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Introduction to ICT

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Учебно-методическое пособие предназначено для студентов всех специальностей, изучающих курс «Информационно-коммуникационные технологии» («Information and communication technologies») на английском языке с целью формирования общего представления о сущности и роли ИКТ в современной системе образования. Данное пособие может быть применено и в старших классах школ в рамках профилирующей траектории любого цикла.

Пособие состоит из введения, двух разделов: теоретический и практико-ориентированный блоки. Теоретический блок содержит описание целей, задач и классификационных аспектов ИКТ средств, отражает основные моменты теории вводного модуля ИКТ. Практический блок состоит из аутентичных статей, имеющих ненулевой импакт-фактор, по трем основным блокам наук - социально-гуманитарного, технического и естественного блоков и заданий для работы над текстами представленных статей.

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Contents

Introduction

Current state of the education that undergoes the scope of changes requires the use of new technologies on a more active basis. The given manual is aimed at introduction into the ICT study.

The overall description of the course on ICT encompasses the following aspects stated below.

Assignment of this discipline is training of the highly qualified specialists owning skills of application of the modern information technologies in the sphere of professional area - teaching sphere. To give students the information and communication competencies that facilitate everyday life and will give an opportunity to use modern information technologies in various areas of professional activity, scientific and practical work, self-education and other purposes. In addition to the practical purpose, the course provides academic and educational purposes, helping to expand the horizons of students, improve their general culture and education as future teachers.

Trainees profile

The student's profile includes the set of competences he/she is to possess. The student must:

Know:

- what economic and political factors promoted development of information communication technologies;
- features of different operating systems;
- architecture, performance measures of supercomputers;

Have skills:

- to use information resources for search and information storage;
- to use different social platforms for communication;
- to use different forms of e-learning for extension of professional knowledge;
- to use different cloud services.

Learning Objectives

At the end of this course, the student will be able to:

• to work with electronic spreadsheets, to execute consolidation of data, to build diagrams;
• to work with databases;
• to project and create simple web-sites;
• to make processing of vector and bitmap images;
• to create multimedia presentations including prezi, 3D.

Pedagogical aims to be reached

- Acquaintance with modern methods on the use of means of ICT.
- Training in use of means of ICT in professional activity of future teachers.
- Training in effective application of means of ICT in educational process, including work with the distributed information resource of educational appointment.
- Acquaintance with opportunities of practical realization of the training focused on use of technologies of multimedia, systems of artificial intelligence, the

information systems functioning on the basis of computer facilities, providing automation of input, accumulation, processing, transfer, operational management of information.

Pedagogical methodologies used:

Methodologies include: individual approach, communicative and interaction based techniques, participative approach, problem-based teaching.

Pedagogical tools

Pedagogical tools include:

1) case-studies;
2) methods of peer assessment and self-assessment;
3) mind-mapping;
4) brainstorming;
5) reporting;
6) formative rubrics based evaluation;
7) mentoring, tutoring, scaffolding.

Environment used

Environment includes three aspects: psychological, material and pedagogical aspects.

Psychological environment must correspond to the mode of face-to-face and mediated teaching and learning (stress-free, comfortable and relaxing).

Material environment is comprised by the set of equipments used for performing the tasks - Computers/gadgets, Internet connection, mobile devices.

Pedagogical environment - creation of the pedagogically friendly interaction (partner-partner mode), using peer and self-assessment, error correction in the mediated form.

Course Timing

Course timing is presented below:

	Form of training			
	full-time		part-time	
	on the base of general secondary education (period of study - 4 years)	condensed on the base of technical and professional, post-secondary education (period of study - 3 years)	condensed on the base of technical and professional, post-secondary education (period of study - 3 years)	condensed on the base of high education (period of study - 2 years)
Total hours by Working Curriculum, including	135			
Lectures	15			
practical (seminar)	30			
laboratory work	-			
SIWT	45			
SIW	45			
Exam (semester)	1,2			

Course Modality

The course has the combination of face-to-face mode with elements of blended and distance learning. Course studying expected following classes forms: lectures, practical, SIW, SIWT.

The given manual is structurally subdivided into two directions:

- ICT for teacher trainees in the field of social and humanitarian sciences;
- ICT for teacher trainees in the field of technical sciences;
- ICT for teacher trainees in the field of natural sciences.

The manual also contains the material necessary for the additional and obligatory reading for the specialties in three basic spheres stated above.

Here goes the list of specialties classified in accord with the three groups of scientific areas.

Social and humanitarian sciences	**Technical sciences**	**Natural sciences**
• 5B011600 5B011700 - «The Kazakh language and literature» • 5B012100 - «The Kazakh language and literature in schools with non-Kazakh language of education» • 5B011800 - «The Russian language and literature» • 5B012200 - «The Russian language and literature in schools with non-Russian language of education» • 5B011900 - «Foreign language: two foreign languages» • 5B010300 - «Pedagogy and Psychology» • 5B010500 - «Defectology» • 5B050300 - «Psychology» • 5B011600 - «Geography» • 5B010100 - «Pre-school teaching and upbringing» • 5B010200 - «Pedagogy and methods of primary education» • 5B011400 - «History» • 5B011500 - «Basics of Law and economics» • 5B010700 - «Fine arts» • 5B010600 - «Musical education» • 5B010800 - «Physical culture and sport» • 5B090200 - «Tourism»	• 5B012000 - «Professional education» • 5B011100 - «Informatics»	• 5B010900 - «Mathematics» • 5B011000 - «Physics» • 5B011200 - «Chemistry», • 5B011300 - «Biology»

Objectives of the manual:

- Students should be able to identify and understand the functions of the main components of a typical information and/or communication system as well as identify and understand the functions of various peripherals.
- They should be able to understand the main functions of a system software environment and to utilize its features in relation to the main applications software being used.
- Students should be able to use the main functions of the system software environment and to utilize its features in relation to the main applications software being used. They should be able to show competence in using a computer to generate simple things such as posters, banners, signs, invitations cards, calendars and drawings.

Sub-objectives:

Students should be able to:

- identify the main components of the hardware in use (i.e. Central Processing Unit (CPU), input devices, output devices and storage devices);
- demonstrate an understanding of the functions of the main components of the hardware in use;
- identify various peripheral devices (e.g. modem, fax-modem, plotter, scanner, digital camera);
- demonstrate an understanding of the functions of the various peripheral devices;
- demonstrate an understanding of the local network in use in relation to the external network (e.g. Internet) and the use of email;
- demonstrate an understanding of the main functions of the system software environment;
- demonstrate an understanding of the features of the system software environment (to the appropriate level) in relation to the main applications software.

Sub-objectives

Students should be able to:

- use the features of the system software environment (to the appropriate level) in relation to the main applications software;
- use network functions (if available) to the appropriate level;
- demonstrate the ability to use a computer competently to produce posters, banners, signs, invitation cards, calendars and letter heads using simple software;
- experience the enjoyment and stimulation of using computers.

1 Theoretical aspects of Basics of ICT

1.1 The role of ICT in education

The foremost aspect to be presented in this manual deals with the definition of ICT.

UNESCO defines ICT as "the scientific, technological and engineering disciplines and the management techniques used to handle transmit information with men and machines" [1].

According to the Digital video technical Glossary "ICT is the computing and communications facilities and features that support teaching, learning and a range of activities in education" [2].

The UK National Curriculum document in 2000 defines "ICT as the technology used to handle information and aid communication" [3].

According to the official IBM Glossary "ICT is the use of computer based information systems and communications systems to process, transmit, and store data and information." [4]

The UK Governments ICT year in 1972 describes "ICT as collective terms involved in handling and transmitting information. It includes computing, telecommunications and microelectronics [5].

The phrase *information and communication technology* has been used by academic researchers since the 1980s, and the abbreviation ICT became popular after it was used in a report to the UK government by **Dennis Stevenson** in **1997**, and in the revised National Curriculum for England, Wales and Northern Ireland in 2000. But in 2012, the Royal Society recommended that ICT should no longer be used in British educational institutions "as it has attracted too many negative connotations", and with effect from 2014 the National Curriculum uses the word computing, which reflects the addition of computer programming into the curriculum [6].

The field of education has been affected by ICTs, which have undoubtedly affected teaching, learning, and research. ICTs have the potential to accelerate, enrich, and deepen skills, to motivate and engage students, to help relate educational institution experience to work practices, create economic viability for tomorrow's workers, as well as strengthening teaching and helping educational institutions change [7]. In a rapidly changing world, computer education is essential for an individual to be able to access and apply information [8].

Information and communications technologies (ICT) provide a range of tools that can significantly extend and enrich teachers' instructional strategies and support students' learning. ICT tools include multimedia resources, databases, websites, digital cameras, and word-processing programs. Tools such as these can help students to collect, organize, and sort the data they gather, and to write, edit, and present reports on their findings.

ICT can also be used to connect students to other educational institutions, at home and abroad, and to bring the global community into the local classroom. A wide range of technologies can be easily integrated into the social sciences and

humanities curriculum. In food and nutrition courses, for example, students' learning is enhanced through the use of Canadian nutrient databases and nutrition analysis software. In fashion and housing courses, computer assisted design (CAD) software provides opportunities to enrich students' learning. Statistical analysis software and Statistics Canada databases can be used in all courses, especially when addressing expectations related to research and inquiry [9].

The role of Information and communication technology in teaching and learning of social studies is rapidly becoming one of the most important and widely discussed issues in contemporary education policy [10]. Most experts in the field of education agreed that when Information and Communication technology is used in the teaching and learning processes, it will improve and boost the ego of the educational institutions to a large extent. To this end, Poole [11] has indicated that computer illiteracy is now regarded as the new illiteracy. This has actually gingered a new and strong desire to equip educational institutions with computer facilities and qualified personnel necessary to produce technologically proficient and efficient students in developed countries of this world. Singapore educational institutions provide a rich diversity of experiences to help students grow holistically. Apart from the academic curriculum, students can develop themselves in music, arts and sports through co-curricular activities [12].

According to the three aspects stated above in introduction it is recommended to highlight the main aim, objectives and competences in the field of ICT applied to social and humanitarian, technical and natural sciences.

Thus, the aim of the ICT in the field of social and humanitarian area includes the following dimensions in pedagogical sphere.

According to Valencia-Molina, Serna-Collazos (2016), "the aim of a training plan based on ICT adoption should develop a series of competencies in the educational use of such technologies". In this case, the skills prioritized are the design, implementation and assessment of ICT-enabled educational spaces.

Competencies in the design of ICT-enabled education settings refer to planning and organizational skills around elements that lead to the construction of ICT-enabled education settings for meaningful learning and comprehensive education for students.

Competencies relating to *implementing* ICT-enabled learning experiences in education settings relate to skills that facilitate the design and planning of an education setting and that are then reflected in a teacher's education practice.

Lastly, competencies to assess the effectiveness of ICT-enabled education settings are linked to skills that enable teachers to *evaluate* effectiveness to promote meaningful learning in students as a result of ICTs being incorporated into their practice. It should be pointed that levels of adoption in terms of these competencies are assessed using activities designed by teachers. With that in mind, it is not possible to attribute a single level of competency to each teacher. Levels are based on how technology is used in specific practices [13].

Advantages of Students Using ICT for Learning

As was pointed out previously, the Internet provides students with the tools they need to discover and own knowledge. And give students the hooks and templates they

need to fasten information to the long-term memory. There are some advantages of student using ICT for learning:

1. Motivating Factor.

The Internet can act as a motivating tool for many students. Young people are very captivated with technology. Educators must capitalize on this interest, excitement, and enthusiasm about the Internet for the purpose of enhancing learning. For already enthusiastic learners, the Internet allows you to provide them with additional learning activities not readily available in the classroom.

2. Fast Communication.

The Internet promotes fast communication across geographical barriers. Your students can join collaborative projects that involve students from different states, countries or continents. This type of learning experience was not possible before the Internet. This is a unique learning experience very essential for each of our students, as the world is becoming one big community.

3. Cooperative Learning.

The Internet facilitates cooperative learning, encourages dialogue, and creates a more engaging classroom. For example, a LISTSER V for our class will allow your students to get involved in class discussions through e-mails in a way not possible within the four walls of the classroom.

4. Locating Research Materials.

Apart from communication, research is what takes many people to the Internet. There are many more resources on the Internet than the educational institution library can provide. We can encourage students to take advantage of this wealth of resources on the Internet for their research.

5. Acquiring Varied Writing Skills

If students are required to publish their work on the Internet, they have to develop hypertext skills. These skills help students gain experience in non-sequential writings. Moreover, and since the Internet is open to all with access, students publishing their work on the Internet are forced to be mindful of their language and to write to non-expert audience.

Disadvantages of Using ICT for Education

The use of the Internet for education is not without problems. Therefore, one should expect the problems to be encountered in using the Internet in teaching to be evolving as well. There are some disadvantage of using ICT for teaching and learning:

1. Plagiarism.

Apart from Web sites that claim to help students write term papers, there are numerous cases of students downloading information from the Net and turning them in for grades. We can minimize this problem by requiring students to cite research sources. There is an online service, Plagiarism.org at http://www.plagiarism.org/, which can assist us in minimizing cases of plagiarism in the class. This service claims to prevent plagiarism by determining if a term paper has been copied from the Internet or not.

2. Student Privacy.

Criminals, marketers, and other persons can easily get information from students when they are online. These could post danger to students' lives or may even lead to litigation against the educational institution. To avoid this problem, students should be educated on the dangers of giving information to people online. Parents and teachers need to supervise students' online activities.

