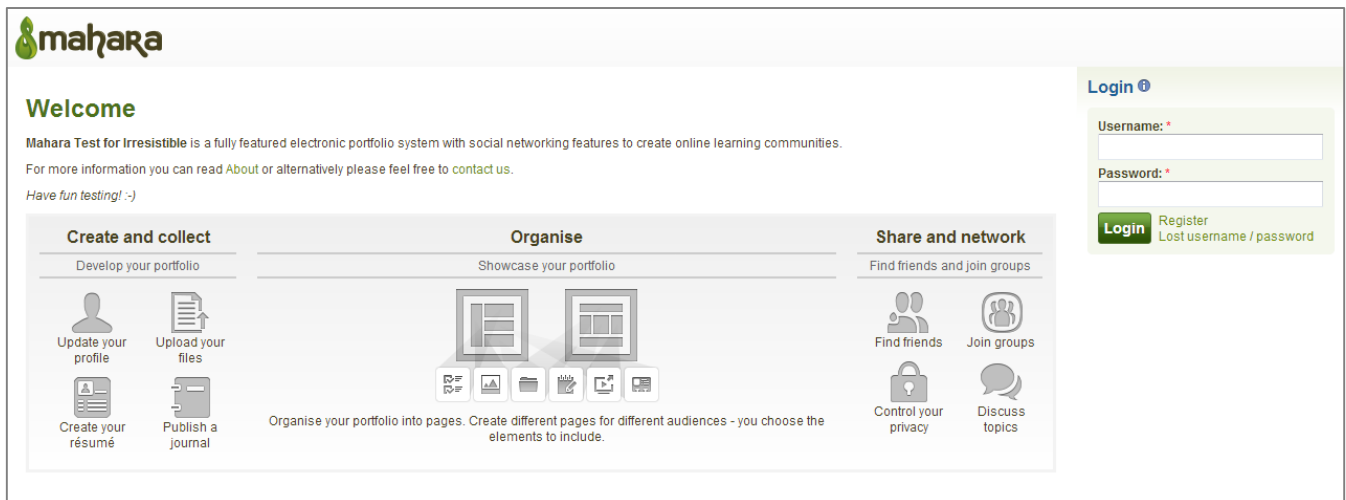
Artefacts	all data created and/or uploaded to Mahara are called artefacts
View	a view is a collection of artefacts, e.g. a journal, a page, a blog entry etc.
Collection	a collection is a set of pages that are linked to one another and have the same access permissions
Sharing	sharing of views and artefacts is possible on several levels: no sharing, sharing with one other member (e.g. sending it to your friend, or submitting it to a tutor), sharing with all your friends, sharing with groups, sharing with all members of the Mahara setup, sharing public (i.e. the web)
Groups	can be created by an admin, or autonomously by users (depends on the admin settings what is allowed). Groups can create own (group) pages, repositories etc.
Forums	can be created by an admin, or autonomously by users, can have public discussion or only restricted to defined members (depends on the admin settings what is allowed)

HowTo's

These HowTo's should allow you to get started with Mahara. Mahara Version 1.8 is the base for this manual.

HowTo: Set up an Account

Go to the main page.



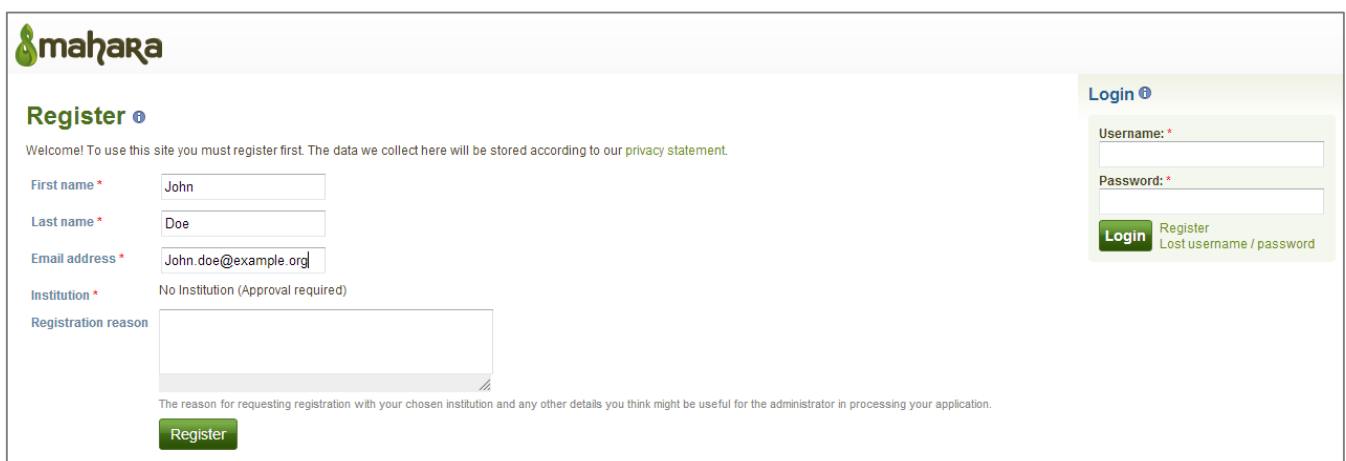
The screenshot shows the Mahara homepage. At the top left is the Mahara logo. Below it is a 'Welcome' message: 'Mahara Test for Irresistible is a fully featured electronic portfolio system with social networking features to create online learning communities. For more information you can read [About](#) or alternatively please feel free to [contact us](#). Have fun testing! :-)'

The main content area is divided into three columns:

- Create and collect** (Develop your portfolio):
 - Update your profile
 - Upload your files
 - Create your résumé
 - Publish a journal
- Organise** (Showcase your portfolio):
 - Organise your portfolio into pages. Create different pages for different audiences - you choose the elements to include.
- Share and network** (Find friends and join groups):
 - Find friends
 - Join groups
 - Control your privacy
 - Discuss topics

On the right side, there is a 'Login' box with fields for 'Username: *' and 'Password: *', and buttons for 'Login', 'Register', and 'Lost username / password'.

Click [Register]



The screenshot shows the Mahara registration page. At the top left is the Mahara logo. Below it is a 'Register' heading and a message: 'Welcome! To use this site you must register first. The data we collect here will be stored according to our [privacy statement](#).'

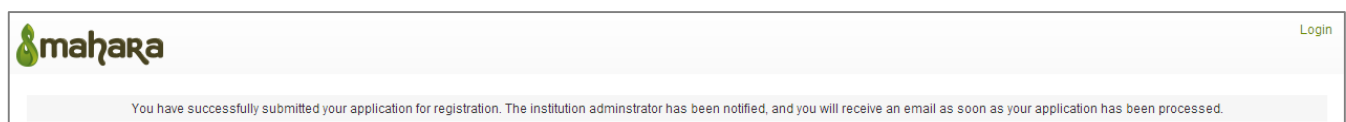
The registration form includes the following fields:

- First name * (filled with 'John')
- Last name * (filled with 'Doe')
- Email address * (filled with 'John.doe@example.org')
- Institution * (filled with 'No Institution (Approval required)')
- Registration reason (empty text area)

Below the form is a note: 'The reason for requesting registration with your chosen institution and any other details you think might be useful for the administrator in processing your application.' and a 'Register' button.

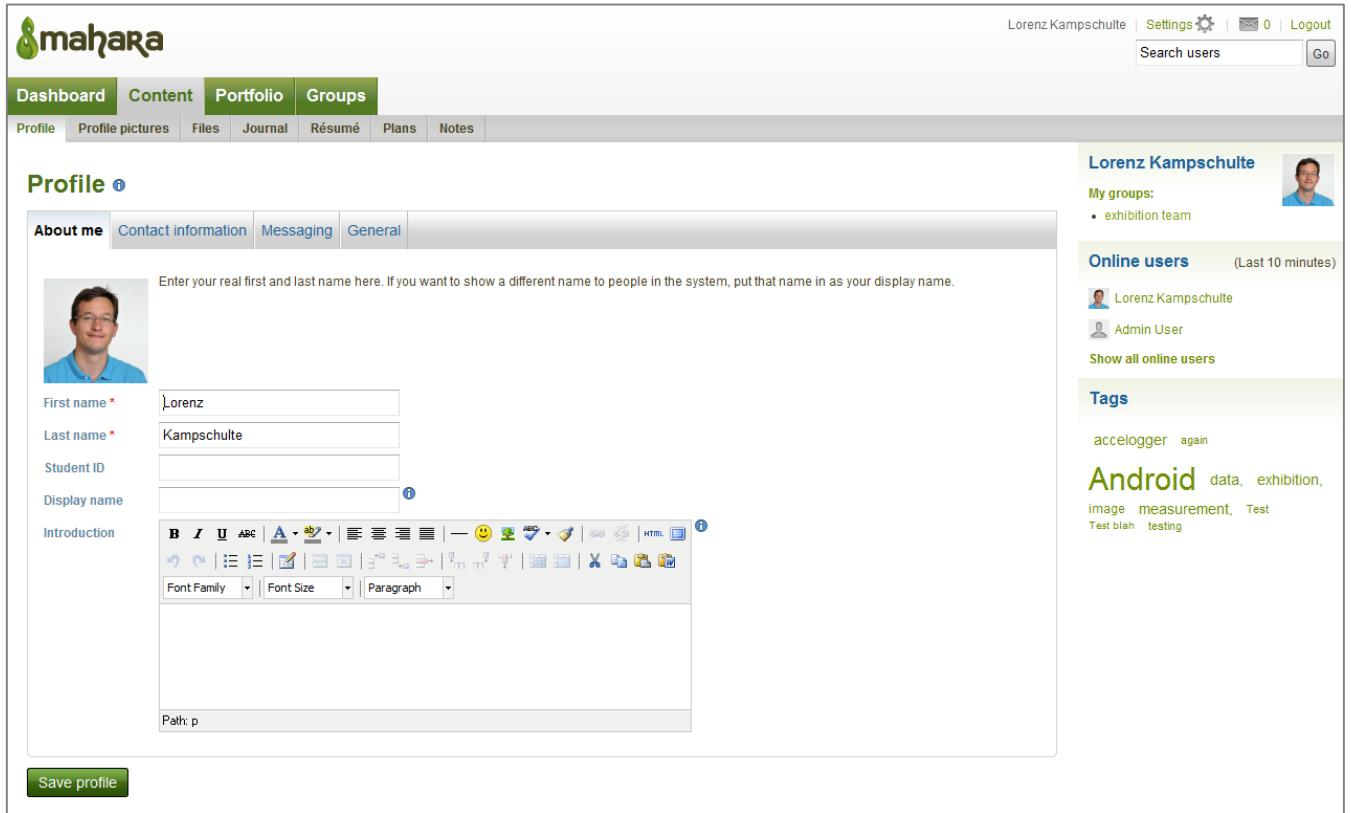
On the right side, there is a 'Login' box with fields for 'Username: *' and 'Password: *', and buttons for 'Login', 'Register', and 'Lost username / password'.

Fill in your data, click [Register].



The screenshot shows the Mahara confirmation page. At the top left is the Mahara logo. At the top right is a 'Login' link. Below the logo is a message: 'You have successfully submitted your application for registration. The institution administrator has been notified, and you will receive an email as soon as your application has been processed.'

Then the admin will get an email, has to approve the request, then you'll get an email with a link to complete the signup process. Clicking this link will guide you to a page asking you to create a user name and a password, and the set up for your profile (e.g. profile picture etc.)



HowTo: General Site Elements

On the Mahara page you have several core elements:

[Dashboard] is your starting / home page, with links to all parts of your Mahara system

The [Content] tab holds all your personal data, e.g. profile, files, journal, resume, plans, notes etc.

The [Portfolio] tab holds all pages and collections you created, and content you share with others. It also gives you export and import options for pages.

In the [Groups] tab you can manage all your contacts: find friends, become member of a group, dismiss membership, create own groups etc.

HowTo: Upload a File

Uploading files is really simple: Go to [Content] → [Files]

The screenshot shows the Mahara user interface for the 'Files' section. At the top, the user is identified as 'Lorenz Kampschulte' with options for 'Settings', 'Logout', and a search bar. The navigation menu includes 'Dashboard', 'Content', 'Portfolio', and 'Groups', with 'Files' selected. Below the navigation, there are tabs for 'Profile', 'Profile pictures', 'Files', 'Journal', 'Résumé', 'Plans', and 'Notes'. The main content area is titled 'Files' and includes instructions: 'Upload your images, documents or other files for inclusion in pages. You can select multiple files to upload them at once. Drag and drop the icons to move files between folders.' There is an 'Upload file' input field with a 'Dateien hinzufügen' button (Maximum upload size 8MB) and a large 'Drop files here to upload' area. Below this is a 'Create folder' button. A table lists the files in the 'Home' directory:

Name	Description	Size	Date
images	Image files		03/03/2014
MobilUploads			03/03/2014
13155.jpg		62.8K	03/03/2014
CAM01670.jpg		3.8M	03/03/2014

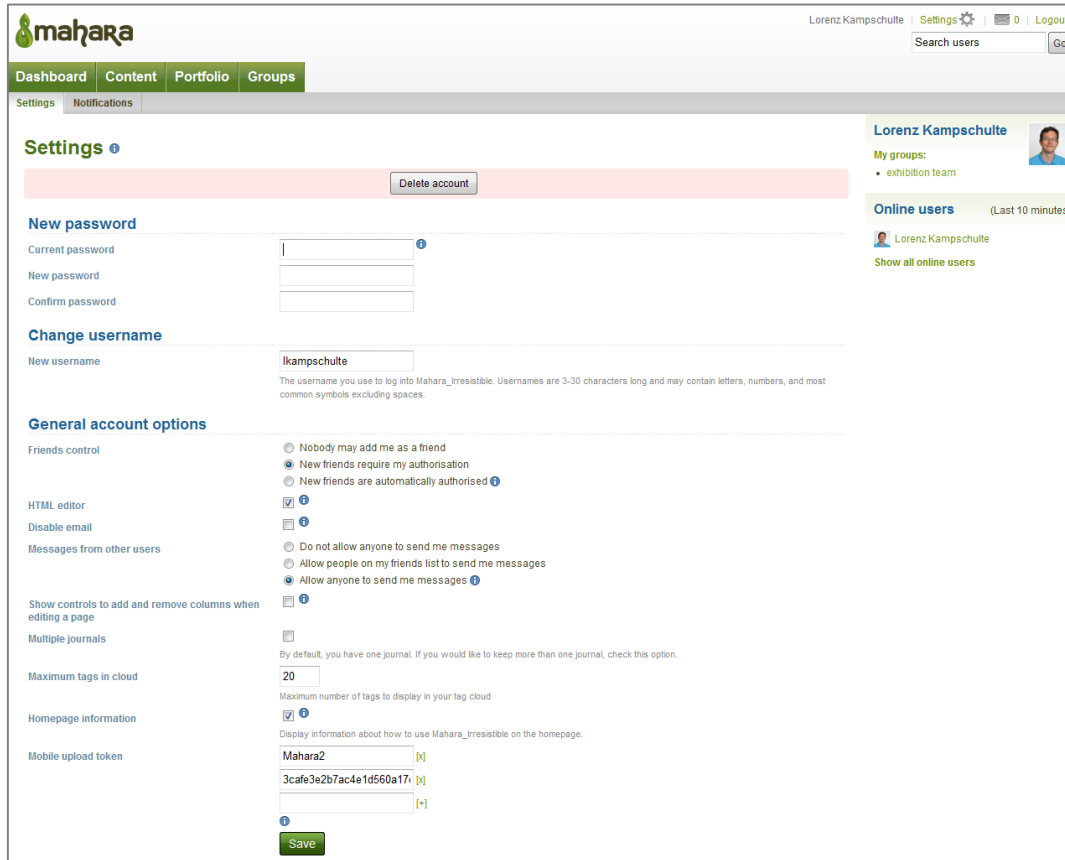
On the right side, there is a user profile for 'Lorenz Kampschulte' with a 'My groups' section listing 'exhibition team'. Below that is a 'Quota' section showing 'You have used 5.1MB of your 50.0MB quota' with a 10% progress bar. The 'Online users' section shows 'Lorenz Kampschulte' as the only user online in the last 10 minutes. The 'Tags' section includes 'accellogger', 'again', 'Android', 'data', 'exhibition', 'image', 'measurement', 'Test', 'Test blah', and 'testing'.

Just drag-and-drop the file on the [Drop files here to upload] field, or use the [Add file] button. In the lower part of the screen you have a list of all your files, can create folders and sort them. Hit the [Edit] button (pen symbol) to add a description and tags for your file.

HowTo: Upload a File with a Smartphone App

You can upload files directly by opening Mahara in your mobile browser. But for Android OS as well as iOS there is an app making uploading even easier. A big advantage is that you can store files in the app, and can upload it later when you are back to a free WLAN connection (so save your data plan).

On your Mahara page go to [Settings] (upper right corner), and at the end of the page enter a [Mobile upload token]. This could be a very simple ID like "Mahara" or your name for the first connection; every time you now upload new artefacts, the system will change the token and then use more secure codes (like the one shown here in 2nd line). Hit [Save].

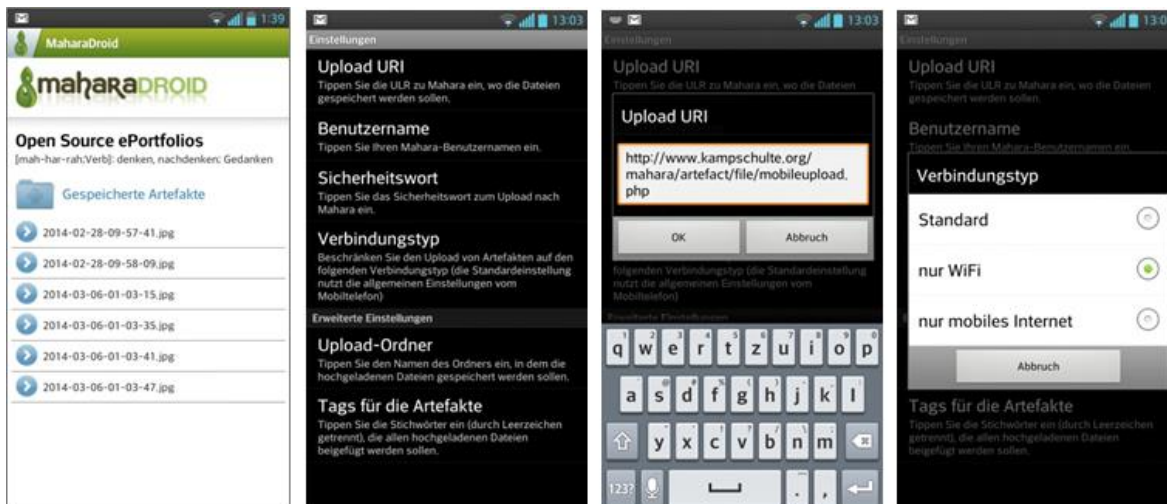


Install the app from the app shop on your phone: MaharaDroid (Android) or PortfolioUP! (iOS)

In the settings dialog of the app, enter the Upload URI as shown below (just change the first part to [http://example.com/mahara]), enter your user name, and the token you just set on the webpage of Mahara (i.e. “Mahara”). You also can choose which connection type should be used, change to [WiFi only].

Now you are finished. Close the app.

Whenever you now hit any sharing button on your device (e.g. in photo gallery), you will have a button called [MaharaDroid] or similar for iOS. If you hit that button you get a dialog to change the file name, description, and to tag it. Then you can directly upload the file, or store it and upload it later, together with other files or when you have a good internet connection.



All files are uploaded to your file repository, into the folder specified in the app, usually called “MobileUploads”.

HowTo: Create a Journal

Go to [Content] → [Journal]. The first journal is already included in the basic settings, you can add further journals.

To create an entry, just hit the [New entry] button.

You can change the journal name and add a description as well as tags in the [Settings] menu (the button right next to the button [New entry]).

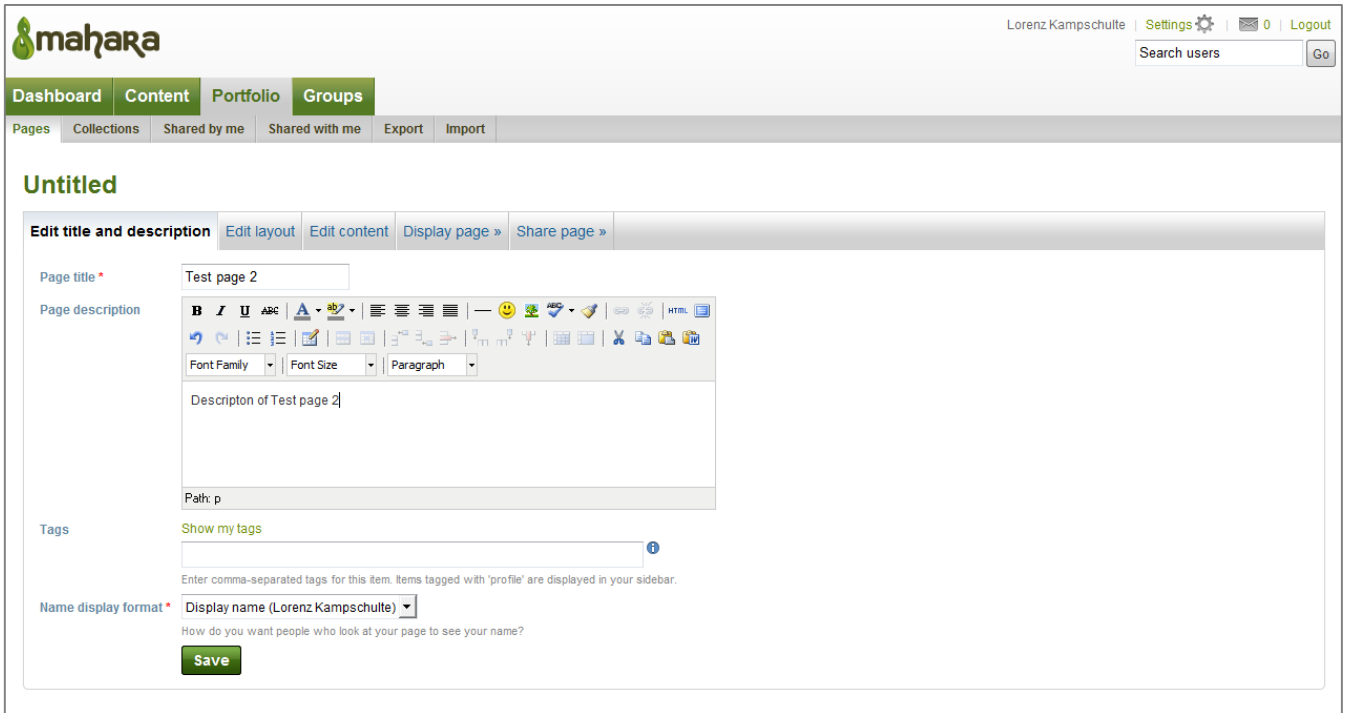
A journal entry usually contains a title and the entry itself. You could add tags and files as you like.