3. Low Income Groups.

According to the US Department of Education, over 50% of public educational institutions with a high minority enrollment had a lower rate of Internet access than public educational institutions with a low minority enrollment in 1997. The same was true of instructional rooms in those educational institutions. In addition, students from low-income families may not have computers at home or may have computers at home with no access to the Internet. Consequently, students in low-income communities may be disadvantaged. To reduce the effect that social or economic status may have, we should give Internet assignments that students can easily complete while in educational institution. If necessary, educational institutions may need to keep computer labs open for longer and/or odd hours. The use of computers at public libraries should also be encouraged.

4. Preparation Time.

It takes a lot of preparation time to effectively use the Net for education. In addition to designing Internet based lesson plans, we may have to surf the Internet to download lesson plans and adapt them to support the curriculum objectives or visit sites to select those appropriate for classes. We have no choice but prepare in order to help your students become responsible user of the Internet [14].

Main advantages of ICT tools for education

1. Images can easily be used in teaching and improving the retentive memory of students;

2. Teachers can easily explain complex instructions and ensure students' comprehension.

3. Teachers are able to create interactive classes and make the lessons more enjoyable, which could improve student attendance and concentration.

Main disadvantages of ICT tools for education:

1. Setting up the devices can be very troublesome.

2. Too expensive to afford.

3. Hard for teachers to use with a lack of experience using ICT tools. [15]

Information and communication technology (ICT) has become, within a very short time, one of the basic building blocks of modern society. Many countries now regard understanding ICT and mastering the basic skills and concepts of ICT as part of the core of education, alongside reading, writing and numeracy.

UNESCO aims to ensure that all countries, both developed and developing, have access to the best educational facilities necessary to prepare young people to play full roles in modern society and to contribute to a knowledge nation. Because of the fundamental importance of ICT in the task of any educational institution today, developments in ICT now demand a completely new document in place of the first of these publications.

The curriculum is designed to be capable of implementation throughout the world to all secondary age students. The programme of teacher professional development relates closely to the ICT curriculum, and particularly to the stage of development that educational institutions have reached with respect to ICT.

ICT permeates the business environment, it underpins the success of modern corporations, and it provides governments with an efficient infrastructure. At the same time, ICT adds value to the processes of learning, and in the organization and management of learning institutions. The Internet is a driving force for much development and innovation in both developed and developing countries.

Countries must be able to benefit from technological developments. To be able to do so, a cadre of professionals has to be educated with sound ICT backgrounds, independent of specific computer platforms or software environments.

Technological developments lead to changes in work and changes in the organization of work, and required competencies are therefore changing. Gaining in importance are the following competencies:

- critical thinking,
- generalist (broad) competencies,
- ICT competencies enabling expert work,
- decision-making,
- handling of dynamic situations,
- working as a member of a team, and
- communicating effectively.

The use of ICT cuts across all aspects of economic and social life. Technological developments in ICT are very rapid. Technology quickly becomes obsolete requiring new skills and knowledge to be mastered frequently. Adaptation is only possible when based on a sound understanding of the principles and concepts of ICT.

Keeping pace with technological development and the changing competencies required of both students and their teachers requires a state-of the-art curriculum and appropriate teacher development.

The ICT curriculum for educational institutions presented in the chapters that follow is a state-of-the-art curriculum. This curriculum offers to educational institutions and countries where ICT curricula are evolving the foundations from which to advance rapidly. It is not effective to repeat the development process with respect to ICT education that has already taken place elsewhere since to do so only slows down development and keeps institutions and countries from closing the gap. Most important is the need to integrate or infuse ICT meaningfully throughout all educational institution subjects. Many opportunities arise from the inclusion of ICT: the ICT curriculum presented in this book attempts to facilitate fruitful use of these opportunities.

The curriculum has been designed in modular form so that education authorities can select appropriate elements to meet their objectives at the phase of development reached in their countries. Sufficient detailed description of each objective has been given so that textbook writers and educational publishers can produce course materials that meet local, cultural, and developmental circumstances. Alternatively,

high quality learning materials from developed countries may be adapted to meet local circumstances.

Teachers need to be adequately prepared to implement a state-of-the-art ICT curriculum. Indeed, introducing any new curriculum calls for careful preparation, management, resourcing, and continuing support.

In the case of an ICT curriculum, even more concerns have to be considered. Educational research studies show that programmes of professional development for teachers are most effective if directed to the stage of ICT development reached by educational institutions. The implications of these research findings are that teacher development is best conceived as an ongoing process, with many professional development activities conducted in educational institutions.

Circumstances and resources vary markedly between countries, all of which will impact on the implementation of any new ICT curriculum and will affect how educational systems cope with change.

Rapid developments in ICT are difficult to manage for Ministries of Education, educational managers, and educational institutions. A situation of constant change is also confronting to teaching staff and publishers. This ICT curriculum has been designed to help cope with these developments and situations of change. It helps Ministries of Education to develop a systematic and controlled secondary education ICT policy. It also helps educational institutions to develop ICT systematically and effectively in their programmes, if need be from scratch.

Circumstances vary between countries and between educational institutions within a country, and implementation factors have therefore to be taken into account when designing ICT curricula. The ICT curriculum presented here offers to countries and educational institutions a development framework that takes account of these variations between countries and educational institutions.

Various curriculum realizations, each of which is strongly influenced by cultural, societal and institutional factors, can be constructed in a straight forward way from the ICT curriculum that is presented. Educational institutions and countries will be able to construct an up-to-date curriculum from the curriculum framework provided in a process in which specific needs, restrictions with respect to resources, and other local circumstances are taken into account. The curriculum allows educational publishers and textbook writers to produce learning materials in the cultural traditions of their country.

In any educational system, the level of available resources places a restriction on the degree to which any new subject can be introduced into the educational institution curriculum, especially where only the most basic facilities have so far been provided. But ICT is of such importance to the future industrial and commercial health of a country that investment in the equipment, teacher education, and support services necessary for the effective delivery of an ICT-based curriculum should rank high in any set of government priorities.

The curriculum proposed takes account of these resource issues and specifies minimum requirements for effective delivery in different circumstances.

Information and communication technology, or ICT, is defined as the combination of informatics technology with other, related technologies, specifically communication technology.

In developing a curriculum for ICT, it is useful to have a model for ICT development. Such a model is not a miniature replica of some three dimensional object but rather a representation of the essential characteristics of ICT development to provide a scaffold or framework. Such a framework shows the interrelationship of various components within a system and aids understanding by educational administrators and policymakers.

Two models are presented here to provide a framework for what follows. The first model conceives ICT development as a continuum along which an educational system or an individual educational institution can pinpoint the approach that relates to the growth of ICT for their particular context. This model is referred to as a continuum of approaches to ICT development.

The second model depicts different stages in the way that those who are most involved in the use of ICT in educational institutions - teachers and students - discover, learn about, understand, and specialize in the use of ICT tools. This second model is referred to as stages of teaching and learning with and through ICT.

The two models, a continuum of approaches to ICT development and stages of teaching and learning with and through ICT, together provide the framework for an ICT curriculum and for the professional development of teachers detailed in this book.

Studies of ICT development in both developed and developing countries identify at least four broad approaches through which educational systems and individual educational institutions proceed in their adoption and use of ICT. These four approaches, termed emerging, applying, infusing, and transforming, represent a continuum depicted as the model in Figure 1.

Figure 1. Model depicting a continuum of approaches to ICT development in educational institutions

Educational institutions at the beginning stages of ICT development demonstrate the emerging approach. Such educational institutions begin to purchase, or have had donated, some computing equipment and software. In this initial phase, administrators and teachers are just starting to explore the possibilities and consequences of using ICT for educational institution management and adding ICT to the curriculum.

Educational institutions at this emerging phase are still firmly grounded in traditional, teacher-centred practice. The curriculum reflects an increase in basic

skills but there is an awareness of the uses of ICT. This curriculum assists movement to the next approach if so desired.

Those educational institutions in which a new understanding of the contribution of ICT to learning has developed exemplify the applying approach. In this secondary phase, administrators and teachers use ICT for tasks already carried out in educational institution management and in the curriculum. Teachers largely dominate the learning environment.

Educational institutions at the applying approach phase adapt the curriculum in order to increase the use of ICT in various subject areas with specific tools and software. This curriculum assists movement to the next approach if so desired.

At the next stage, the infusing approach involves integrating or embedding ICT across the curriculum, and is seen in those educational institutions that now employ a range of computer-based technologies in laboratories, classrooms, and administrative offices. Teachers explore new ways in which ICT changes their personal productivity and professional practice. The curriculum begins to merge subject areas to reflect real-world applications.

Educational institutions that use ICT to rethink and renew educational institution organization in creative ways are at the transforming approach. ICT becomes an integral though invisible part of daily personal productivity and professional practice. The focus of the curriculum is now learner-centred and integrates subject areas in real-world applications. ICT is taught as a separate subject at the professional level and is incorporated into all vocational areas. Educational institutions have become centres of learning for their communities.

Teaching and learning are best thought of, not as separate and independent activities, but rather as two sides of the same coin, interconnected and interrelated. Studies of teaching and learning in educational institutions around the world identify four broad stages in the way that teachers and students learn about and gain confidence in the use of ICT. These four stages give rise to the model depicted in Figure 2.2 that shows the stages in terms of discovering, learning how, understanding how and when, and specializing in the use of ICT tools.

The first stage (Stage A in Figure 2) that teachers and learners go through in ICT development is of discovering ICT tools and their general functions and uses. In this discovery stage, there is usually an emphasis on ICT literacy and basic skills. This stage of discovering ICT tools is linked with the emerging approach in ICT development.

Following on from the discovery of ICT tools comes the stage of learning how to use ICT tools, and beginning to make use of them in different disciplines (Stage B in Figure 2). This stage involves the use of general or particular applications of ICT, and is linked with the applying approach in ICT development.

Understanding how and when to use ICT tools

The next stage (Stage C in Figure 2) is understanding how and when to use ICT tools to achieve a particular purpose, such as in completing a given project. This stage implies the ability to recognize situations where ICT will be helpful, choosing the most appropriate tools for a particular task, and using these tools in combination

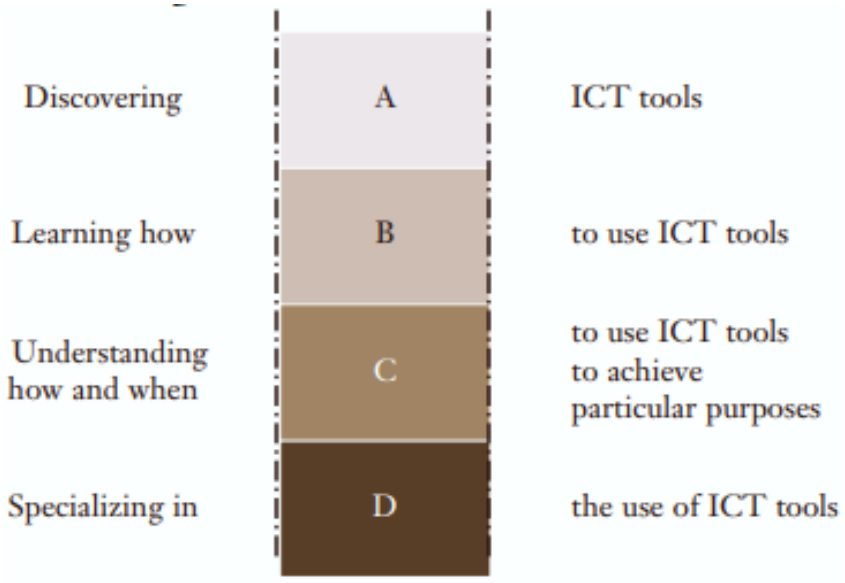


Figure 2. Model of stages of teaching and learning with and through ICT

to solve real problems. This stage is linked with the infusing and transforming approaches in ICT development.

Specializing in the use of ICT tools

The fourth and last stage (Stage D in Figure 2) involves specializing in the use of ICT tools such as occurs when one enters more deeply into the science that creates and supports ICT. In this stage students study ICT as a subject to become specialists. Such study concerns vocational or professional education rather than general education and is quite different from previous stages involving the use of ICT tools.

The model depicted in Figure 2 is useful in developing the structure of a curriculum designed for both teachers and students to improve their knowledge and skills in ICT. The design supplies four curriculum areas tied to the four stages of teaching and learning, allowing educational institutions to progress from:

• ICT Literacy (where ICT skills are taught and learned as a separate subject).

• Application of ICT in Subject Areas (where ICT skills are developed within separate subjects).

• Infusing ICT across the Curriculum (where ICT is integrated or embedded across all subjects of the curriculum).

• ICT Specialization (where ICT is taught and learned as an applied subject or to prepare for a profession).

ICT literacy

This curriculum area covers the use of ICT as encountered in the daily life of many communities. Specific units include basic concepts of ICT, using computers and managing files, word processing, spreadsheets, databases, creating presentations, finding information and communicating with computers, social and ethical issues, and jobs using ICT. The International Computer Driving Licence, which derived from The European Computer Driving Licence, was helpful in the organization of this area of the curriculum.

Application of ICT in subject areas

This area of the curriculum covers the application of ICT tools for working within specific subject areas such as languages, natural sciences, mathematics, social sciences, and art. Specific units include measurement, modelling and simulation, robots and feedback devices, statistics, creating graphics, spreadsheet design, and database design.