HowTo: Create a Page

Go to [Portfolio] → [Pages]. You can create as many pages as you like.

To create a new page use the [Create page] button on the right. Dashboard and Profile page are installed on every profile. Dashboard page is your (customizable) start page when you log in. Profile page is the page you can design to introduce yourself to other Mahara users in your Setup.

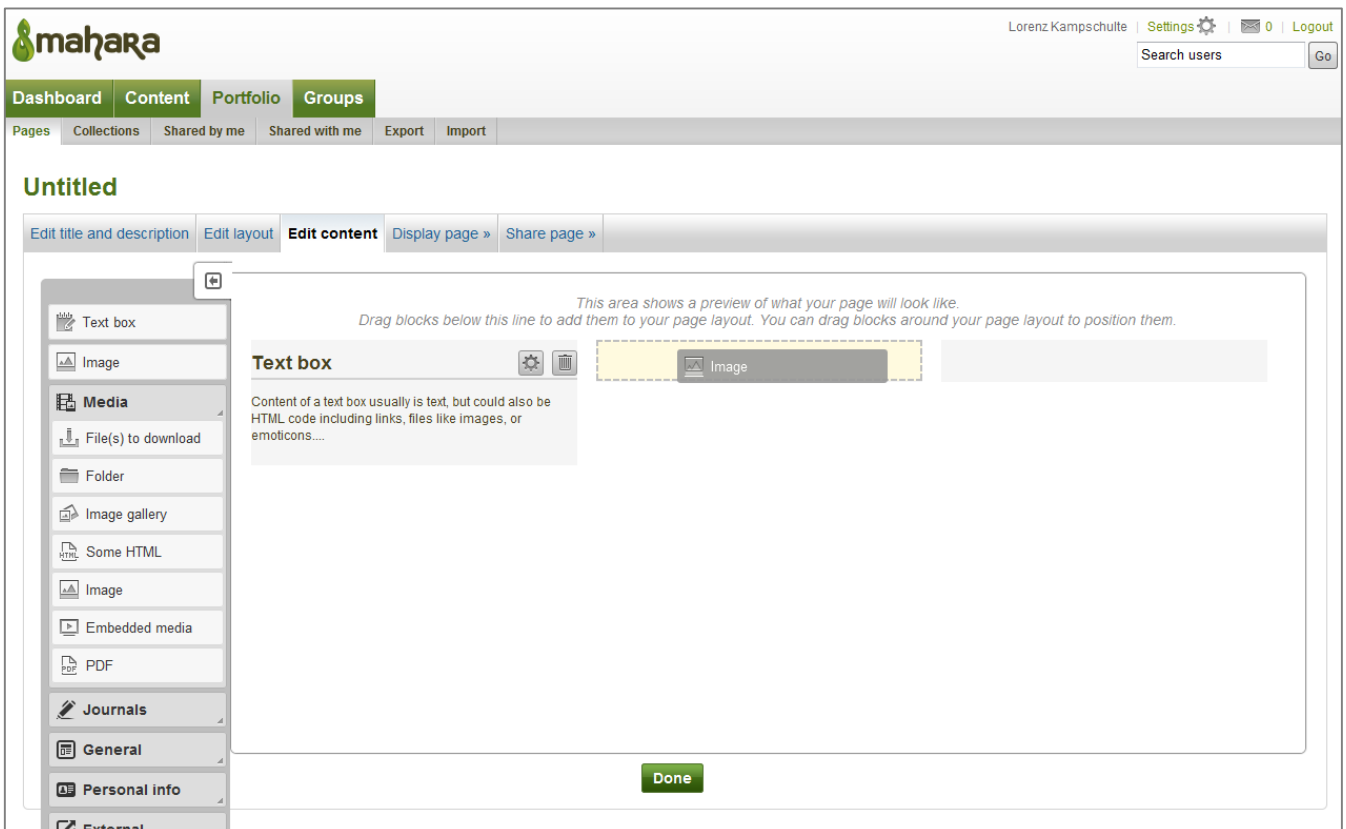
When you start with a page:



Set a page title and a short description of the page. Use the blue tabs for further settings.

Set the layout to the style you need (basically how many columns, rows etc.; you can change that later as well).

Add and edit content:



Just drag-and-drop the content placeholders from the menu on the left to your page on the right. If you have specified the position, an options menu opens where you can add and edit the content, e.g. set a title, text, image, video, pdf etc. (whatever you like). You can combine internal content (e.g. images, movie clips etc.) uploaded to your Mahara repository, and external content like YouTube clips, which then will be embedded in your page. If you add a PDF box and specify a file to it, you'll see a simple PDF reader embedded in your page showing the document. Finish the dialog with the [Save] button, and it will be included in your page.

The tab [Display page] gives you a preview of your page.

In the tab [Share page] you can specify who can see your page. Besides others, you can allow users to only view your page, or to copy it and work on it. So as a teacher, you can create framework pages, share them with your students who fill in the content, and then share them back to you for review.

For all sharing, you can set a start and end date to define the time when it is accessible. When you share the page with the public, it might be wise to create a SecretURL. A standard Mahara page URL is something like `http://example.com/mahara/view/view.php?id=17`, a Secret URL would be `http://example.com/mahara/view/view.php?t=KWRv0QEILYVXcldTpFAG` thus masking the page ID.

You can export your page in HTML code, so it is usable standalone without Mahara.

Collection:

A collection is a set of pages that are linked to one another and have the same access permissions. You can create as many collections as you like, but a page cannot appear in more than one collection.

HowTo: Create a Group

There are two ways to becoming a member of a group: Either search for groups and join them (could be free access or needed to ask permission to join from the group administrator), or found a group yourself.

Go to [Groups] → [My Groups] → [Create a new group]

The screenshot shows the Mahara interface. At the top left is the Mahara logo. The top right shows the user 'Lorenz Kampschulte' with options for 'Settings', '0' notifications, and 'Logout'. Below the logo is a navigation bar with 'Dashboard', 'Content', 'Portfolio', and 'Groups'. Under 'Groups', there are sub-tabs: 'My groups', 'Find groups', 'My friends', 'Find friends', 'Institution membership', and 'Topics'. The 'My groups' tab is active, displaying a list of groups. The first group is 'exhibition team', which is 'Open' and has 3 members. A 'Create group' button is visible. On the right, there is a user profile for 'Lorenz Kampschulte' and a list of 'Online users' including 'Lorenz Kampschulte' and 'Admin User'.

In the dialog for creating a new group you can specify the member permissions, e.g. how to enter the group, who is allowed to edit the group pages etc.

maħara Lorenz Kampschulte Settings 0 Logout Search users Go

Dashboard Content Portfolio **Groups**

My groups Find groups My friends Find friends Institution membership Topics

exhibition team

You are a member of this group. [Leave this group](#)

About **Members** Forums Pages Collections Share Files

All people working together on the exhibition are welcome!

Open
Group administrators: John Doe
Created: 6 March 2014
Members: 3 Pages: 2 Files: 0 Folders: 0 Forums: 1 Topics: 0 Posts: 0

Latest forum posts

There are no posts in this group yet

[Go to forums »](#)

Group pages

Group pages
This is the group exhibition page...

Pages shared with this group by others

Ferrofluid extra by Expo Neer1
Additional infos to ferro fluids, for online viewing in the exhibition
Tags: ferrofluid, nano, nanotechnology

Ideas for an exhibition by John Doe
Trying to build an exhibiton, with all your help and input...
Tags: exhibition, plan, project, topic

Members

Expo Neer1 Lorenz Kampschulte John Doe

Lorenz Kampschulte
My groups:
• exhibition team

exhibition team

- About
- Members
- Forums
 - General discussion
- Pages
- Collections
- Share
- Files

Online users (Last 10 minutes)

Lorenz Kampschulte
[Show all online users](#)

HowTo: Create a Collaborative Page

If you want to create a page for a group that all members can contribute to, go on the before-mentioned group home page (see screenshot above) to the tab [Pages], and then hit the button [Create page].

The procedure of filling the page with content is that same as for your private pages. Different users can work on the page and edit the content at the same time (but be aware that minor inconsistencies could happen), although the modular system of these pages helps keeping them low. Use your refresh button every now and then to keep the page up-to-date.

5. Examples of Using ICT in a Learning Unit

Introduction

In addition to the App Catalogue in the section above, this part of the document contains several examples of how ICT tools could be integrated into the teaching units. Whereas the App Catalogue’s aim is to present the large variety of tools available on the market and to spark ideas of what could be used in general, the goal of this part 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 CO₂ footprints for food and travel. The examples have an illustrative character and are focused on including ICT tools rather than providing full content teaching units.

The examples have been developed within the IRRESISTIBLE project, thus illustrating the core topics of the project, namely Responsible Research and Innovation (RRI), Inquiry Based Science Education (IBSE), gender issues and exhibitions. Nevertheless, taking the main ideas and transferring them to your teaching needs should be easy. The following Table gives a brief overview on the main aspects represented in the different examples. In addition to the examples shown in this document, a further instance of working with different app tools and integrating the results on the e-learning platform Mahara is documented in the Deliverable to the workshop, D4.2⁸.

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 website⁹ (pdf version and print copy to order, both free of charge).

Table 2: 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 etc.	-	-	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 calculated ('Science Education'), Regulations on CO ₂ emissions ('Governance'), contributors to the problem ('Engagement') etc.	Tracking individuals' CO ₂ footprint travelling to school for one week, comparing and discussing results	Comparison and discussion of the CO ₂ footprint of female / male eating behavior (group work2)	Presentation of core results as a poster

⁸ <http://www.irresistible-project.eu/index.php/en/resources/deliverables>

⁹ <http://www.science-on-stage.de/page/display/en/7/7/0/unterrichtsmaterialien//>

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 they create 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 exemplary tool to be used here, there are comparable tools around that could be used in a similar way (e.g. Edmodo, page 62ff).

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 is included in this guide on pages 40 to 49.

2. Entry task: everyday reference

The students get the task to photograph three different objects made of plastic in their home. 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 smartphones 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 for sorting the plastic pictures (this could be e.g. color, hard / soft, applications etc.). If pupils come up with several classifications schemes, multiple portfolios can be created and filled. Afterwards, the different sorting criteria are discussed by the learners, either face-to-face in class or digitally within a Mahara *forum*.

3. Topic plastics

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

When the new categories are developed, a new Mahara *portfolio* is created. As an 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

This section starts with a short teaching unit on plastic: “Problems with Production and Recycling”. Different plastics are analyzed and compared with respect to their sustainability, considering not only the current use but their impact over the entire life span. The findings from the unit are collected in a new plastic *portfolio*.

Subsequently, the task to research bio-friendly alternatives to the plastics shown in the portfolio is given 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 can recycling be further improved or how can the construction of products be optimized to reduce the use of plastic and to ease recycling (reduced quantity of conventional plastic, composite materials, recycling friendly

construction etc.). The research results of the groups are collected on further Mahara *portfolios*, the (digital) discussion can be dealt with in topic-related Mahara *forums*.

5. Presentation

Each group prepares a final *portfolio* page or a small series of *blog* entries within Mahara, which summarize 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 in the end embedded in the school website.

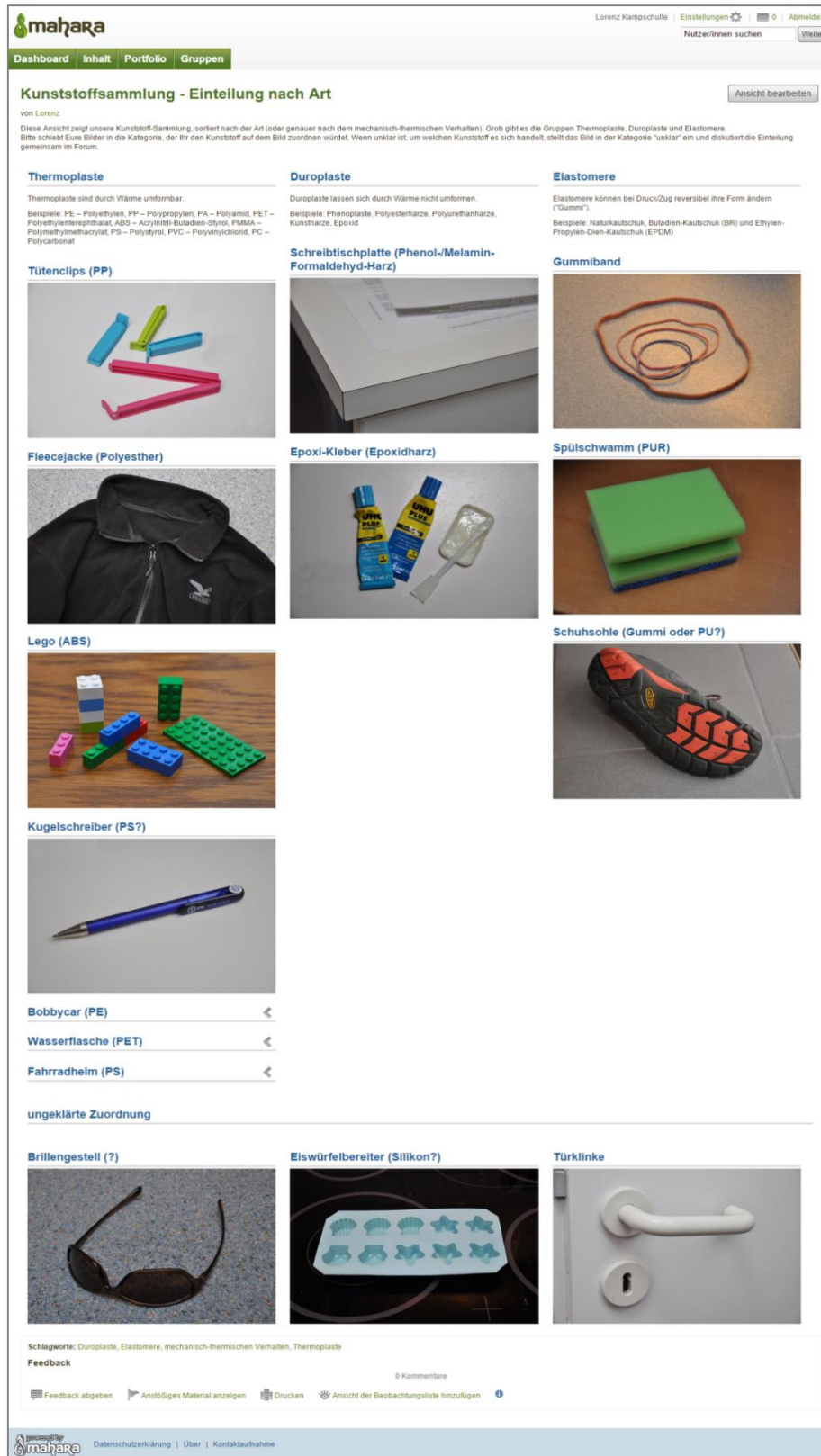


Fig. 7: Example of a Mahara portfolio during the sorting process: students’ photographs are grouped in four categories: thermoplast, duroplast, elastomer, unsettled.

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 at 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 etc.), the regional position (e.g. influenced by topography, sunshine duration etc.), as well as the technical position (e.g. orientation, tilting angle etc.). 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 their orientation towards the light. 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 a day, seasonal sun position, obstacles (houses, trees) into account. Use the App Sun Position¹⁰ or Sun Surveyor¹¹ to work out the best place.

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

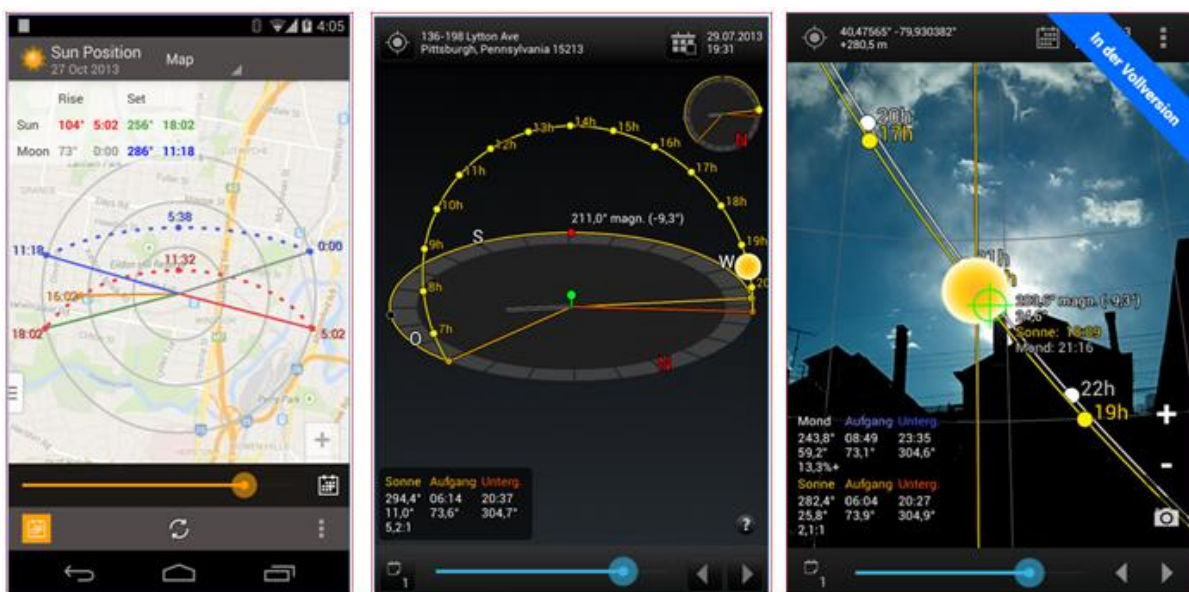


Fig. 8: Screenshots of the apps Sun Position (left) and Sun Surveyor (middle and right) to determine the best position for a solar panel (screenshots: ^{10,11}).

¹⁰ <https://play.google.com/store/apps/details?id=com.andymstone.sunpositiondemo&hl=de>

¹¹ <https://play.google.com/store/apps/details?id=com.ratana.sunsurveyor&hl=de>

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 50 km from your school location. Take factors as local sunshine duration, topography, sites (buildings, grassland, large roofs etc.) into account. Use Tools like Google Earth¹² (topography, site options), sunshine duration maps¹³, or tools to analyze the course of the sun for a specific place.¹⁴

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.

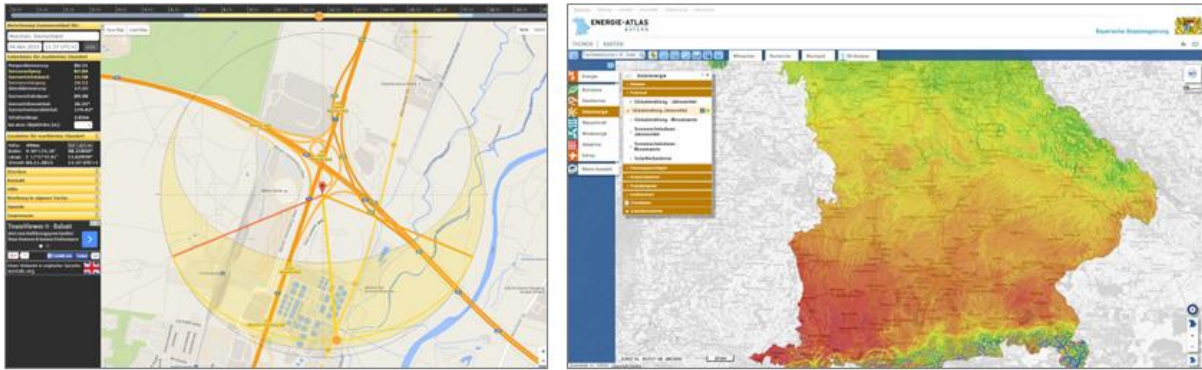


Fig. 9: Course of the sun simulated on sonnenverlauf.de¹⁴ (left), map of global radiation for southern Bavaria¹³ (right).