Infusing ICT across the curriculum

Examples of projects included in this area of the curriculum demonstrate the use of ICT across subject areas to work on real-world projects and to solve real problems. Some examples show how, within a particular course, ICT can help students integrate several subject areas, such as mathematics, science, and art. Other examples show larger projects that cut across several subject areas or illustrate how a number of educational institutions can integrate ICT in community or global projects.

ICT specialization

This area of the curriculum is designed for students who plan to go into professions that use ICT such as, for example, engineering, business, and computer science, or for students who plan to advance to higher education. Content covers the use of advanced tools and techniques for the ICT specialist. Specific units include basic and advancing programming, planning information systems, designing process control systems, and project management.

In the same way that a model proves useful in developing a curriculum structure for educational institutions, the model is similarly useful in planning for the professional development of teachers, which is so essential in the professional life of teachers when they begin to use ICT. The model depicted in Figure 1 that identifies approaches to ICT development helps provide a framework for professional development of staff in educational institutions.

Emerging ICT skills and knowledge

In the emerging approach to ICT development, the focus is on the technical functions and uses of ICT and on the need for some knowledge and representation of the impacts of ICT systems as a whole. This approach often involves teachers' personal use of ICT, such as, for instance, the use of word processing to prepare worksheets, locating information on CD-ROMs or on the Internet, or communicating with friends and family by email. Here, teachers are developing their ICT literacy and learning how to apply ICT to a range of personal and professional tasks. The emphasis is on training in a range of tools and applications, and increasing teachers' awareness of the opportunities for applying ICT to their teaching in the future.

In the applying approach, teachers use ICT for professional purposes, focusing on improving their subject teaching in order to enrich how they teach with a range of ICT applications. This approach often involves teachers in integrating ICT to teach specific subject skills and knowledge; beginning to change their methodology in the classroom; and using ICT to support their training and professional development.

Teachers gain confidence in a number of generic and specialized ICT tools that can be applied to the teaching of their subject area. The opportunity to apply ICT in

all their teaching is often limited only by a lack of ready access to ICT facilities and resources, which is why it is not fully integrated into all lessons for all students.

Infusing ICT to improve learning and management of learning

In the infusing approach to ICT development, ICT infuses all aspects of teachers' professional lives in such ways as to improve student learning and the management of learning processes. The approach supports active and creative teachers who are able to stimulate and manage the learning of students, integrating a range of preferred learning styles and uses of ICT in achieving their goals. The infusing approach often involves teachers easily integrating different knowledge and skills from other subjects into project-based curricula.

In this approach, teachers fully integrate ICT in all aspects of their professional lives to improve their own learning and the learning of their students. They use ICT to manage not only the learning of their students but also their own learning. They use ICT to assist all students to assess their own learning in achieving specific personal projects. In this approach, it becomes quite natural to collaborate with other teachers in solving common problems and to share their teaching experiences with others.

Transforming teaching through ICT

In the transforming approach to ICT development, teachers and other educational institution staff regard ICT as so natural and part of the everyday life of educational institutions that they begin to look at the process of teaching and learning in new ways. The emphasis changes from teacher-centred to learning-centred. Teachers, together with their students, expect a continuously changing teaching methodology designed to meet individual learning objectives.

1.2 ICT development at the educational institution level

Advances in technology and the way technology is incorporated into a system is a dynamic process. Each educational institution must work within the context of its own system to fit choices to what best suits its unique situation and culture. Even within an educational institution, various units or courses may use different approaches. The approaches are hierarchical with the emerging approach as a beginning point, and the transforming approach as a goal many perceive as the future of education.

Emerging

The emerging approach is linked with educational institutions at the beginning stages of ICT development. Such educational institutions begin to purchase computer equipment and software or perhaps have had some donated. In this initial phase, administrators and teachers are just starting to explore the possibilities and consequences of adding ICT for educational institution management and the curriculum. The educational institution is still firmly grounded in traditional, teacher-centred practice. For example, teachers tend to lecture and provide content while students listen, take notes, and are assessed on the prescribed content. Educational

institution organization provides discrete time periods for each subject. Learners' access to technology is through individual teachers. A curriculum that focuses on basic skills and an awareness of the uses of ICT assists movement to the next approach.

Applying

The applying approach is linked with educational institutions in which a new understanding of the contribution of ICT to learning has developed. In this phase, administrators and teachers use ICT for tasks already carried out in educational institution management and in the curriculum. Teachers still largely dominate the learning environment. For example, instructing may be supplemented with ICT such as electronic slide presentations and word-processed handouts. Students receive instruction and add notes to teacher prepared handouts. They use ICT tools to complete required lessons and are assessed on prescribed content. Educational institution organization provides discrete time periods for each subject with some flexibility to combine subjects and time periods. Learner access to technology is through one or two classroom computers and computer labs. Until now, ICT has been taught as a separate subject area. To move to the next phase, the educational institution chooses to implement an ICT-based curriculum that increases ICT across various subject areas with the use of specific tools and software.

Infusing

The infusing approach is linked with educational institutions that now have a range of computer-based technologies in laboratories, classrooms, and administrative areas. Teachers explore new ways in which ICT changes their personal productivity and professional practice. The curriculum begins to merge subject areas to reflect real-world applications. For example, content is provided from multiple sources, including community and global resources through the World Wide Web. Students' access to technology enables them to choose projects and ICT tools that stimulate learning and demonstrate their knowledge across subject areas. Educational institution organization provides the flexibility to combine subjects and time periods. Learners have more choices with regard to learning styles and pathways. They take more responsibility for their own learning and assessment. ICT is taught to selected students as a subject area at the professional level. To advance to the next phase, educational institutions choose an ICT curriculum that allows a project-based, ICT-enhanced approach. These educational institutions begin to involve the community more in the learning environment and as resource providers.

Transforming

The transforming approach is linked with educational institutions that have used ICT creatively to rethink and renew educational institution organization. ICT becomes an integral though invisible part of the daily personal productivity and professional practice. The focus of the curriculum is now much more learner-centred and integrates subject areas in real-world applications. For example, students may work with community leaders to solve local problems by accessing, analyzing, reporting, and presenting information with ICT tools. Learners’ access to technology is broad and unrestricted. They take even more responsibility for their own learning

and assessment. ICT is taught as a subject area at an applied level and is incorporated into all vocational areas. The educational institution has become a centre of learning for the community.

Characteristics of educational institutions related to ICT development

Along with approaches to ICT development noted above, there are various characteristics of educational institutions, or aspects of educational institution leadership, that relate to an educational institution's progress in ICT development. Below are general descriptions of the more important of these characteristics of educational institutions that have an effect on ICT development within educational institutions.

Vision

Vision refers to the aspirations and goals of both individuals within an educational institution and the educational institution system as a whole. As the educational institution advances, the mission statements should become clearer and provide a basis for decision-making. Mission statements should help individual members of the learning community visualize an educational institution's aspirations for the future and act in harmony.

Philosophy of learning and pedagogy

Ways in which teachers and students interact and how the educational institution is managed for learning are part of what is meant by an educational institution's philosophy of learning and pedagogy. These philosophies will necessarily characterize the ways in which ICT is incorporated into an educational institution. A setting that is dominated by the teacher as the main provider of subject content is adopting a teacher-centred philosophy. The teacher controls the use of ICT in such a setting as well. A learner-centred philosophy, by contrast, describes a setting where content comes from a variety of resources, and where projects are chosen and designed by the students. ICT tools and resources are selected by students in ways that match the aims of a project best. These contrasting approaches to pedagogy are sometimes referred to as instructivist and constructivist respectively.

Development plans and policies

How an educational institution's vision and teaching philosophies are carried out is translated into development plans and policies. In the detailed steps of such plans and policies, goals and objectives are further defined providing interim and long-term targets. Policies are set, a budget is allocated, facilities are determined, roles are defined, tasks are delegated, and an evaluation plan is created to define the direction ICT development will take.

Facilities and resources

The learning environment in which ICT is used requires certain facilities and resources. Facilities include basic infrastructure such as electrical wiring, Internet access, lighting, air-conditioning, and space. Decisions on inclusion or lack of ergonomic design and choice of furniture impact not only on use of ICT, but also on the health and well being of users. Resources include various types of technological devices from computers with peripherals, video equipment, and specialized tools like

digital microscopes. Further resources include various types of software, as well as traditional tools like books, videos, and audiotapes.

Understanding the curriculum

An understanding of the curriculum affects the progression of ICT in the curriculum in following various stages of development. First, is an awareness stage in which students become ICT literate with regard to what technology is available and how it might be used. Second, as students learn basic skills, they begin to apply various ICT tools to their regular learning assignments and projects. Third, as students become more capable and confident with ICT, they begin to integrate and overlap both subject areas and tools. Last, is the applied use of ICT in which students are now enabled to address larger, more complex, real-world professional issues.

Professional development of educational institution staff

In parallel with the curriculum for students, there must be professional development of the staff within an educational institution. The personal productivity and professional practice of teachers are enhanced with the use of ICT. First, is an awareness stage in which teachers and staff become ICT literate with regard to what technology is available and how it might be used. Second, as teachers and staff learn basic skills, they begin to apply various ICT tools to their regular tasks and projects. Third, as teachers and staff become more capable and confident with ICT, they begin to integrate and overlap both subject areas and tools. Last, is a change in professional practice in which teachers are now enabled to design lessons to incorporate larger, more complex, real-world projects using ICT tools and resources. As ICT is introduced into educational institution systems, there is a tendency to move from discrete skills training to reflective practice and integrative professional development. Budgetary allocation and provision for release time for teacher professional development seriously impact on the ability of an educational institution system to incorporate ICT in a meaningful way.

Community involvement

Community involvement may include parents, families, businesses, industry, government agencies, private foundations, social, religious and professional organizations, as well as other educational institutions such as vocational educational institutions and universities. Community involvement can come in the form of donations of equipment and resources, or may be in human resources provided for training and technical assistance. As a community contributes to an educational institution, so the educational institution can give back in many ways. For example, an educational institution may decide to provide community members with evening access to computer labs, or have students offer training to parents. The use of ICT provides an opportunity for an educational institution and its students to interact with both local and global communities. Interaction may range from building web sites for community organizations, to sharing projects with remote educational institutions.

Assessment

Assessment includes both assessments of students as well as overall evaluation of an educational institution system, two aspects that are intricately interwoven. An improvement in the one should predicate an improvement in the other. Means of

student assessment should reflect choices in learning pedagogy and an understanding of ICT in the curriculum. For example, in the emerging and applying stages of ICT, assessment may be linked to pencil and paper tests, whereas in the infusing and transforming stages project based portfolios may be more appropriate. Each part of an educational institution system needs to be evaluated to determine its impact on learning. Assessment should inform practice and support the management of learning. Assessment should allow a system to determine whether outcomes have been met, and then reviewed and revised accordingly. Budget allocations, policies, and procedures for ICT should match vision, teaching philosophies, and curriculum choices.

A matrix for ICT development in educational institutions

A two-dimensional matrix is developed below (see Table 1) that helps educational institutions determine their stage of progress with regard to the implementation of ICT in the curriculum. Along the horizontal dimension are charted the four approaches to ICT development described first in this chapter, while along the vertical dimension are the eight characteristics of educational institutions that relate to ICT development described immediately above in this chapter. Each cell of the matrix provides a brief picture or set of indicators of how a particular approach to ICT may look like in educational institutions sharing similar characteristics. For each row of the matrix, an educational institution may find itself more in one cell while being less involved in other cells. Both the identified approaches and the characteristics of educational institutions depicted in Table 1 derive from international trends in the use of ICT in education.

Emerging approach

The second column of Table 1 lists indicators for eight characteristics of educational institutions under the emerging approach to ICT development. These indicators are now described in more detail.

Vision

The educational institution's vision of learning and ICT is beginning to develop. The use of ICT is focused on computers under the responsibility of an enthusiastic individual or a small group with very specific uses for teaching or administration, based on their own knowledge and expertise. The vision is a pragmatic response with access to resources and expertise available.

Philosophy of learning and pedagogy

The individual teacher is responsible for discrete lessons concentrating on the development of ICT skills and the transmission of subject knowledge. The pedagogy of the enthusiastic individual or small group of teachers is restricted by the educational institution organization and fixed timetable lesson periods.

Development plans and policies

The development of ICT in the educational institution is separate from the overall educational institution development plan and policies regarding curriculum, personnel, professional development, finance, community, teaching, learning and assessment. Teachers and students discover for themselves opportunities to use computers and software.

Table 1. Matrix of indicators to determine an educational institution's stage of progress in implementing ICT in terms of four approaches to ICT development and eight characteristics of educational institutions

	Emerging	Applying
Vision	Dominated by individual interest. Limited. Pragmatic.	Driven by ICT specialists.
Learning pedagogy	Teacher-centred. Didactic.	Factual knowledge-based learning. Teacher-centred. Didactic. ICT a separate subject.
Development plans and policies	Non-existent. Accidental. Restrictive policies. No planned funding.	Limited. ICT development led by specialist. Centralized policies. Hardware and software funding. Automating existing practices.
Facilities and resources	Stand-alone workstations for administration. Individual classrooms. Computers and printers. Word processing, spreadsheets, databases, presentation software. Educational institution administration software. Games.	Computer lab or individual classrooms for ICT specific outcomes. Computers, printers and limited peripherals. Word processing, spreadsheets, databases, presentation software. ICT software. Internet access.
Understanding of curriculum	ICT literacy. Awareness of software. Responsibility of individual teachers.	Applying software within discrete subjects. Use of artificial and isolated contexts.
Professional development for educational institution staff	Individual interest.	ICT applications training. Unplanned. Personal ICT skills.
Community	Discreet donations. Problem-driven. Accidental.	Seeking donations and grants. Parental and community involvement in ICT.
Assessment	Equipment-based. Budget-oriented. Discrete subjects. Didactic. Paper and pencil. Controlling. Closed tasks. Responsibility of individual teacher.	Skills-based. Teacher-centred. Subject focused. Reporting levels. Moderated within subject areas.