¹² <https://earth.google.com/>

¹³ <http://geoportal.bayern.de/energieatlas-karten> (similar maps should exist for most regions)

¹⁴ <http://www.sonnenverlauf.de/#/48.2184,11.6294,15/2015.11.04/07:24/1>

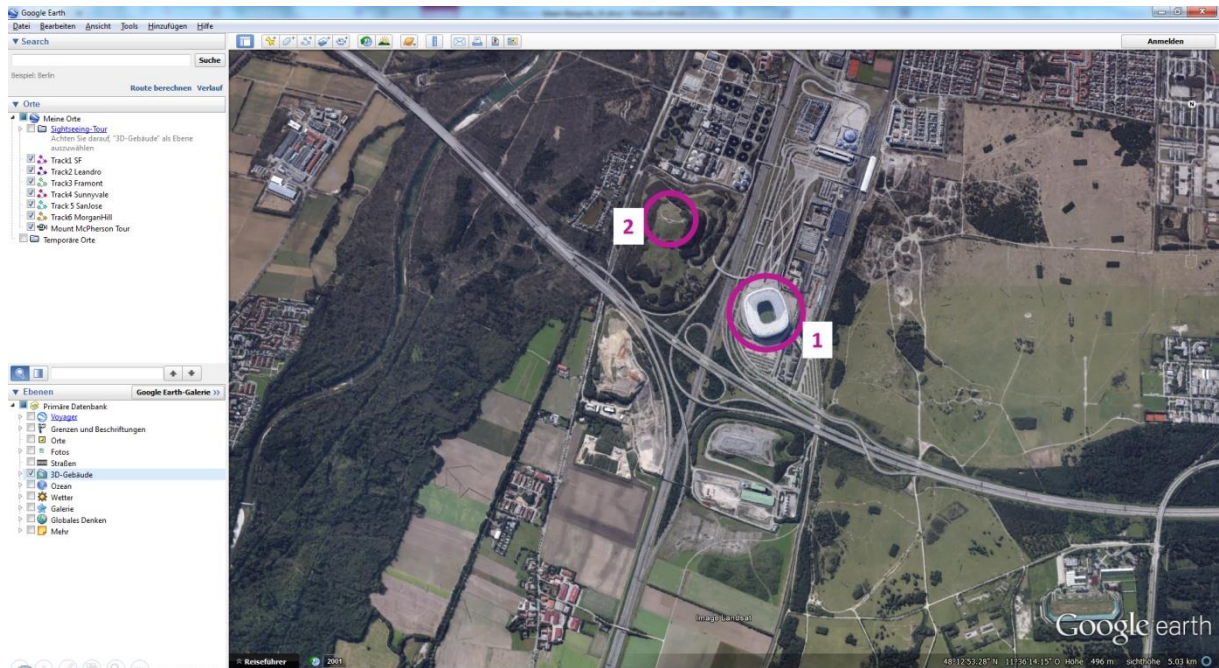


Fig. 10: Two possible positions for a small PV solar power plant, visualized in Google Earth¹²: (1) on the roof of a football stadium, (2) on the top of a small hill close by.

4. Group 3 – optimal position to the sun

Photovoltaic solar cells are most effective, if the panels are hit directly vertically by the sun’s rays. Tilting the panel by +/- 20° off the optimal position results in ~17% power loss, when tilting it by +/- 50° only 10% of the maximum power is left.

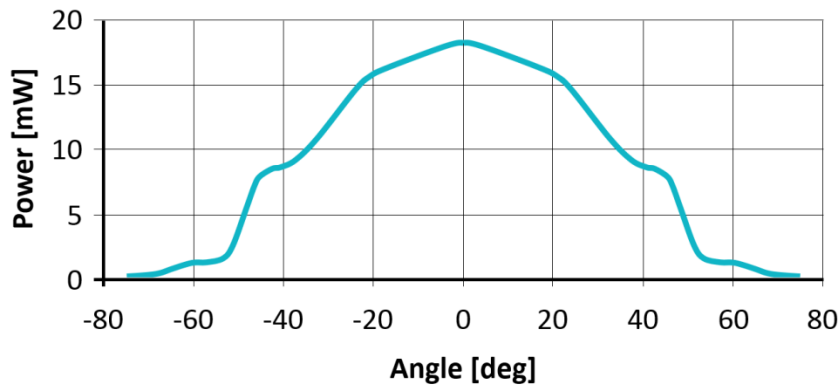


Fig. 11: Angle dependent power of a typical solar cell.¹⁵

Task: Find out the optimal orientation of a solar panel towards the sun under the current conditions. 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 Meter¹⁶ (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 Level¹⁷ and Smart Compass¹⁸. Since these values are highly dependent on current conditions, note down exact location (GPS), date and time as well.

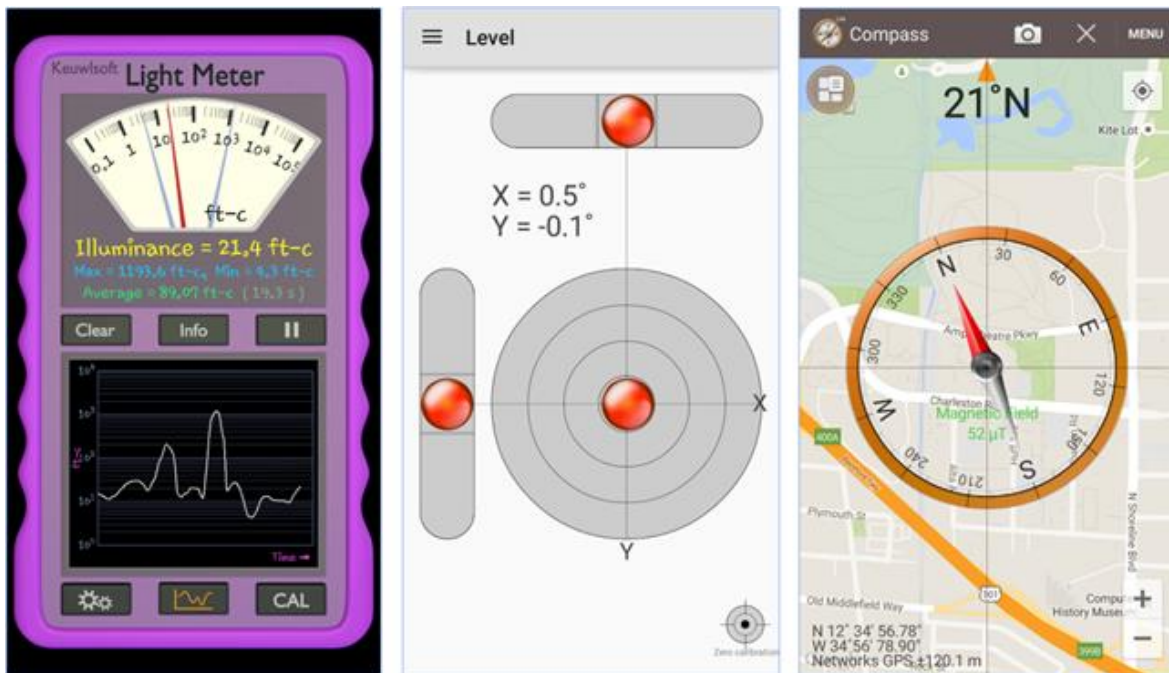


Fig. 12: Screenshots of the apps Light Meter, Smart Level, Smart Compass (screenshots: ¹⁶, ¹⁷, ¹⁸).

¹⁵ source of data: http://www.drollinger-wds.de/benjamin/study/docs/et_solar.pdf

¹⁶ <https://play.google.com/store/apps/details?id=com.keuwl.lightmeter&hl=en>

¹⁷ <https://play.google.com/store/apps/details?id=kr.sira.level&hl=de>

¹⁸ <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.

Unit on CO₂ Footprints: Calculating and Comparing CO₂ 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 (CO₂) and methane (CH₄) 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 (CO₂e) using the relevant 100-year global warming potential (GWP100).”¹⁹ Working with and reflecting these measures, students should get an idea on the dimension of CO₂ emissions and how the individual can influence climate change by controlling his/her 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 the Finnish partners within the IRRESISTIBLE project includes several aspects on CO₂ and Carbon footprints²⁰.

Activity sequence

1. Introduction

The introduction to the topic starts with a more general approach to climate change and the role of CO₂ and other greenhouse gases. Following, the concept of carbon footprints is introduced, illustrating their idea of not only taking direct emission (e.g. transportation) into account, but also considering indirect emission (e.g. food, textiles etc.). For the latter it is especially interesting to have a look on product lifecycle analysis.

2. Determining the CO₂ emission of getting to school for one week

Introduce students to using the app Changers CO₂ fit²¹. The app allows the user to track all travelling, it 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.

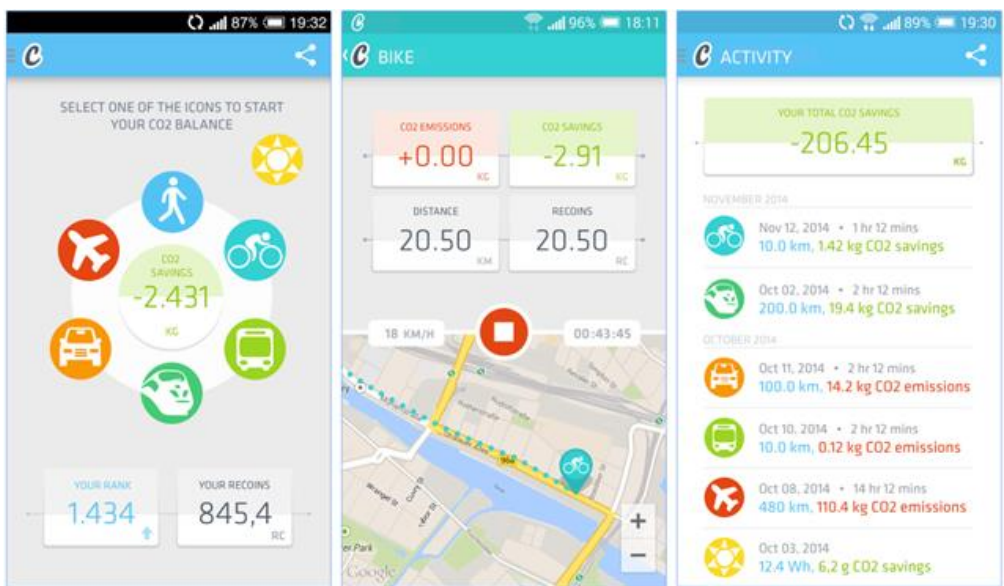


Fig. 13: Screenshots of the app Changers CO₂ Fit: start screen, travel screen, list of travel activities (screenshots ²¹).

¹⁹ 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.

²⁰ <http://www.irresistible-project.eu/index.php/en/topics>

²¹ <https://play.google.com/store/apps/details?id=com.blacksquared.changers&hl=de>

3. CO₂ emission caused by food

Calculating the CO₂ footprint of food is quite complicated, since many factors influence the footprint: production conditions, production itself, wrapping, transport, storage, retail system, transport to household etc. 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 (CH₄) when producing meat), which are far more dangerous than CO₂. Introduce the Global-warming potential (GWP) of greenhouse gases and the concept of carbon dioxide equivalents (CO₂e)

Group work1: Students explore the different food items and their respective carbon dioxide equivalents (CO₂e) on the webpage Eat Low Carbon²². Let them write down three food ingredients that they presume to have a very low CO₂ 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 food for each person for an average day, based on the meals they like best. Then students calculate an average CO₂ 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.

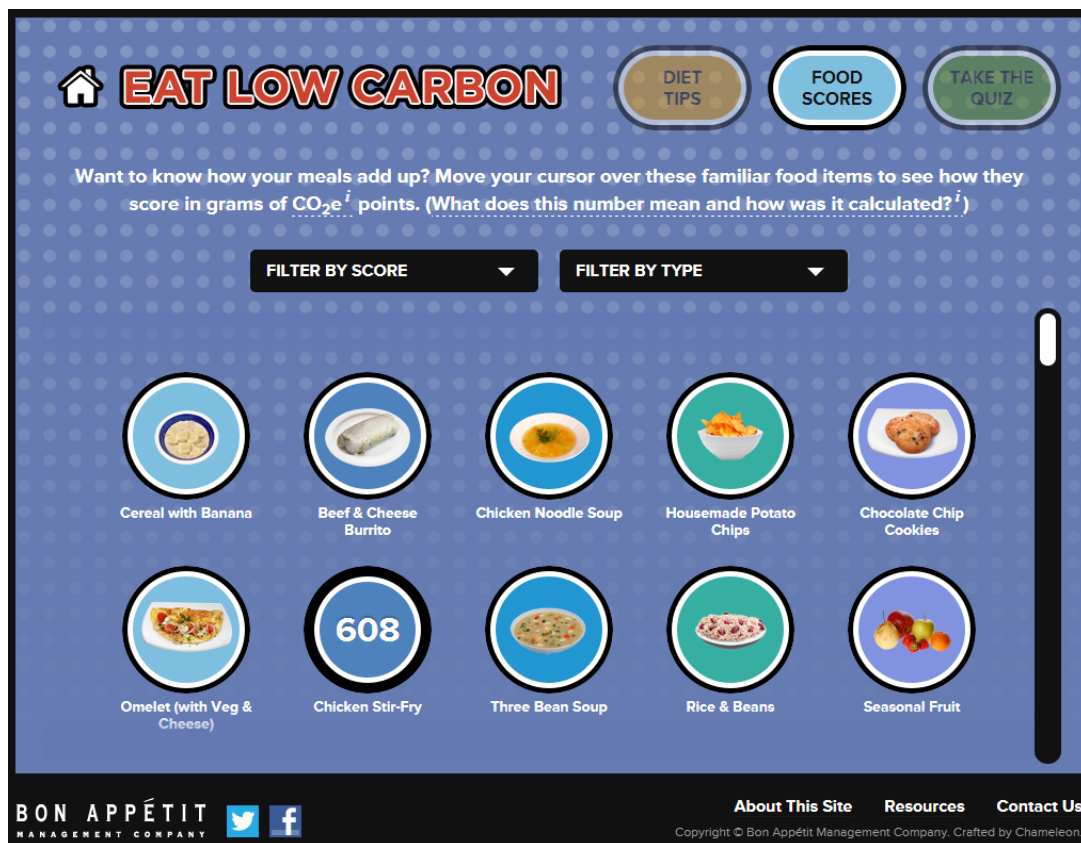


Fig. 14: Screenshot of the website Eat Low Carbon. The page contains a huge variety of food and meals, hovering over the photo with the mouse indicates the grams of CO₂e (screenshot²²).

Note: some nice examples of professional CO₂e calculation are listed on the website of CleanMetrics²³ (right column).

Note for an extended project: With the app Veggietizer²⁴ one can easily calculate how much CO₂, water and crops can be saved by banning meat from your meals.

²² <http://www.eatlowcarbon.org/food-scores/>

²³ <http://cleanmetrics.com/html/foodcarbonscope.htm>

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 (CO₂e)
- Catchy 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
- Students research the CO₂e for ten different kinds of food (e.g. 100g of pasta, 100g soy milk, 100g beef etc.) and calculate how far you could travel with a car producing the same CO₂ emission (for a graphic inspiration look at the illustration of the CO₂e of different products published by the *meateater's-guide*²⁵).

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

²⁴ <https://play.google.com/store/apps/details?id=freerunningapps.veggietizer&hl=en> (currently only a German version available)

²⁵ http://static.ewg.org/reports/2011/meateaters/images/eatsmart_twenty.gif

6. Collection of Best Practice Examples

For all teaching modules developed within the IRRESISTIBLE project it was a requirement to include ICT tools. To include ideas of the integration of tools in a teaching module that worked especially well, a set of best practice examples was collected from the partners. The selection was based on the self-evaluation of the partners, i.e. them stating that the integration in the module was fitting very well and the implementation at school was highly successful.

The following table lists best practice examples, indicating the ICT tool used, the main purpose why it was included in the module, as well as the technical infrastructure the tool was used with and teachers' experience with ICT.

Table 3: Overview of Best Practice Examples

ICT Tool	Main use in the teaching module	Technical system the ICT tool was used with	Teacher Experience with the specific tool / in general	Page Example in App Catalogue
Edmodo (1)	Teachers: share content, distribute quizzes, assignments, and manage communication; Students: collaborate, communicate and share content	Computers at home	Teacher had used it before on other teaching occasions, using it was a suggestion of the teacher	62
Edmodo (2)	Platform to post students' reflections and to share ideas about the exhibit	Personal computers, tablets and smartphones	For this teacher it was the first time using Edmodo in class, but had practiced before using it during module development	64
Skype	To conduct teleconferences with experts far away from the school's region	Computers in classroom	Teachers had used Skype before but not in class for educational purpose	65
Popplet	Building a concept map that highlights the main characteristics of the topic	Students' computer at home OR computer-room at school	Teacher had used Popplet before, some experience in using ICT tools, but outside of classroom	67
Apple iMovie	Tool to produce videos for exhibition as well as for reflection	School/University iPads	Teachers were skilled users of iPads	69
Video and Audio Recording	Tool to collect data and knowledge needed to be presented at the exhibition, presentation in student exhibits	computers / students' laptops in classroom, digital recorder / camera	The teacher of this class was familiar with most of the ICT, believed that ICT improves student's learning	70
Scratch	Development of a digital game which was the main part of the exhibition	Computers at Technology Laboratory of the Eugenides Foundation (EF)	Teacher had no experience in using Scratch, but students got support from EF-Technology Laboratory staff as well as museum ICT expert	72
Glogster and Scratch	Glogster and Scratch were used for the design of four digital posters for the exhibition, additional PowerPoint slides acted as an interface for the exhibit guiding to the posters	Computers in classroom and at home	Teacher was familiar with these tools and had used them in teaching before	74

Edmodo (1): Online Platform for Teacher and Student Collaboration



by Dimitris Stavrou (Greece)

Teachers used Edmodo to share content, distribute quizzes, assignments, and manage communication with their students. Students used the platform to collaborate from distance, communicate and share content with each other and their teacher.

Integration into the teaching module

At the beginning of the module, Edmodo was used by the teacher as a means of sharing extra content (as for example impressive videos of nanomaterials, short articles about various topics etc.) with her students to attract their interest and engage them in the module. It was used as a platform to assign them short tasks for their next lesson e.g. to read an article or to prepare some questions they would like to ask a scientist (before their visit to the research center).

Edmodo was a useful tool to send announcements to the students and to organize their following meetings but also to remind them of changes made to the program or the visits they would make to out-of-school settings.

Its indispensability became clear during the exhibits development phase. At that phase, students were divided in groups of 5-6 members and had to collaborate and to exchange ideas for their exhibit to take shape. Students had to meet during the afternoons but their schedules were too full for personal meetings. So Edmodo enabled them to communicate and to share their suggestions asynchronously (not in the same time), while working independently on their tasks. The teacher had the opportunity to follow their progress, to have the overall supervision and to intervene whenever students faced a dead end or when she wanted to give them a hint towards a certain direction.

What are the main reasons why this tool worked so well here?

At first, Edmodo is a tool easy to use, both for teachers and students, as it has an interface similar to Facebook that resembles the social media networks. It enables the user to send personal messages, others to join in groups etc. So it was really helpful in the exhibit development phase, as students created different groups according to the exhibit they were assigned to construct, worked independently, shared their ideas and then collaborated when trying to compose their exhibit.

Recommendations for teachers

Edmodo is a handy, user-friendly platform that doesn't have many prerequisites for using it. If your students possess computers at home, it is a fun way to communicate with them, and in the same time to follow their progress.

The screenshot shows the Edmodo interface for a group named 'bahcesehir koleji nanoteknoloji kulubu'. The group is managed by 'Mr. Yaşar' and is for '6th Grade-7th Grade Science'. The left sidebar lists other groups like 'Mrs. Özgül's 9. Sınıf grade group', 'NANOBİLİM', 'Nanosayışal', and 'Collaborative_PCK_Chemistry'. The main content area has tabs for 'Posts', 'Folders', and 'Members'. Below the tabs, there are icons for 'Note', 'Assignment', 'Quiz', and 'Poll'. A text input field says 'Type your note here...'. Under 'Group Posts', there is a post by 'melih g' to the group, featuring a photograph of a small, cylindrical, white object with a lens, possibly a microprojector or a similar nanotechnology device.

This screenshot shows a post by 'Mr. Yaşar' to the 'bahcesehir koleji nanoteknoloji kulubu' group. The post is titled 'Sela'nın notları ve çizimleri' and contains two images of handwritten notes and diagrams. Below the images, there are options to 'Like', 'Reply', 'Share', and 'Follow', along with the date 'Dec 2, 2014'. A reply input field is visible below the post. Below this, another post by 'Mr. Yaşar' is partially visible, titled 'İla'nın notları' and featuring another image of handwritten notes.

Fig. 15: Examples of students work on the Edmodo platform.

Edmodo (2): A Simple Platform for Teachers and Students to Share and Communicate

by Sevil Akaygün (Turkey)



Edmodo is a simple platform that is used as a Learning Management System (LMS) through which teacher and students share their ideas, announcements, and materials. They also post comments and express their feeling such as 'Like'.

Integration into the teaching module

The Nanosilver module is composed of 8 lessons, each of which is 80 minutes long. In every lesson, the teacher created a page where students could upload their reflections or assignments of that lesson. Then they conducted online discussions about the past lesson. So, both the teacher and the students actively used Edmodo throughout the module.

What are the main reasons why this tool worked so well here?

1. Edmodo is a good tool that allows interaction among the students and the teacher, so it was very appropriate for our module in which students work in groups, yet individually reflect on the tasks. Edmodo allows both group and individual work.
2. The interface of Edmodo looks like Facebook so it was very attractive and easy to use for students.

Recommendations for teachers

We have an Edmodo page for the teachers developing the module, so they practiced and got used to it. I think it might be recommended to have an Edmodo page / group for a bigger group where they can join as participants before being a teacher.

Skype: Teleconferences with Experts Far Away from the School's Region



by Dimitris Stavrou (Greece)

Skype was used to conduct teleconferences with experts (science centers or science museums) far away from the school's region.

Integration into the teaching module

We used Skype to conduct teleconferences on several occasions. In our module one of the main objectives was for students to come in direct contact with experts and to exchange ideas with them as these experts had contributed in the module development: researchers from the FORTH (in Crete) and museum experts from EF (in Athens). As a result, students whose schools were far away from the aforementioned institutions had to overcome the obstacle of the distance. Skype helped us eliminate the distance, enabling the conduction of tele-meetings with the experts.

So in the engagement phase, when (according to our module) students should visit the Interactive Exhibition of Science and Technology of EF in Athens and be toured around the exhibits, students of Rethymnon made a Skype connection with the expert there, who – holding his tablet – was guiding them through the various exhibits discussing their designing advantages and disadvantages. Likewise, in the exhibits development phase, the museum expert showed the exhibits via Skype in a particular tele-meeting and gave his advices from a distance instead of visiting the class in person in order to advise them on the exhibits they had started developing (as he did with the schools in Athens).

Respectively, in the elaboration phase, when students were supposed to personally discuss the nanotechnology applications developed and RRI issues involved with the FORTH scientists in Crete, instead those students from Athens had the opportunity to pose their questions and talk to them via Skype.