Continuation of the table 1

Infusing	Transforming
Driven by subject specialists. Discrete areas.	Leadership. Acceptance by entire learning community. Network-centred community.
Learner-centred learning. Collaborative.	Critical thinking and informed decision-making. Whole learner, multi-sensory, preferred learning styles. Collaborative. Experiential.
Individual subject plans include ICT. Permissive policies. Broadly-based funding, including teacher professional development.	ICT is integral to overall educational institution development plan. All students and all teachers involved. Inclusive policies. All aspects of ICT funding integral to overall educational institution budget. Integral professional development.

Infusing	Transforming
Computer lab and/or classroom computers. Networked classrooms. Intranet and Internet. Resource-rich learning centres. Range of devices, including digital cameras, scanners, video and audio recorders, graphical calculators, portable computers, remote sensing devices. Video-conferencing. Word processing, spreadsheets databases, presentation software. Range of subject-oriented content. Multimedia authoring, video/ audio production. Range of subject specific software.	Whole educational institution learning with ICT with access to technology resources and a wide range of current devices. Emphasis on a diverse set of learning environments. The whole range of devices in the column to the left and web-based learning spaces. Brainstorming. Conferencing and collaboration. Distance education. Web courseware. Student self-management software.
Infusion with non-ICT content. Integrated learning systems. Authentic contexts. Problem solving project methodology. Resources-based learning.	Virtual and real-time contexts, new world modelling. ICT is accepted as a pedagogical agent itself. The curriculum is delivered via the Web and staff in an integrated way.
Subject specific. Professional skills. Integrating subject areas using ICT. Evolving.	Focus on learning and management of learning. Self-managed, personal vision and plan, educational institution supported. Innovative and creative. Integrated learning community with students and teachers as co-learners.
Subject-based learning community providing discrete, occasional assistance, by request. Global and local networked communities.	Broad-based learning community actively involved parents and families, business, industry, religious organizations, universities, vocational educational institutions, voluntary organizations. Global and local, real and virtual. Educational institution is a learning resource for the community – physically and virtually.
Integrated. Portfolios. Subject-oriented. Learner-centred. Student responsibility Multiple media to demonstrate attainment. Moderated across subject areas. Social and ethical as well as technical.	Continuous. Holistic - the whole learner. Peermediated. Learner-centred. Learning community involvement. Open-ended. Project-based.

Facilities and resources

The ICT facilities and resources consist of a few isolated, stand-alone computers and printers in the educational institution office and a few classrooms. The content available is very limited consisting of generic office type applications and educational institution management software, with a few games providing reward to some pupils. Content will be determined by the needs of a few teachers and their teaching.

Understanding the curriculum

ICT teaching is to ensure students are ICT literate. The curriculum is structured to teach students a sound basic understanding of available software applications. The curriculum is planned and delivered by individual teachers.

Professional development of educational institution staff

Learning and ICT training will emphasize the need to learn to operate a limited range of software for teaching and administration. Individual members of staff will identify their training needs, which is generally restricted to technical training. The ICT development plan will identify training separately from other educational institution training and professional development. ICT training and development is partly funded by the educational institution and teachers.

Community

Community involvement in the educational institution is a welcome, although often an un-planned activity. There may be contribution by community members to educational institution activities and the educational institution becomes a focus of the community.

Assessment

Assessment strategies emphasize the limiting nature of equipment and budget on levels of attainment. Paper and pencil testing is widely used due to the limited ICT resources. Assessment allows the teacher to control the pace of learning. Assessment tasks and moderation of levels of attainment is the responsibility of the individual teacher. ICT assessment is independent of other student and educational institution assessments.

Applying approach

Indicators for the eight characteristics of educational institutions under the applying approach to ICT development listed in the third column of Table 1 are described in more detail below.

Vision

The educational institution ICT specialist is responsible for any statement about a vision of learning and ICT in the educational institution. There is an emphasis on learning about ICT and developing the educational institution's facilities and resources.

Philosophy of learning and pedagogy

A teacher-centred didactic approach focuses on development and transmission of ICT skills and factual knowledge. The pedagogy of the educational institution ICT specialist drives the teaching and use of ICT as a separate, specialist subject.

Development plans and policies

Responsibility for development of an ICT plan and policies is delegated to the ICT specialist in the educational institution. Emphazis is placed on acquiring computer equipment and resources but plans and policies centralize the use and access to ICT resources, tightly managing access opportunities. Funding is provided for the acquisition of hardware and software in support for a defined part of the educational institution's curriculum and pedagogy. The educational institution plan seeks to increase teaching and administration efficiency and effectiveness.

Facilities and resources

The educational institution ICT specialist manages all available ICT resources, such as any computer laboratories in the educational institution and stand-alone computers in classrooms, together with access to these. There is a limited range of computer peripherals such as printers with usage specific to the ICT curriculum.

Internet access is available for some of the computers in the educational institution. Software is available to teach the ICT curriculum. The applications are used within teaching contexts created by individual teachers to provide clear and predictable results for students, ensuring success. The Internet and the World Wide Web are used in a customized way with planned access to selected sites to ensure predictable outcomes to lessons.

Understanding the curriculum

ICT teaching will provide opportunities for students to apply their ICT literacy skills using teacher-created examples within specified contexts. The curriculum is structured to provide students with opportunities to apply their ICT literacy in other subject areas to acquire specific skills and knowledge.

Professional development of educational institution staff

Skills training will be provided to support teachers of the ICT curriculum. The training will support the use of individual software applications and learning resources. Training will concentrate on the management of ICT, emphasizing personal ICT skill development. Training will tend to be "just-in-time" for a specific teaching topic or to coincide with the arrival of a new piece of software. Internet-based training will emphasize the identification of information, with direct support for the existing curriculum in a range of subjects.

Community

The educational institution ICT specialist will seek donations and grants to develop the ICT resources and facilities within the educational institution. ICT skills of parents and community members will be sought in support of the specified curriculum.

Assessment

Assessment allows teachers to report students' level of ICT literacy and their ability to apply what they have learned in ICT and other subjects. Individual teachers share assessments of students' attainment with other teachers within their subject area to moderate their reporting of standards of attainment. The assessments provide the opportunity for teachers to amend their curriculum. Assessment strategies are the responsibility of individual subject areas.

Infusing approach

Further detail about the indicators for each of the eight characteristics of educational institutions under the infusing approach to ICT development listed in the fourth column of Table 1 follow.

Vision

The educational institution's learning and vision for ICT is developed and shared by subject specialists who seek to increase student levels of attainment in their subjects, exploring new ways of learning and the management of learning. The vision belongs to all staff and to the educational institution's local and global learning communities, as well as to students.

Philosophy of learning and pedagogy

A learner-centred approach, supporting students' choice of preferred learning styles and learning environments, tends to dominate. Students are able to collaborate

with other learners, infusing learning across subjects, and utilizing a wide range of resources found by students. The use of ICT to investigate and explore new approaches to learning is accepted.

Development plans and policies

The individual subject areas infuse ICT into their plans and policies within the total educational institution development plan and policies. The educational institution's planning processes encourage collaborative approaches to learning and the management of learning by staff and students. Funding of ICT is broadly-based and integral to the annual budgetary cycle. The provision of funding covers all aspects of ICT, including professional development of educational institution staff.

Facilities and resources

The whole educational institution is networked to ensure access to multimedia and learning-rich resources via the educational institution's Intranet and the Internet wherever students and teachers are, in or out of educational institution. The computer labs and classroom computers are sufficient in number to allow ready access by students and staff in most subjects across the educational institution. Software content is critically appraised to ensure it matches the requirements of the curriculum supporting a wide range of multi-sensory learning styles. All staff help identify the software and learning resources required. A wide range of peripheral and remote working devices, including video-conferencing, is provided and integrated into the curriculum. Large and small group presentation facilities are readily available.

Understanding the curriculum

The curriculum provides the opportunity for students to utilize their ICT literacy skills in real problem solving by means of project work that offers new ways for students to demonstrate their learning. The curriculum seeks to use real contexts for learning, using educational institution-based and externally available resources. ICT is used as a tutor to support specific learning goals. Teachers regularly review the curriculum for opportunities to incorporate the use of ICT.

Professional development of educational institution staff

Emphazis is placed on the professional development of teachers' subject skills and their capabilities to apply ICT in a range of contexts. The provision of educational institution-based, in-service training to support the shared development of collaborative, cross-curriculum uses of ICT complements any external professional development provision. The educational institution's programme of professional development has evolved to meet changing needs and new opportunities.

Community

Staff and students make ready use of their local and emerging global learning communities to provide specific assistance for additional opportunities offered through ICT, especially the Internet and video-conferencing. The educational institution has a regular programme to attract donations and grants to further develop ICT resources and curriculum within the educational institution.

Assessment

Students' assessments are not limited to specific subjects, with reports on attainment informing all teachers in planning teaching and learning programmes of

study. Students are responsible for maintaining personal portfolios of their work, demonstrating their attainment, over one or more years, using ICT facilities and resources to complement paper-based records. The assessments inform whole educational institution curriculum planning and resource allocations.

Transforming approach

The final column in Table 1 lists indicators for the eight characteristics of educational institutions under the transforming approach. These indicators are described in further detail below.

Vision

The educational institution provides leadership to its learning community, providing innovative and creative access and opportunities to learning and the management of learning, maximizing the contribution of ICT to realize the educational institution of tomorrow, today. The educational institution sees itself as network-centred, providing a physical place to learn, as well as web-based learning spaces, accessible any time, anywhere, by students and staff.

Philosophy of learning and pedagogy

Emphazis is upon the whole learner in all aspects of their learning, with a focus on critical thinking skills and well-founded decision-making. Every student is responsible for his or her own learning. Learning is experiential, with learning pathways and learning styles continuously changing to meet learner requirements. The use of ICT to investigate and explore new approaches to learning is expected.

Development plans and policies

The educational institution and learning community use ICT to rethink creatively and to renew the learning environment of students and staff, including the development planning and policy-making processes. The plans for the educational institution seek to support continuous change and renewal, striving to provide truly differentiated and individualized curriculum for all students, and seeking to maximize student achievement. ICT funding is seen as essential as funding for basic utilities like water and power. Effective, accessible, and inclusive ICT ensures that learning environments are mission-critical to all staff, students and learning communities.

Facilities and resources

A whole educational institution learning and ICT infrastructure provides ready access to innovative learning environments and contexts. Educational institution facilities and resources are designed and enabled to support continuous change and development of approaches to learning, the management of learning, and technology.

Understanding the curriculum

The curriculum is enabled by an understanding of the learning needs of every student, informed on a continuous basis by management of learning systems. Students' ICT literacy skills are assumed to enable learning readily within a personalized curriculum. The curriculum uses as a matter of course virtual and real world, real-time contexts, and modelling. Students are involved in solving real problems.

Professional development of educational institution staff

Focus is placed on learning and the management of learning, with specific ICT training provided when it is required. Teachers' development is self-managed, and informed by a well-founded personal vision and plan, that supports the educational institution's overall vision and the needs of the learners. Teachers accept their role as co-learners, learning together with their students. Teachers are committed to professional development as a continuous, critically reflective process.

Community

The community is a natural partner with the educational institution, actively involved in all aspects of the staff and students' learning processes, and providing real-world contexts through which learning takes place. In turn, the educational institution is a learning resource for the whole community, offering access to local and global learning environments with physical visits as well as virtual visits through the Internet. The educational institution is as much a part of the community as the community is a part of the educational institution: the boundaries are indistinct to the observer.

Assessment

Students are responsible for their own continuous assessment to inform and plan a personal curriculum that is matched to their preferred learning styles. The assessments are moderated between students as well as between teachers, providing a holistic view of the whole learner across the curriculum. Students maintain a portfolio of all their work on the network. Students' attainments and preferred learning styles determine the educational institution's curriculum and policies. Staff and student assessments determine the management of learning [16].

1.3 Principles for the choice of ICT tools

The principles or guidelines are of paramount importance when choosing any tool connected with ICT. Principles are necessary due to the following reasons:

1. principles are directions to be followed in the rapidly changing ICT world;
2. psychological approach must be taken into account when dealing with ICT;
3. various specialties in the HEIs (like KSPI) have specific aims and special levels of the outcome gained at the end of the course on ICT.

Let us consider the principles on ICT tools choice when dealing with the various specialties and personalities, and demands of the future teachers.

Principles of the choice of ICT:

1. Principle of scientific orientation of the educational process;
2. Principle of consciousness when perceiving information;
3. Principle of accounting individual peculiarities of participants;
4. Principle of visualization in education;
5. Principle of motivating character of education;
6. Principle of interactivity in education;
7. Principle of the complex use of ICT tools and other aids in education.

Approaches to ICT development

Advances in technology and the way technology is incorporated into a system is a dynamic process. Each educational institution must work within the context of its own system to fit choices to what best suits its unique situation and culture. Even within an educational institution, various units or courses may use different approaches. The approaches are hierarchical with the emerging approach as a beginning point, and the transforming approach as a goal many perceive as the future of education. This information in a more detailed mode has been discussed above. Here is the outline of every approach used to ICT development.