In this way every student, no matter where his/her school was, had the same stimuli and the same experiences as other students in different locations.

What are the main reasons why this tool worked so well here?

Firstly, students were excited about conducting a teleconference especially with experts from the science center and the science museum, as it was their first time, and somehow they felt like this procedure was adding prestige to their effort.

Secondly, as was said before, our module development group and the institutions that were collaborating in developing the module were located in three different cities (Athens, Heraklio, Rethymno). If students would have had to limit their visits to the sites which they could have physically traveled to, they certainly would have missed important experiences that were indispensable to fulfill the module.

Recommendations for teachers

Skype is a useful tool that enables the minimization of all distances. We would recommend it whenever for some reason you cannot accomplish students' physical presence in a certain place, as it is really easy to use.



Fig. 16: Skype video conference connecting students with experts in places too far apart to travel.

Popplet: A Tool for Building Concept Maps

by Rita Marques (Portugal)



The tool is used for building a concept map that highlights the main characteristics of the Polar Regions after students have done some research on the topic.

Integration into the teaching module

After doing some research on the Polar Regions (climate, biology, geology, geography), students had to organize their knowledge and represent it through a set of concepts and their relationships (indicated by a connection line between two concepts). The relationships between concepts in different domains of the concept map helped us to see how some domains of knowledge represented on the map were related to each other. A final feature that may be added to concept maps is listing specific examples of events or objects that help to clarify the meaning of a given concept. Concerning the tool, students need to create an account (or they can try it out) and choose the free version, although limited in the number of concept maps it allows. After building their maps, they then share them (i.e. share their hyperlink or embed them, via blog or other platform) for evaluation regarding the evaluation criteria. Students were aware of these criteria since the onset of the task.

What are the main reasons why this tool worked so well here?

- a) It allows teachers to identify both valid and invalid ideas held by students.
- b) It allows the incorporation of images or videos (from YouTube, Vimeo) as representation of concepts, not only text.
- c) In order to establish relationships between concepts, students have the opportunity to structure their knowledge about the topic, becoming more aware of what they know or don't know yet.
- d) The concept maps can be easily built and shared.

Recommendations for teachers

First of all, students don't usually know what concept maps are – for them, they're a list of words, structured in a linear fashion. If there is no time available in class for teachers to show, as an example, how to build a concept map using Popplet, it is very important to share a tutorial with students (although the tool is very easy to use and very intuitive).

As a tool for building concept maps, Popplet has a downside: it does not allow the user to write (in a quick way) a word on the connecting line, and this word is very important since it specifies the relationship between the two concepts. But students can place it, nevertheless, inside a box: then they will have two concepts connected through a line with a box, inside of which is the linking word. It's an alternative way of making the map more complete.

Another important issue is the assessment criteria: they should be delivered to students on the onset of the task.

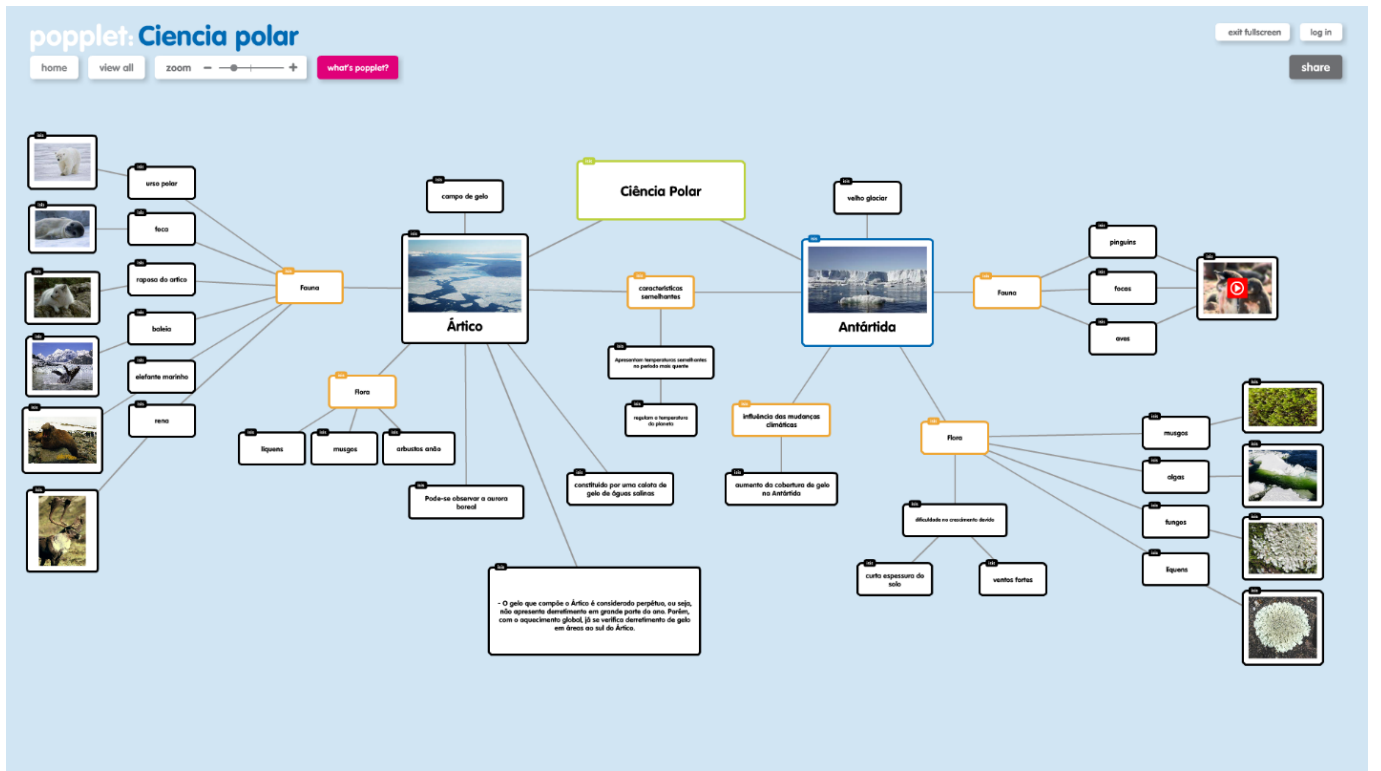


Fig. 17: Popplet concept map created by students in a teaching module on Polar Science.

Apple iMovie: Make Videos about Climate Change to Show at a Museum



by Anna-Leena Kähkönen (Finland)

The tool was used for editing videos shot with an iPad or otherwise. The tool can be used to clip and paste video, add music and effects, or edit colors etc.

Integration into the teaching module

Pupils made videos about climate change to show at a museum. The whole class decided to make a newscast report about the climate in 2050 and they acted the roles of reporters and designed short animations for the news videos.

The students started with a brainstorming phase in small groups, subsequently sharing their ideas with the whole class and deciding on the topics and the way the movies would be made to give them a uniform look. Roles were assigned to the different groups. Before students started working in groups on their own, each group made a checklist. The finalized videos were displayed in the museum as part of the exhibition.

In phase two of the project, the groups of students made a short movie of their visit to the museum, including the exhibition and reflecting what they had learned. In the end, the videos were watched by all student and a list of “things” the class had learned during the project was collected.

What are the main reasons why this tool worked so well here?

- Easy to make an exhibit without physical restraints; it can be shown online or as part of a physical exhibit
- Video editing is motivating and easy for pupils, they are more familiar with video making than e.g. posters
- Multiple uses: documenting what students want to present to others, but also what they learned during the museum visit (by making the reflective video about “what we learned today”), and returning to the videos afterwards in class

Recommendations for teachers

- Trust the pupils to work as peer support for each other; some are bound to be very skilled movie editors and can help novices.
- Time spent in video production depends much on how structured the instructions are; we have had pupils working self-directed, and they spend about 2 hours – if there are also lessons on storyboards or directing, or other learning about videos as art form, much more time could be spent on it.
- The class should observe the principles of copyright when they make their movie; if they film each other or puppets that they make, there is little problem, but if the pupils use images, music, or animations found online, they need to find out if they are free to use, and credit the authors.

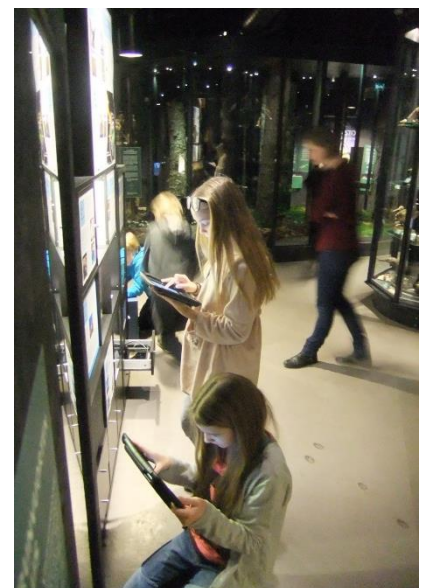


Fig. 18: Students working with iMovie in the museum.

Audio and Video Tools for Collecting Data and Knowledge to be Presented in the Exhibition

by Ron Blonder (Israel)

Next to standard audio and video recording equipment, several digital animation tools were used to develop content for the exhibitions. (Voki: www.voki.com, PowToon: www.powtoon.com, Go Animate: goanimate.com/videomaker).

Integration into the teaching module

The module on solar cells was developed using the 6E-model, the tools were used in the following phases:

1. Engage: presenting a high-quality "special news broadcast" as a tool for raising interest, engaging and challenging students to provide relevant information to their guiding question.
2. Explore: Student exploration of the subject is promoted by providing students with experiences (e.g. digital and live experiment on photovoltaic cells, RRI presentations).
3. Explain: Students collect data and knowledge to answer the questions by engaging in the science museum visit, in addition to using their computers as a tool for collecting the data and knowledge needed to be presented at the exhibition, later on.
4. Elaborate: Students are encouraged to elaborate on their findings during the exhibit-design phase of the module. The students connect the scientific content to RRI by using computers, animated videos, digital animations for (a) designing the RRI-related parts of their exhibits and (b) applying RRI to the research topics of the Weizmann Institute graduate students, in discussions with these students.
5. Exchange: Students are encouraged to communicate their findings and conclusions with the wider audience of their fellow students (who did not participate in the module), by presenting their exhibits to them, using different tools such as the digital camera recorded experiment of photovoltaic solar cell.
6. Evaluate: Students' learning of the main goal of the module (i.e., to foster positive attitudes towards RRI) is also measured by using online pre/post RRI questionnaire, what is also considered an ICT educational tool.

What are the main reasons why this tool worked so well here?

For example, using the You tube animated film or storytelling of Dr. Peterson and his attitudes regarding using lead, exposed the students indirectly to several 6E RRI dimensions, which were naturally integrated into the story as a part of the story consequence. The students raised few of the dimensions as a result of watching the film. They were exposed to ethical issues, the governance role and effect on scientific research, open access issues and who should be responsible.

Recommendations for teachers

Students' exposure to educational ICT has a significant and positive impact on students' attendance and concentration. ICT enables teachers to easily explain complex instruction, ensures students' comprehension, creates interactive classes and makes the lessons more enjoyable.