Emerging

The emerging approach is linked with educational institutions at the beginning stages of ICT development. Such educational institutions begin to purchase computer equipment and software or perhaps have had some donated. In this initial phase, administrators and teachers are just starting to explore the possibilities and consequences of adding ICT for educational institution management and the curriculum. The educational institution is still firmly grounded in traditional, teacher-centred practice. For example, teachers tend to lecture and provide content while students listen, take notes, and are assessed on the prescribed content. Educational institution organization provides discrete time periods for each subject. Learners' access to technology is through individual teachers. A curriculum that focuses on basic skills and an awareness of the uses of ICT assists movement to the next approach.

Applying

The applying approach is linked with educational institutions in which a new understanding of the contribution of ICT to learning has developed. In this phase, administrators and teachers use ICT for tasks already carried out in educational institution management and in the curriculum. Teachers still largely dominate the learning environment. For example, instructing may be supplemented with ICT such as electronic slide presentations and word-processed handouts. Students receive instruction and add notes to teacher prepared handouts. They use ICT tools to complete required lessons and are assessed on prescribed content. Educational institution organization provides discrete time periods for each subject with some flexibility to combine subjects and time periods. Learner access to technology is through one or two classroom computers and computer labs. Until now, ICT has been taught as a separate subject area. To move to the next phase, the educational institution chooses to implement an ICT-based curriculum that increases ICT across various subject areas with the use of specific tools and software.

Infusing

The infusing approach is linked with educational institutions that now have a range of computer-based technologies in laboratories, classrooms, and administrative areas. Teachers explore new ways in which ICT changes their personal productivity and professional practice. The curriculum begins to merge subject areas to reflect real-world applications. For example, content is provided from multiple sources, including community and global resources through the World Wide Web. Students'

access to technology enables them to choose projects and ICT tools that stimulate learning and demonstrate their knowledge across subject areas. Educational institution organization provides the flexibility to combine subjects and time periods. Learners have more choices with regard to learning styles and path ways. They take more responsibility for their own learning and assessment. ICT is taught to selected students as a subject area at the professional level. To advance to the next phase, educational institutions choose an ICT curriculum that allows a project-based, ICT-enhanced approach. These educational institutions begin to involve the community more in the learning environment and as resource providers.

Transforming

The transforming approach is linked with educational institutions that have used ICT creatively to rethink and renew educational institution organization. ICT becomes an integral though invisible part of the daily personal productivity and professional practice. The focus of the curriculum is now much more learner-centred and integrates subject areas in real-world applications. For example, students may work with community leaders to solve local problems by accessing, analyzing, reporting, and presenting information with ICT tools. Learners' access to technology is broad and unrestricted. They take even more responsibility for their own learning and assessment. ICT is taught as a subject area at an applied level and is incorporated into all vocational areas. The educational institution has become a center of learning for the community [17].

1.4 Classification of ICT tools in education

Teachers need to be adequately prepared to implement a state-of-the-art ICT curriculum. Indeed, introducing any new curriculum calls for careful preparation, management, resourcing, and continuing support. In the case of an ICT curriculum, even more concerns have to be considered. Educational research studies show that programmes of professional development for teachers are most effective if directed to the stage of ICT development reached by educational institutions. The implications of these research findings are that teacher development is best conceived as an ongoing process, with many professional development activities conducted in educational institutions.

ICT tools play an important role in teacher training of all specialties. But the requirements to their choice must be strictly followed when training social and humanitarian, technical and natural fields.

The following examples of ICT tools, devices and infrastructure provide an overview of some of the technologies you will encounter as you teach and interact with learners of all ages. The list in Table 2 is by no means exhaustive but is intended to guide your thinking, planning, and future questions about if, how, why and when to use different forms of ICT in your teaching [18].

Table 2. ICT tools and devices

Example of tool, device, infrastructure	Definition
Web-based Tools and Applications for managing learning and teaching	
Learning Management Systems	Internet based software that deploys, manages, tracks and reports on interaction between the learner and the content, and the learner and the instructor. They enable student registration, track learner progress, record test scores and indicate course completions. They also allow the instructor to assess student performance. Example: WebCT. (p. 32)
Student Management Systems	May include financial, timetabling, student records and reporting. May also enable parents to review their child's performance online Example: PowerEducational institution (p.34)
Digital Student Report Card Systems	A digitized system for transmitting student information. Can embed real examples of a student's work from an e-portfolio. (p. 36)
Plagiarism Detection Systems	Examines digital text and by comparing nature and frequency of particular word strings, provides feedback to educator on the likelihood that a particular piece of work has been plagiarised. Example: turnitin software. (p. 37)
Online Collaborative Workspaces	Online communication tools to enable collaboration. Examples: Bulletin board, email discussion lists. (p. 38)
Virtual Classroom Software Systems	Deliver an interactive learning environment to students with a computer and Internet connection. The software presents the student with a screen consisting of an instructional area, bordered by items such as class location, message board etc. (p. 40)
e-Portfolios	Electronic (or digital) portfolio - digital storage to enable an individual to maintain an ongoing record of their work, achievements, awards and assessments. (p. 42)
Learning and teaching tools	
Interactive whiteboards	A whiteboard surface that displays digital files from a computer via a data projector. May function as a standard whiteboard i.e., teacher or student may write on it and then digitise the marked up material. (p. 50)
Personal communication	Digital communication, which enables individuals to talk to one person or more. E.g. web forums, Internet relay chat, sms (short messaging service) on mobile phones. (pp. 57-60)
Mobile delivery devices: The digital backpack	
Storage devices	Device for transferring electronic work between various devices and physical locations and to backup work, e.g. USB memory stick. (p. 63)
Personal Digital Entertainment Devices (PDEs) and MP3 Players	Enable user to download, store and play audio, photo and video files and in many cases, to take part in interactive activities. (pp. 64–65)
Personal Digital Assistants (PDAs) (also known as Handheld Devices)	PDAs and PocketPCs allow input of data via a mini keyboard or equivalent, they usually include a calendar,

Example of tool, device, infrastructure	Definition
	organiser functions, basic software functions such as word processing, email, spreadsheets, data storage and wireless capacity. (p. 67)
Mobile phones	Increasingly these allow communication via photos, video as well as text messaging. (p. 68)
Laptops	A mobile computer that is operated with a battery away from power sources. Newer versions are now wireless and can connect to the Internet in wireless hotspots. (p. 70)
TabletPCs	A small screen (12") laptop PC in which data may be directly entered onto the screen with a special pen. (p. 72)
Gaming Devices	Consist of a gaming console (e.g. Gameboy) and games or a content delivery method. (p. 73)
Assistive and Adaptive Technologies	Technology that supports students with disabilities, such as screen readers, and virtual pencils. (p. 75)
Content delivery methods	
Podcasts	Podcasting is a method of publishing audio files via the Internet, allowing users to subscribe to a feed to receive new files automatically. (p. 78)
Vodcasts	Video on demand is the same concept as podcasting but with video files. (p. 80)
Blogs	A web-based journal or log book. Logs are chronologically ordered web-postings by an author or group of authors. They may be personal, individual records, group collaborations or representative of an institution. (p. 81)
Wikis	A Wiki or wiki is a website (or other hypertext document collection) that allows users to add content, on an Internet forum, but also allows anyone to edit the content. "Wiki" also refers the collaborative software used to create such a website. (p. 83)
Voice over Internet Protocol (VoIP)	Enables transmission of voice across the Internet. Example: Skype (p. 84)
Digital TV	Similar to analogue TV but has the capacity to deliver rich multimedia learning experiences. It enables interactivity. (p. 86)
Other devices, concepts, and technologies	
Moblogs and Photoblogs	A combination of the words blog and mobile. It means the capacity to post items to a blog using a mobile phone or other mobile device. (p. 88)
Digital Cameras	Film is stored digitally.
Scanners	Enable the digitisation of analogue content. Digital items can then be manipulated by software on the computer and stored. (p. 89)
Swarming (also called "meetups")	People with a common interest come together quickly to experience or participate in an event. Mobile devices are often used to generate swarms. They may be used for educational, political or social reasons. Example: learning

Continuation of the table 2

Example of tool, device, infrastructure	Definition
	swarms - students come together for a learning event. (p. 89)
Peer-to-peer Networking and Technologies	A network that allows two or more computers to share their resources, such as hard drives, CD-Rom drives and printers. Enables students and teachers to share files locally and internationally. (p. 89)

As it has been already mentioned - Information and Communication Technology consists of various tools and systems that can be exploited by capable and creative teachers to improve teaching and learning situations.

Classification of ICT tools was widely given by Lim and Tay (2003). This classification includes:

1) Informative tools - Internet, Network Virtual Drive, Intranet systems, Homepage, etc.

2) Situating tools - CD-ROM, etc.

3) Constructive tools - MS Word, PowerPoint, FrontPage, Adobe Photoshop, Lego Mindstorm, etc.

4) Communicative tools - e-mail, SMS, etc.

5) Collaborative tools - discussion boards, etc. forum [19]

Informative Tools

Informative tools are applications that provide large amounts of information in various formats such as text, graphics, sound, or video. Informative tools can be regarded as a passive repository of information (Chen & Hsu, 1999). Examples include tools and information resources of the existing multimedia encyclopedia of the Internet.

Situating Tools

Situating tools can be a system that lay the students in the environment where it involve a context and the occurrence of a situation. Examples of such systems include simulation, virtual reality and multi-user domain.

Situating tools software tools such as CD-ROM. CD-ROM offers hypermedia application which gives better opportunities for teachers to enhance learning environment. Hypermedia application covers more than one of the following media such as text, audio, graphic images (still images), animation and video clips. Hypermedia applications are well integrated in the learning environment to enhance student autonomy and thinking (Cheung & Lim, 2000).

Constructive Tools

Constructive tool is a general purpose tool that can be used to manipulate information, construct their own knowledge or visualize students understanding. Construction tools such as Microsoft Word or Power Point has a strong impact in the educational environment and is widely used in most organizations in the form of memos, reports, letters, presentations, record routine information, giving businesses the most (McMahon, M. 1997.) In learning a second language, Microsoft Word

manage to help students to make correct sentences and texts as well as modern word processors include spell checking and dictionaries and grammar checkers.

Therefore, teachers can use the software to promote writing in the curriculum. PowerPoint is a presentation graphics program packaged as part of Microsoft Office for Windows or Macintosh. Although generally used for developing business presentations, it is also very advantageous in the context of increase creativity among students. While word processing program is the most common computer applications used, as a spreadsheet like Excel is just as important in teaching and learning of English. Students will be exposed to learning design and statistical data using the Excel program that can be automated through the formula.

Communicative Tools

Communicative tools are systems that allow easy communication between teachers and students or between students outside the physical barrier classroom. (Chen, D., Hsu, JJF, and Hung, D. 2000). It is including e-mail, electronic bulletin boards, chat, teleconference and electronic whiteboard. Synchronous communicative tools such as chat or video conference enable real-time communication while using the tools of communicative asynchronous (e-mail and electronic whiteboard) is a system in which exchange of messages between people are not 'live' but somehow delayed.

Communicative tool most appropriate for activities requiring more time to think before responding. Utilization of electronic mail is increasing day by day. E-mail is the most commonly used on the Internet. It is easy to use as it is a primarily text-based system and simple communication tool for teachers and students that allows students to dominate class beyond physical barrier. (Chen, D., Hsu, JJF, and Hung, D., 2000.)

Collaborative Tools

Collaboration tools of ICT is currently the focus of much interest and emerging as development of new tools that make online collaborative projects draw a realistic option for a distributed group work. Internet can be used for many collaborative activities such as meetings, discussions are taking place, working in the document, information dissemination, and other tasks. Interactive electronic whiteboard is not just used as tools for meeting and development, but recently became the most popular tool among teachers.

Whiteboard is an electronic device that interfaces with the computer where the computer image is displayed on the board that can be manipulated interactively (Weiser and Jay, 1996). This tool is increasingly popular with teachers, when used in conjunction with a computer and a video projector that produces interactive learning community. Instead of having to crowd around one or two computers, interactive whiteboard not only display the materials, but also to respond to human interaction with computer commands and orders on a touch screen. In addition, these technologies provide impulsive information sharing, constructing knowledge and stimulate personal growth. (Mona, 2004) [20].

According to Elia, (2007) “ICT …plays apart in fostering intercultural competence”, which is a part of learning a second or foreign language. ICT provides

a variety of different approaches as well as learning styles that reinforce the material delivered in other formats. Enjoyment is very much a part of effective learning, thereby captivating learners' interest, increasing personal discovery, generating enthusiasm and the desire to learn thereby instilling an interest from within to improve the learners' motivation. Students love working with ICT and especially using ICT an instrument to aid in the development of their language skills. Using ICT attracts them because it is challenging, yet it is apart from their everyday lives.

Nevertheless, when students use ICT in the class the "… undeniable improvement of language skills and strategies related to handling information and the language through which it is conveyed in the stages of searching, analyzing and processing information", (Lanni, 2005) when mixed together along with other skills students are benefited and gain much more than what was expected. Nevertheless, due to the students' simultaneous, natural and often incidental acquisition of IT skills, that are needed in order to manage hardware and software so that various tasks are completed and problems are solved [21].