Created with Storyboard That for Mrs N

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Fig. 19: Comic strip created by students in a module on solar cells.

Scratch: an Online Application Used to Develop a Digital Game



by Christina Troumpetari (Greece)

Scratch was used for the development of a digital game which was the main part of the exhibit entitled “From the Nanotechnology to the Prodigy”. As children create with Scratch, they learn to think creatively, work collaboratively, and reason systematically. The scratch application was developed at the Technology Laboratory of the Eugenides Foundation with the participation of the experts of the Lab such as graphic designers and ICT experts. Furthermore there was the use of tools for processing photos at the stage of the development.

Integration into the teaching module

The main idea was to create a digital game for visitors learning about the subjects of breast cancer or HIV. The scenario is that in the future, a presumed patient will have been diagnosed with breast cancer or HIV. The doctor recommends as a remedy to "attack" the cancer cells or the virus from an appropriate Nano-robot, which will be introduced in the patient's body or blood for this purpose.

The presentation method of the exhibit as organized by the students is the following:

This game consists of a PowerPoint presentation in combination with a Scratch application. Visitors – through the presentation – opt to learn about subjects of breast cancer or HIV by selecting gender and disease. After that, they play a digital game where they control a Nano-robot which attacks the cancer cells or HIV, trying to destroy them. When the game is finished, the exhibit tries to put forward a query to the visitors on what would happen in case the robot attacks a healthy cell by mistake.

Since the idea of creating the game and integrating it in a museum style exhibit seemed highly promising but technically ambitious, the Technology Laboratory of the Eugenides Foundation supported the students in different ways: The selected images were modified and improved by the graphic designers of the Lab under the guidance of the students. At the same time, students developed the environment and the instructions of the game as Scratch application with the assistance of the museum ICT expert, at the Utech Lab.

What are the main reasons why this tool worked so well here?

Scratch is a useful tool to create animations that help visualize difficult concepts such as nanotechnology. To this end, Scratch was selected to be used for the visualization of the students’ storyline for their exhibit. Moreover, Scratch is a web-based environment and can be accessed as a free desktop version by students, teachers, parents and other communities of users in various settings: schools, museums, libraries etc. across Europe.

Recommendations for teachers

If there’s no professional support (as in this case) it is important that teachers (or students) are familiar with the Scratch program.

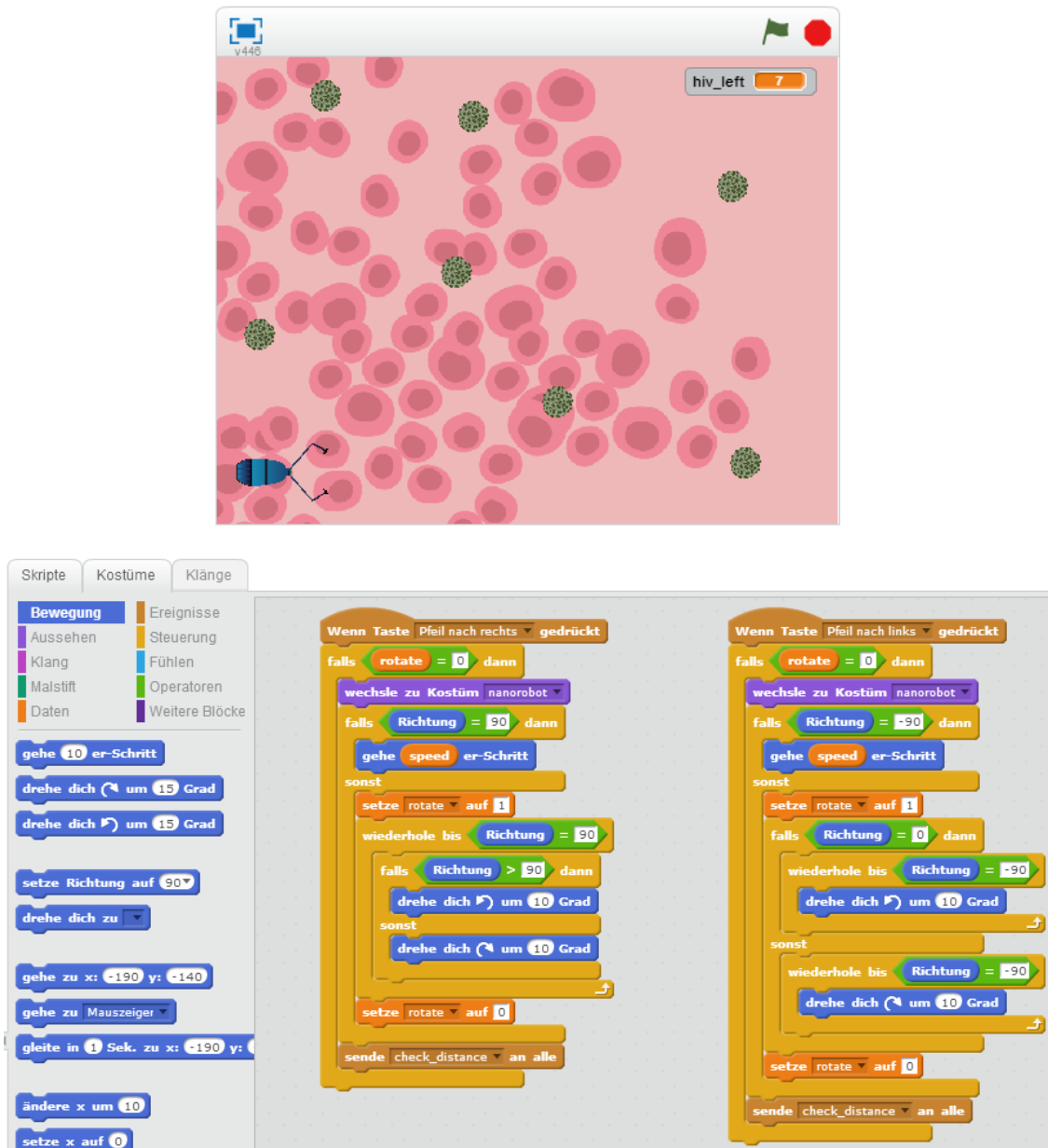


Fig. 20: The Scratch application "Fighting HIV" programmed by the students as well as some of the code.

Glogster and Scratch: Designing Interactive Digital Posters



by Christina Troumpetari (Greece)

Glogster is a Web 2.0 tool that allows users to create virtual posters combining text, audio, video, images, and hyperlinks and to share them with others electronically. Students used the ICT tools of Glogster and Scratch for the design of four digital posters entitled “Nanotechnology in the service of Medicine” and additional material. All material was included in a PowerPoint presentation.

Integration into the teaching module

The 4 digital Glogster posters and the Scratch presentation were developed mainly by the students in the classroom and at home with an intervention of the teacher regarding the editing of various elements (text, layout etc.).

Visitors of the exhibition interacted with PowerPoint slides which acted as an interface and guided them to four different interactive Glogster posters concerning Nanotechnology in the service of Medicine. In addition, a Scratch application was available in order to introduce visitors to the RRI aspects and to be the trigger on RRI issues. At the end of this application, visitors were asked to give their opinion which was recorded for the next visitor in order to see it.

Students presented their scenarios during the visit of museum staff to their class. The idea was discussed and suggestions were made to the students concerning the design of the posters and the exhibit interface.


What are the main reasons why this tool worked so well here?

Glogster and Scratch were the most appropriate ICT tools to support the storyline of the students. Students using Glogster had at their disposal a great variety of different elements such as text, images, podcasts, music, hyperlinks for web pages, videos and furthermore other objects in order to create an interactive digital poster. Moreover, since Glogster is a web based platform, students had the opportunity to meet and work as a team from their homes and not exclusively in the limited time of school hours and also the result of their work could be shared online via Glogster community with many others students and educators.

Recommendations for teachers

The option of Glogster is a very creative process and it is a user-friendly application for teachers.

Η νανοτεχνολογία στην υπηρεσία της ιατρικής

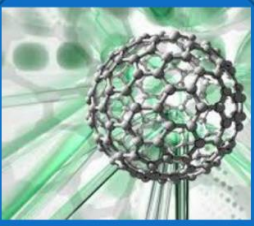




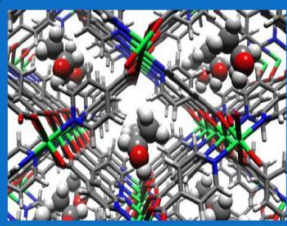
Γενικές Πληροφορίες



Εισαγωγή:
Σωματίδια φορείς φαρμάκων



Παράδειγμα I:
Φουλλερένια



Παράδειγμα II:
Metal-Organic Frameworks

2^ο Πρότυπο Πειραματικό Γυμνάσιο Αθηνών
Όμιλος Πειραματικών Μεθοδολογιών στις Φυσικές Επιστήμες

Δελάλης Βασίλης, Δελιπρίμης Λευτέρης, Μπαλάφα Δήμητρα-Δηώ,
Παπαδόπουλος Κωνσταντίνος, Σπηλιόπουλος Αιμίλιος, Χωριανοπούλου Μαριλένα

Υπεύθυνη
Έρευνα και
Καινοτομία:
Ανησυχίες και
κίνδυνοι



Fig. 21: The PowerPoint start page in the exhibition, linking to the four interactive Glogster posters.

Conclusion

The best practice examples were analyzed with a special focus on the two main challenges when using ICT at school as detailed in section 5. When looking at the ICT skills of the teachers in these examples, it is not surprising that all except one teacher being responsible for the implementation were skilled ICT users. The one exception was a teacher that was trained to use the tool during the module development, thus highlighting a proper way to engage teachers. When analyzing the infrastructure challenges, there was no uniform picture: From computers in classroom to students' computers at home to school tablets and students' smartphones – all kinds of infrastructure were present. This indicates that even with a less powerful infrastructure best practice ICT use is possible (see for instance the example Greece (3), where computers and the support team of the science center were utilized to develop a digital game).

When looking for similarities within the best practice examples, there are a few factors that stand out: six out of the eight examples indicate that the tool is easy to use, making this one of the most important prerequisites for proper integration. In five examples, the tools or the content that was developed with the tools were used as special (interactive) elements in the exhibition. This shows that if the tool is integrated in a way properly supporting the task in the project, an extra value (in this case interactive exhibition elements) could be created. In three cases, the tools were also used to share the results even beyond the student exhibitions, i.e. via the internet to a larger community.

Offering a base for collaborative work seems to also be an important feature for a tool being considered for a best practice example – this could either be realized with a learning management system (as demonstrated with the two Edmodo-examples in the list) or on a smaller scale with Glogster – a tool for collaboratively creating posters.

Summing up the analysis of the best practice examples, the success of ICT tool integration is defined by four main factors:

- the right tool (easy to use, fitting the task etc.)
- a proper integration (adding extra value, collaborative etc.)
- the necessary infrastructure (important although not the only factor etc.)
- proper ICT skills of the teachers (very important!)

With this ICT Guide we hope to support you in advancing on all four levels: discovering the right tools, finding ways of target-oriented integration, coping with (and getting around) infrastructural challenges and – last but not least – improving your own ICT skills by simply trying out these tools in your classroom. Get started!