Another classification is based on the tool of visually / auditory aspects of ICT tools. The Figure 3represents these types of tools:

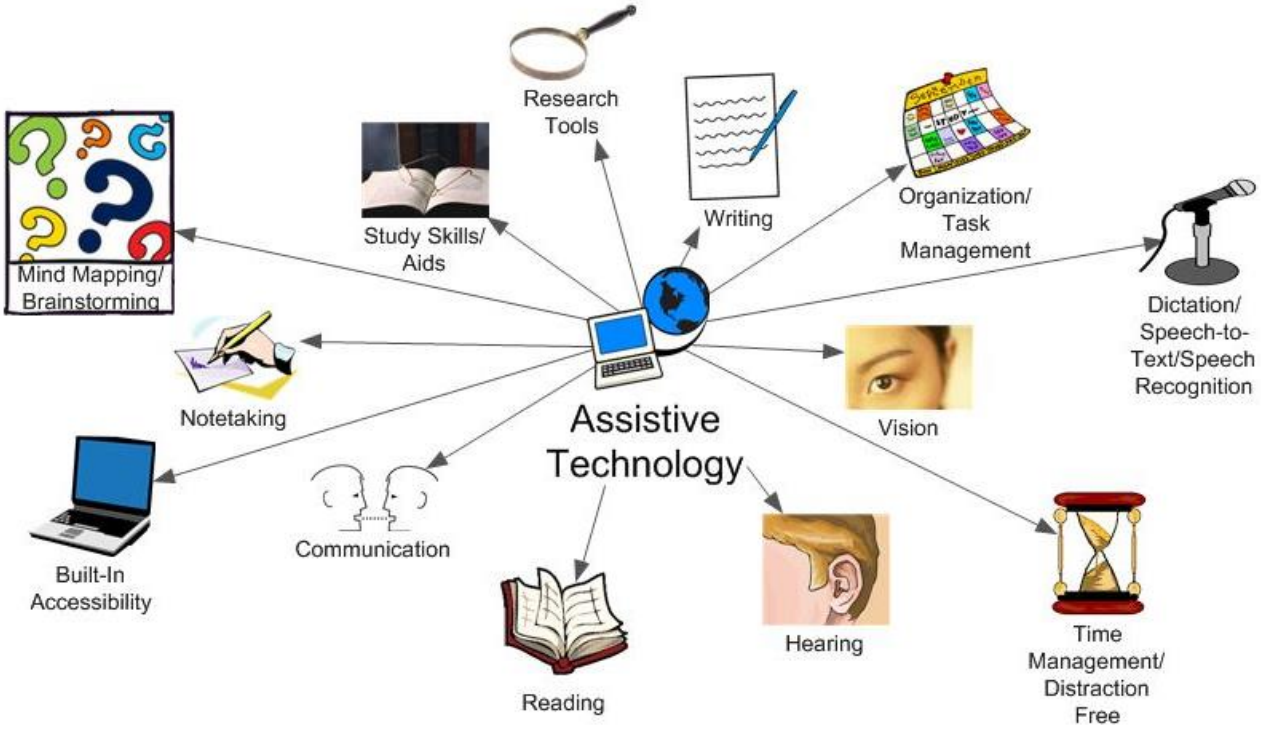


Figure 3. Classification of ICT tools according to skills to be formed by students

Another view deals with the famous Bloom's taxonomy and is centered on the levels of needs' satisfaction (See Figure 4,5).

Benjamin Bloom proposed 3 domains or areas:

• **Cognitive** - person's ability to process and utilize information (thinking), this is what Bloom's Digital Taxonomy;

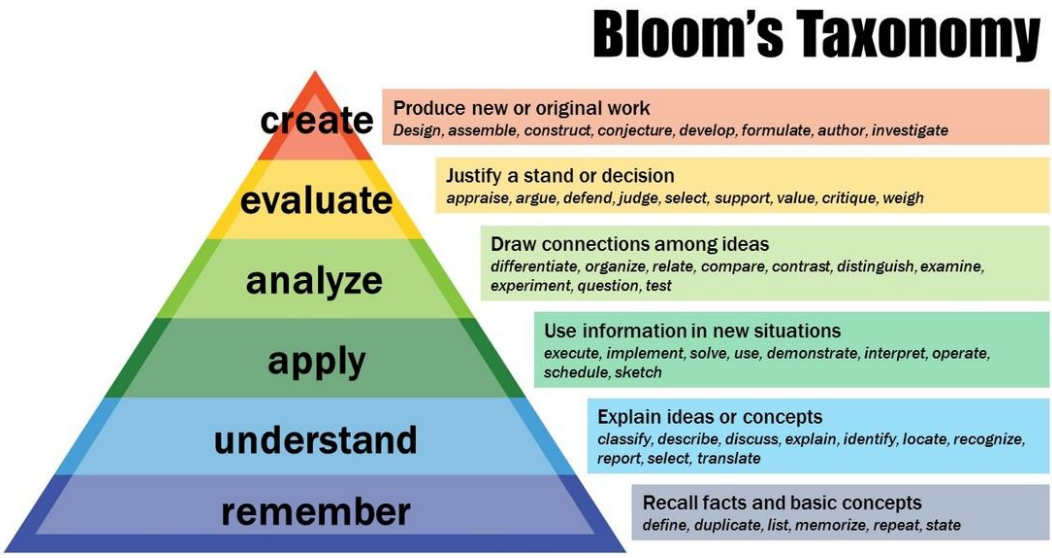


Figure 4. Overall picture of Bloom's taxonomy

- **Affective** - This is the role of feeling and attitudes in the learning/education process;
- **Psychomotor** - This is manipulative or physical skills.

Figure 5. Classification of ICT tools according to Bloom's taxonomy

Bloom's Taxonomy is a taxonomy of activities and behaviours that exemplify Higher Order Thinking Skills (HOTS) and Lower Order Thinking Skills (LOTS).

Bloom's allows us to rank and structure different classroom activities and plan the learning process.

ICT tools have been reported to yield positive results in ELT classrooms. In fact, judicious use of ICT tools to teach English, for example, boosts learning in terms of attitudes, autonomy and authenticity. In this section, we will list several ICT tools, classified according to their functions. To this effect, we will use Erben et al., (2009) classification which focuses on the functions of the different ICT tools (see Figure 6).

Figure 6. ICT tools for teachers

E-creation tools

Those tools enable English language learners to be creative. They involve playing with and using language to create, explore, and discover while producing content and learning performances that can be measured. Examples of these tools include web publishing, presentations software, exercise creating tools, podcasting, camera, moviemakers, and audio makers.

E-communication tools

Software that promote communication among students and teachers may be divided into two kinds of tools. First, there are those types of software that allow for in real time interaction (i.e. synchronous) such as telephone conversations, a board meeting, voice conferencing, and instant messaging. The second type of software includes those that occur with a time delay (i.e. asynchronous) such as email, text messages transmitted over cell phones, and discussion boards.

Reading/ writing-facilitative e-tools

Some ICT tools can facilitate and boost teaching and learning of writing and reading skills. Examples of these tools include online boards, online journals, blogs, wikis, and e-books.

Blogs, wikis, boards and journals can be used to create digital material or portfolios online are spaces where learners work in collaborative projects. They can also be used for professional development or to summarize learners' work.

Similarly, E-books have many functionalities. Learners can use them to develop their reading skill. For instance, e-books have added audio, interactive tasks and built-in dictionaries. Another advantage of this tool is that learners can access e-books on several devices such as tablets, mobile phones, and laptops.

Listening/speaking-facilitative e-tools

The listening skill can be developed through ICT tools such as:

- Video and audio files;
- Podcasts (syndicated audio files) and vodcasts (syndicated video files);
- Audio Video sharing libraries like YouTube.

E-assessment tools

Tony Erbe et al., (2009) list three basic performance types of assessment, namely, performances, portfolios, and projects. The main difference between these types of assessment and standardized traditional tests lies in the fact that with the alternative assessment tools, the leaner "produces evidence of accomplishment of curricula objectives". This evidence is put in the form of a performance, project, or portfolio and can be "archived and used at a later date with other pieces of learning evidence as a compilation of proof to demonstrate achievement." Erben et al., (2009: 153) [22].

Correlation between learning styles and ICT types is reflected in Figure 7.

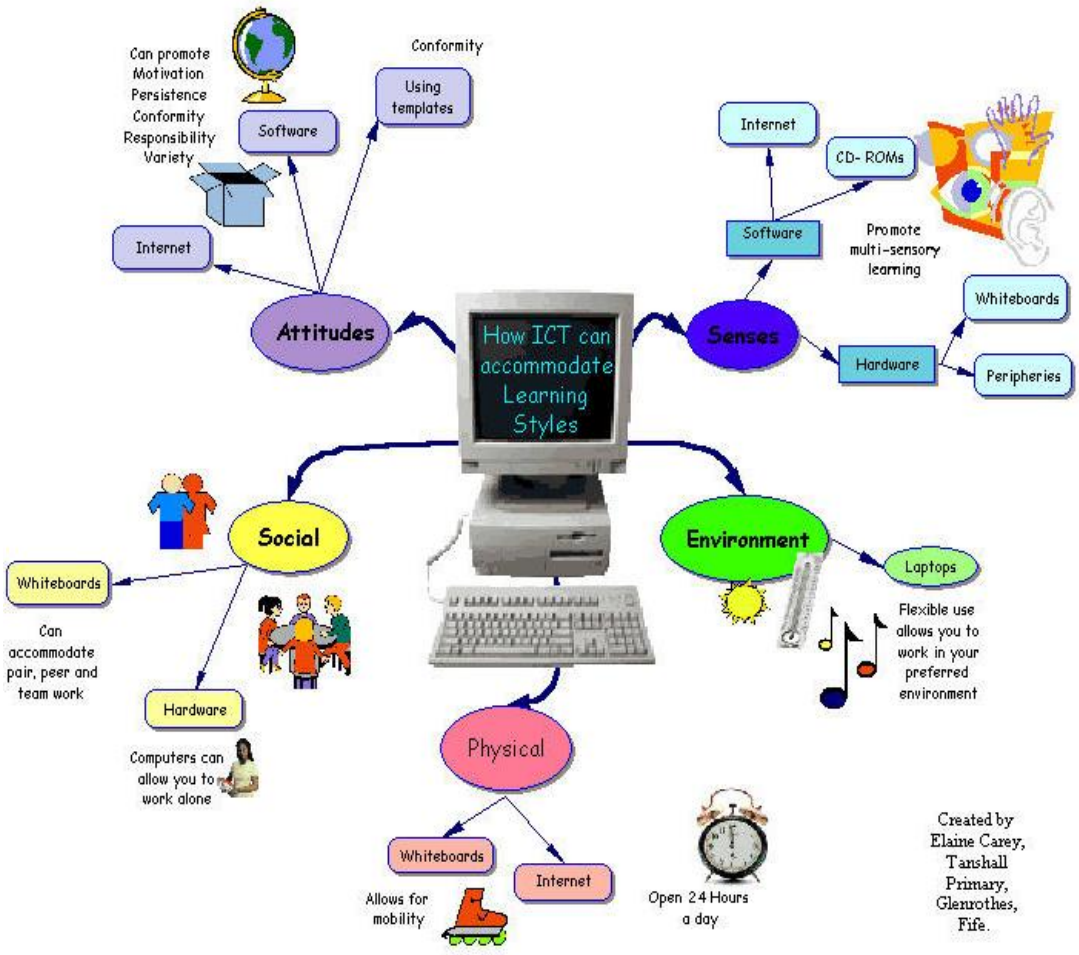


Figure 7. Correlation between 5 aspects of ICT and teaching styles.

It includes 5 main aspects of UCT use:
1) Attitudes
2) Senses
3) Social aspect
4) Physical aspect
5) Environment.

1.5 Development of teachers and ICT

Findings of studies of innovation in educational contexts around the world show that many educational innovations ultimately fail because too little effort or too few resources are devoted to preparing teachers for the innovation. Although the primary aim of this book is to develop an ICT curriculum for secondary educational institutions, such development would be insufficient without also considering the professional development of teachers. Therefore, while Chapter IV sets out the structure of an ICT curriculum for students in secondary educational institutions, this chapter takes up the equally important question of how best to prepare teachers for a new ICT curriculum.

Developing ICT skills and knowledge

In the emerging approach, teachers are developing their ICT literacy, learning how to apply ICT to a range of personal and professional tasks. The emphasis is on training in a range of tools and applications, and increasing their awareness of the opportunities to apply ICT to their teaching in the future.

ICT literacy is not really different for pupils than for teachers: the basic concepts of understanding and using ICT contain essentially the same elements. Hence, for this basic level of teacher literacy, the same units as for the student curriculum presented in Chapter IV are appropriate. As already indicated, these ICT literacy units have a parallel with the International and European Computer Driving Licence. Of course, the actual use of ICT will be different for teachers than it is for students. Table 3 presents a brief description of each of the nine ICT Literacy units together with a brief statement of the rationale for their inclusion in a programme of teacher development. An ICT literate teacher should be familiar with all the ICT Literacy units.

Conducting professional development

To raise teachers' awareness of the need to become ICT literate, most countries expend considerable effort in public relations around ICT, describing good or emergent practices, organizing discussion sessions, developing informative web sites, and so on.

There are different ways of conducting professional development programmes. Many educational institutions organize meetings and after-educational institution sessions where teachers can be trained in using particular software under the guidance of a fellow teacher, for example, the ICT-coordinator or an expert colleague.

Table 3. Description and rationale for nine ICT Literacy units in a programme of teacher professional development

Unit	Description
A1 Basic Concepts of ICT	• to identify and understand the functions of the main components and of various peripherals of a typical information and/or communication system. • to understand the main functions of the systems software environment in relation to the main generic applications software.
A2 Using the Computer and Managing Files	• to use the main functions of the systems software environment and to utilize its features in relation to the main applications software being used.
A3 Word Processing	• to use a word processor skilfully and intelligently to produce various readable and structured documents.
A4 Working with a Spreadsheet	• to understand and make use of a prepared spreadsheet.
A5 Working with a Database	• to understand and make use of a prepared database.
A6 Composing Documents and Presentations	• to make and use graphical (re)presentations.
A7 Information and Communication	• to understand and be able to communicate with computers online, with sources of information, as well as with other people.
A8 Social and Ethical Issues	• to understand the social, economic and ethical issues associated with the use of ICT. to explain the current situation and trends in computing against the background of past developments.
A9 Jobs and/with ICT	• to be aware of the nature of change of jobs in one's own discipline and in the teacher profession itself, to be aware of the way ICT plays a role in these different jobs.
Rationale	
It is not only necessary to know the basic principles of ICT and the use of ICT for personal development but also to cope with the daily life contexts of students and teachers.	
It is necessary for all teachers to be able to use ICT for their own purposes and to help students to use ICT.	
Word processing is the most commonly used application of ICT. It is helpful to make documents (e.g. letters, tests, and assignments) for teaching purposes and to be able to help students in using word processing. Word processing is necessary for teachers in all subjects.	
Spreadsheets are useful for many teaching and personal uses: preparing class lists, mark sheets, and tax returns. Spreadsheets are relevant in all subjects.	
Most information systems in use today (e.g. educational institution administration) are based on the principles of databases, and so an understanding of databases is useful for teachers. Databases are also useful in the teaching of many subjects.	
As with word processing, the ability to layout documents and make presentations is useful for many teaching purposes. Such abilities are also relevant in the context of multiple learning styles of students.	

Continuation of the table 3

Rationale
Using email and searching for information on the Internet is important for teachers personally. It is also important that they can assist students in these basic literacy skills. As educational institutions begin to set up their own Intranets, this unit becomes even more relevant.
It is critical that teachers set good examples for students with respect to such ICT issues as privacy, copyright, backing up of data, and virus protection. Teachers in all subjects need to be role models.
It is part of a teacher's professional development and attitude to know about changes with respect to ICT in the profession, and in a teacher's own subject area, as well as in the general work force that students will enter.

Sometimes a lecturer or teacher is engaged from a local teacher education institute or from another educational institution. In some countries, teacher education institutes and other (often private) enterprises provide a range of courses in basic ICT instruction. In other countries, there are accredited organizations for delivering courses of instruction for the International Computer Driving Licence, or similar especially modified units for teachers. In these latter cases, assessment and testing certification is also provided (the computer driving licence).

Learning materials on most aspects of ICT are available on the Internet for self-learning. Teachers often prefer just to explore different software tools, but it is best to organize a systematic programme of professional development for teachers to ensure that all teachers are adequately prepared for an ICT curriculum.

Further points to consider

Teacher education and professional development are essential for the success of an ICT curriculum in educational institutions. A few additional points to consider are the following:

• At the very initial stage, psychological or affective factors are critically important. One of the main goals is to decrease teachers' fears of computers, and to show new learners that they are able to use a computer. Confidence is as important as competence.

• Most of the professional life of teachers is spent at home. Many of the basic ICT skills relevant at this initial stage are of value in their personal lives. Confidence and competence can be acquired through autonomous work, using carefully prepared learning materials and, where possible, some distance interactions through appropriate communication tools.

• Teachers, like all learners, need to be provided with opportunities to make mistakes. Such opportunities are often best provided in arranging professional development programmes for small groups of teachers with similar needs.

• At the initial stage of ICT development, many teachers are affected by serious motor-skill difficulties. The most basic motor skills (e.g. pointing, clicking, and dragging with a mouse) need to be mastered before developing skills to use ICT tools: mastery is about confidence and self-esteem.

• Beginners have not only to be able to use ICT tools and environments, but to understand basic principles about architecture, file managing, and email transmission.

Hence, it is important to provide accurate representations of the computing systems and ICT tools they are expected to use in their educational institutions, not the theory of what may happen.

Applying ICT to teachers' subject areas

After teachers have acquired basic ICT skills and knowledge, they feel confident in using a number of generic and specialized ICT tools that can be applied to the teaching of their subject areas. The opportunity to apply ICT in all of their teaching is often limited by a lack of ready access to ICT facilities and resources, and hence is not fully integrated into all lessons for all students.

Teachers can apply ICT in their teaching, in languages, natural sciences, mathematics, social sciences, and art:

S1 ICT in Languages
S2 ICT in Natural Sciences
S3 ICT in Mathematics
S4 ICT in Social Sciences
S5 ICT in Art
B1 Measurement
B2 Modelling and Simulation
B3 Robots and Feedback Devices
B4 Statistics
B5 Creating Graphics
B6 Music
El Spreadsheet Design
E2 Database Design

Teacher competencies

There are general ICT competencies, common to all uses, regardless of the subject area. Training and professional development will need to focus upon these competencies as teachers' technical confidence and competence grows and as they seek ways to improve their teaching.

Examples of general teacher competencies include the following:

Ability to decide why, when, where, and how ICT tools will contribute to teaching objectives, and how to choose from among a range of ICT tools those that are most appropriate to stimulate pupils’ learning, that is:

- choose ICT tools and pedagogy from those recommended for specific subjects;
- explain the reasons for choosing particular ICT tools and pedagogy;
- emphasize the content of students' productions;
- plan a whole lesson sequence, deciding in advance when and how ICT will best be used.

Ability to manage a class-based learning environment using team work to achieve teaching objectives, that is:

- be able to describe difficulties in using ICT to achieve planned lesson objectives;
- understand differences between pupils according to their competencies in using ICT;

• have available strategies to manage such differences in the course of teaching.

Ability to decide when whole class or group multimedia presentations will be useful, that is:

• vary the kind of presentation or lesson materials according to the main goals and the teaching method;

• analyze a presentation for legibility, structure, coherence with objectives, and suitability for students.

Ability to analyze subject specific multimedia educational software, that is:

• evaluate CD-ROMs, web sites, video and audio, courseware;

• assess activities proposed for learners and the contribution of these to lesson objectives;

• analyze the specific contribution of ICT tools to individual students' learning.

Ability to assist students to find, compare, and analyze information from the Internet, and from other sources specific to a subject area, that is:

• teach students to construct simple searches;

• help students to manage, to criticize, to synthesize and to present information using ICT tools.

Ability to select and use appropriate tools to communicate, according to teachers' own objectives, with colleagues or with fellow students, that is:

• assess communication tools to use teaching situations to facilitate collaboration.

Ability to use ICT more efficiently, choosing training sessions and participating in new developments in order to enhance professional development, that is:

• participate and be active in groups working on the use of ICT;

• use ICT tools (forums, conferencing, bulletin boards, email) to collaborate in the improvement of teaching and learning and in the management of learning processes.

Organizing teacher development

The ability to use ICT in teaching and be competent in the areas noted above in a given teaching subject requires more adapted training. The way this training is conducted depends very much on the learning style of the teachers involved, as well as on the specific subject and application. The following are two possibilities:

Training courses, seminars and workshops on specific applications used in a teacher's subject area. It is sometimes recommended to include these ICT workshops in accepted conferences within the specific teacher subject community in order to increase the opportunities for participation.

Communities of teachers, set up to achieve a particular goal. In this case, a few teacher colleagues (from different educational institutions, but within the one subject – best number seems to be between 6 and 12 teachers) can decide to work together (perhaps under guidance from the ICT coordinator) on the implementation of a certain ICT topic in their subject area. They can communicate by means of email but it appears important also to organize face-to-face meetings. The success of these teacher networks is proven, although there are pitfalls to be aware of:

• not too much difference in starting position,

• an equal input from participating members,
• an open mind for sharing experiences,
• involvement of all members,
• task orientation,
• shared responsibility, but also somebody who takes an organizational lead.

Further points to consider

Where educational institutions are at the applying stage, professional development takes on slightly different emphases and priorities compared with the emergent stage. Further points to consider are the following:

• Emphasis is on the use of generic or specialist tools to improve teaching, in particular subject areas.

• Teachers need to be able to assess the contribution of ICT tools to subject skills and knowledge.

• Teachers need to develop their teaching pedagogy as well as further develop their technical confidence and competence in ICT.

• Teachers will still want to control the teaching and learning processes to ensure that lessons are a success: they will only experiment as their confidence with ICT develops.

• Teachers who share the same subject area can work together in their educational institution to pool ideas and the learning resources they have prepared.

Infusing ICT to improve learning

At the infusing stage, teachers are fully integrating ICT in all aspects of their professional life to improve their own learning and the learning of their students. Teachers use ICT to manage their own learning and that of their students. They use ICT to assist all students assess their own learning in completing specific personal projects. It is natural for teachers to collaborate with other colleagues in sharing experiences to solve problems. ICT becomes a stimulus for exciting new teaching opportunities.

Teacher competencies

There are general competencies and abilities common to all approaches to infusing ICT in learning and the management of learning. The focus of professional development will be on developing the confidence and competence of teachers, building upon their previous education and professional development in applying ICT to teaching.

Professional development in this stage will encourage teachers to collaborate in developing their subject curriculum and identifying innovative teaching methodologies. Opportunities for students and teachers to experiment to identify preferred learning styles and differentiated pathways is encouraged. Infusing ICT across the curriculum to enhance learning and the management of learning leads teachers to an understanding of how to transform their teaching practice as well as the learning of their students. General competencies include, and build on, those at the applying stage.

Examples of general teacher competencies include the following:

Understanding why, when, where, and how ICT tools will contribute to learning objectives; and choosing from among a wide range of ICT tools those that are most appropriate to stimulate students' learning:

• choosing ICT tools and teaching methods that integrate ICT into the whole curriculum;

• choosing and recommending ICT tools and teaching methods appropriate to individual students' learning objectives;

• emphasizing the quality of what students produce and the contribution to individual learning goals and levels of attainment;

• planning a whole learning programme that allows a range of ICT tools and teaching methods to be used, as and when required;

• choosing tools and teaching methods that allow the teacher and student to manage their own learning.

Managing whole educational institution and classroom-based environments, and teamwork to achieve learning objectives:

• managing learning environments that contribute to the use of different ICT tools and teaching methods;

• understanding differences between students according to their competencies in using ICT, and having available strategies to manage differences as students progress;

• managing difficulties that can arise when using ICT to minimize impact on planned lesson objectives;

• creating learning situations such that students manage their own learning;

• infusing ICT-based and non-ICT-based media, such as books and video, into learning programmes;

• assessing the levels of attainment of individual students when working collaboratively.

Infusing multimedia presentations into whole class, group or individual teaching, and learning to increase access to learning programmes:

• ensuring that the most appropriate media are built into learning programmes, that learning is accessible to all students irrespective of ability, special need, or preferred learning style;

• varying the kind of presentation, documents or other media according to the main goals and the chosen teaching method;

• analyzing a presentation for legibility, structure, coherence with teaching objectives, and suitability for students.

Analyzing multimedia learning environments:

• utilizing web-based learning spaces and environments;

• including CD-ROMs, web sites, video and audio, courseware;

• assessing the contribution of different activities to learners and the lesson objectives;

• analyzing the specific contribution of ICT tools to individual student learning.

Supporting students to find, analyze and synthesize information from disparate Internet and educational institution-based learning environments:

• supporting individual students and groups of students to perform complex web searches;

• supporting students in managing, criticizing, synthesizing, and presenting learning processes and products using ICT tools.

Utilizing a range of communication tools to collaborate with colleagues, with students, and other learning communities beyond the educational institution.

Using ICT more proficiently, regularly taking part in professional development, and participating in teaching experiments and developments:

• participating in, and contributing to, group discussions on the use of ICT;

• using ICT tools (forums, conferencing, bulletin boards, email) to collaborate in the improvement of teaching and learning and management of learning processes.

Organizing teacher development

The kind of teacher activities described in this section on professional development cannot be obtained through short courses, seminars or workshops. These forums can be used as appetizers to inform teachers about infusing ICT into all teaching activities but teachers cannot be expected to achieve all this as a result of just a short course. Most effective for this kind of teacher development is teamwork and educational leadership within a educational institution.

A good starting point for teacher development is to form a group of enthusiasts within a educational institution. Later, this group can be extended to larger groups of teachers from different educational institutions, and even teachers from different districts, states, or countries.

Where teacher networks can be built on teachers from different educational institutions as described under the applying approach above, such networks should preferably involve some teachers from each educational institution from different subject areas. Because the way of working in a totally integrated way is so different from what most teachers are used to, it is most important to share experiences, adopt common goals and tasks, have involvement and equal input from all teachers, and have others to lean on and give support when things do not go quite as expected.

It is often valuable to involve students themselves in the work of a community. Students can often take responsibility for activities and frequently have the necessary ICT expertise needed in a particular project.

Further points to consider

Two further points to consider are the following:

One of the roles of a teacher is to help students transform information, which is everywhere and in enormous quantities on the Internet, into knowledge that only exists in human brains, and then into wisdom so that they can transform their own lives and the communities to which they belong.

As ICT puts stress on teamwork and on teacher collaboration, teacher education and professional development needs to be organized, not for individuals but for teams, that are both local and global, and where learners are co-learners.

Infusing ICT throughout a educational institution needs (as in other areas of the educational institution curriculum) human resources to support users' work and needs. Hence, there must be experts or specialist teachers who are available to spend

a great amount of time acting as resource persons or ICT coordinators. Without this kind of human support, infusion unfortunately will not take place, however favourable other educational institution factors are in creating a supportive climate for ICT.

Sometimes this support person is also the one who teaches the ICT specialization units in a educational institution, though other teachers can also undertake this support role. Professional development for these teachers is not addressed here, other than to note that additional specialization on top of a teacher education qualification is normally undertaken in tertiary institutions in departments of computer science.

Role requirements for support teachers in ICT

In this section, the more essential role requirements of a resource person or ICT co-ordinator are elaborated. Such a person will need the ability to do the following:

Collaborate with the educational institution management and administration:

• be precise, in agreement with management, about their role, availability, and modes of intervention according to act;

• regularly inform management about the progress of activities and projects;

• disseminate the results of any experiments in the use of ICT undertaken inside or outside the educational institution;

• develop a global view on needs and means with respect to ICT support for teaching and learning.

Be responsible for policy concerning technical infrastructure:

• be responsible for the availability and usability of computers and networks within a educational institution;

• be the intermediary between educational institution and hardware or software providers, and between educational institution and other educational institutions.

Support teachers in infusing ICT in their teaching practice:

• propose lines of development for infusing ICT by suggesting, showing examples, or providing motivation on the use ICT;

• help teachers to be trained, in accordance with their needs and requests, by proposing training resources, by assuming training sessions, and by enabling the sharing of knowledge and experiences between teachers (on the basis of their personal competencies);

• accompany teachers on occasion within the classroom, to provide backup and to offer support;

• encourage emerging successes arising from team projects using ICT.

Give support to ICT team projects:

• help teaching teams to make their ICT-based projects more precise by showing what is possible, setting limits, and assisting teams to specify their training needs;

• help with planning and scheduling of team projects;

• help with implementation, make resources available, and even take part in the realization of projects;

• cope with relations between teachers in a team to ensure that individuals agree with the aims of a team project, and to manage any conflicts within a team;

• help a team to evaluate process and outcomes, and to schedule steps in evaluation of projects.

Promote ICT uses inside a educational institution and facilitate these uses:

• develop and support the use of email, and share communication solutions via the educational institution Intranet;

• discuss and set up procedures for accessing and using ICT resources, and reach agreement with users about access;

• organize how ICT resources can be accessed and used by teachers and students.

Support specialized student activities with ICT:

• without taking the place of, or without playing the role of, other teachers, and in agreement with these teachers, help any students who face special problems in using ICT;

• organize special training sessions, and arrange meetings of teachers and students to demonstrate or discuss advanced features or tools.

Organizing teacher development

It is essential that ICT co-ordinators or other ICT resource personnel should continue their own professional development. This development will involve mastering new technical and teaching competencies required due to technical evolution and changes inside a educational institution organization. It also involves communicating and exchanging experiences with other educational institution ICT co-ordinators.

For ICT Specialization, teachers need on occasion to attend special courses, which in some countries include examination, leading to certification as teachers of computer studies or informatics.

1.6 ICT tools through description

Taken from: Lorenz Kampschulte and Karsten Eilert, May 2016 // IPN – Leibniz Institute for Science and Mathematics Education at the University of Kiel. www.ipn.uni-kiel.de - Olshausenstr. 62, 24118 Kiel, Germany / IRRESISTIBLE project on teacher training - 67 p. [23].

ICT tools like apps, programs and web2.0 applications are part of our modern society. Educational institutions 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 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 focuses on the ICT tools itself: Although in many educational institutions 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 us 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.

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), so a mixed set of handhelds could be used in the classroom. Another option would be a web-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 is dedicated to presenting examples of the integration of ICT tools in teaching, lists examples of teaching units which contain one or several ICT tools that students need to use in order to fulfill different learning tasks. 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.

Smartphone Market Share and Penetration

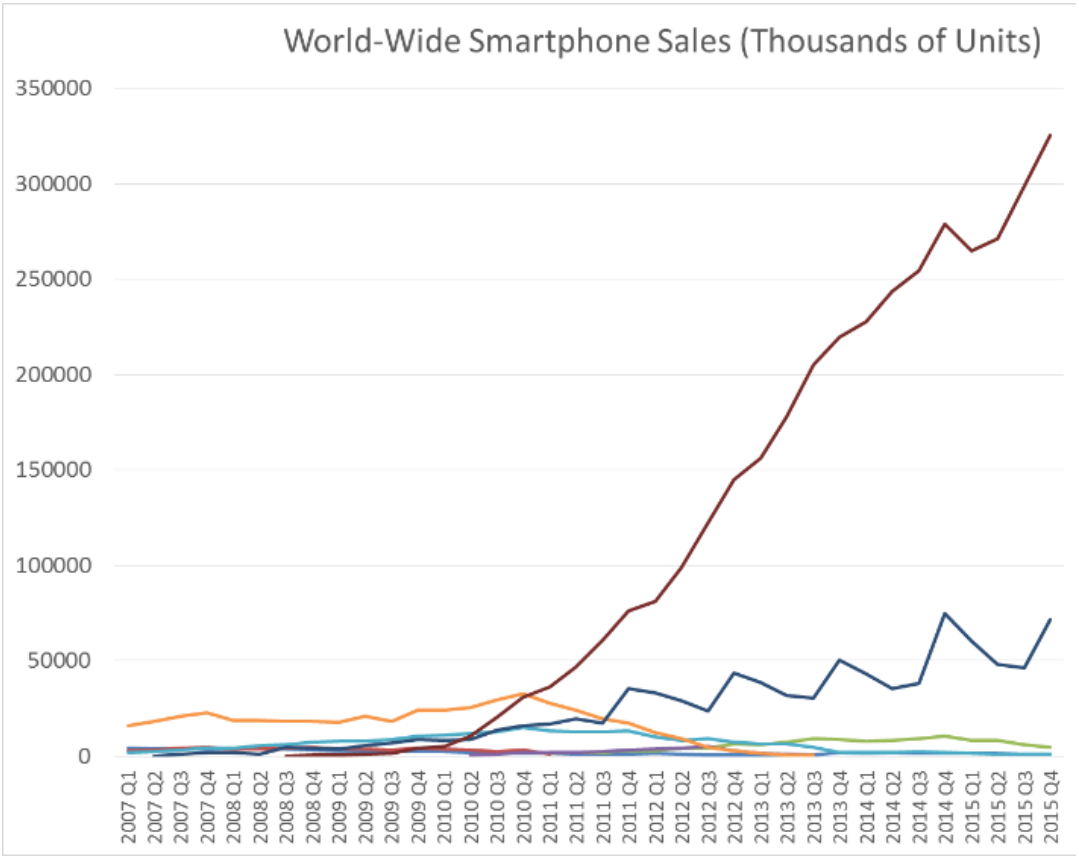
Due to the growing number of 'tablet classes' at educational institutions and with an increasing number of students owning a smartphone even in lower grades, the relevance of smartphone and tablet apps to be used in teaching increases. To give a brief overview of this trend, the following section lists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

Smartphone sales

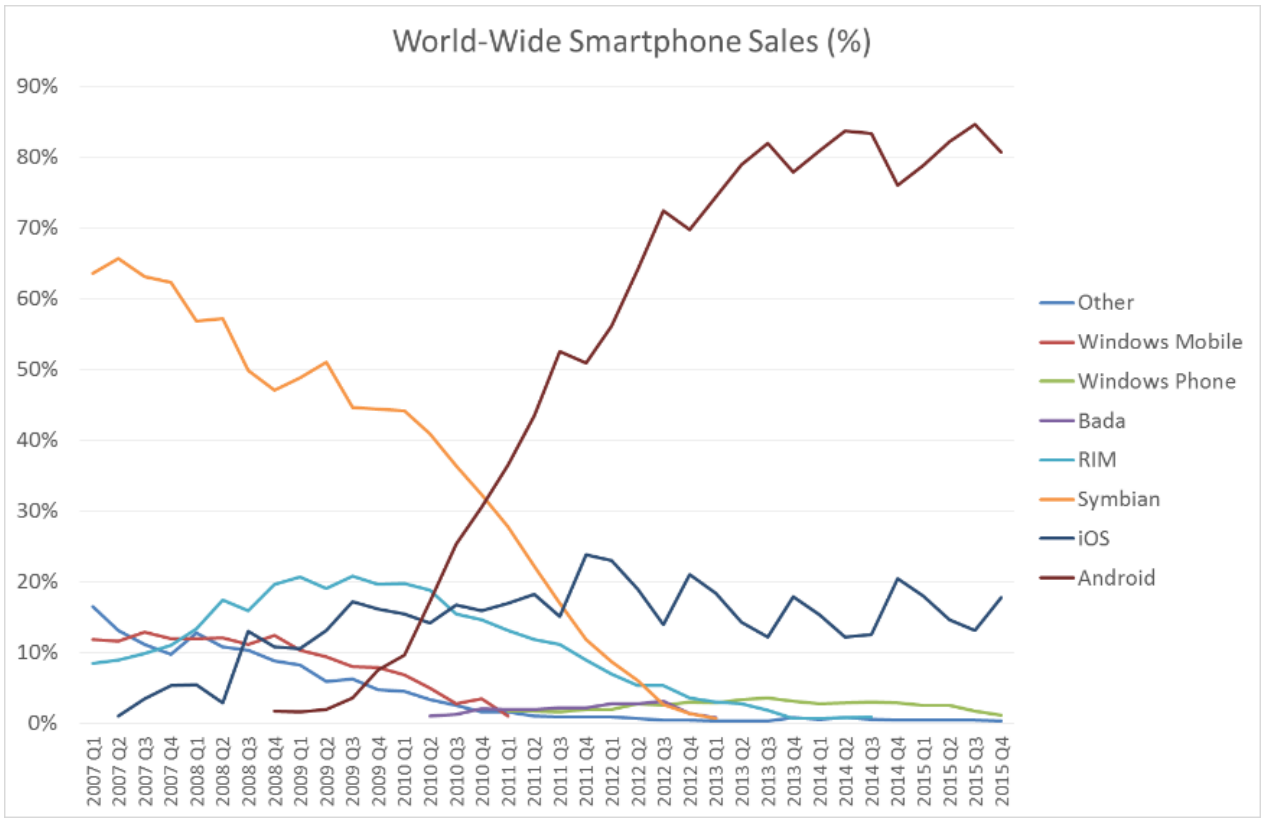
In 2015, more than 1.4 billion smartphones were sold, a growth of 14.2 percent from 2014. Android (Google) is by far the most widely used operating system with over 80 percent, followed by iOS (Apple) with almost 18 percent and Windows Phone (Microsoft) with slightly above 1 percent (see Figure 8).

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.

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 2014. Android has a share of roughly 68 percent, iOS about 22 percent, and Windows about 10 percent.



a)

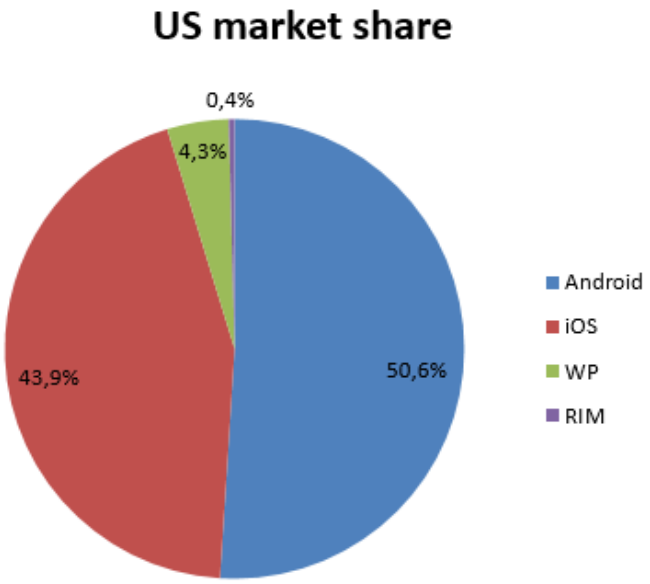


b)

Figure 8. Worldwide smartphone sales in thousands of units and in 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 (see Figure 9).



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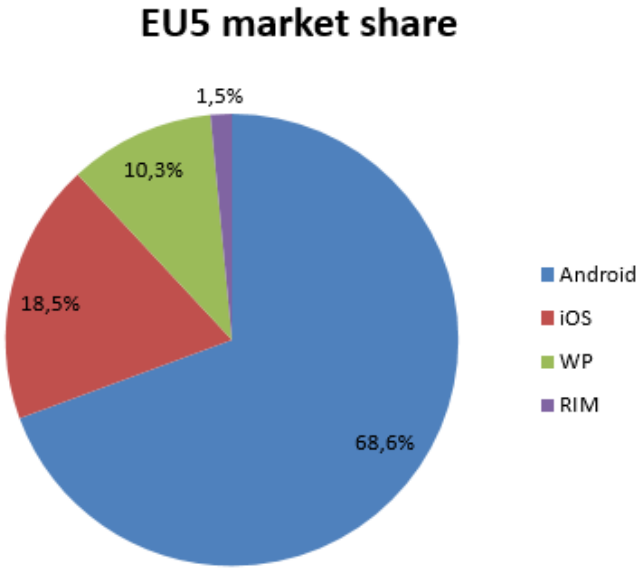


b)

Figure 9. 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) (see Figure 10).

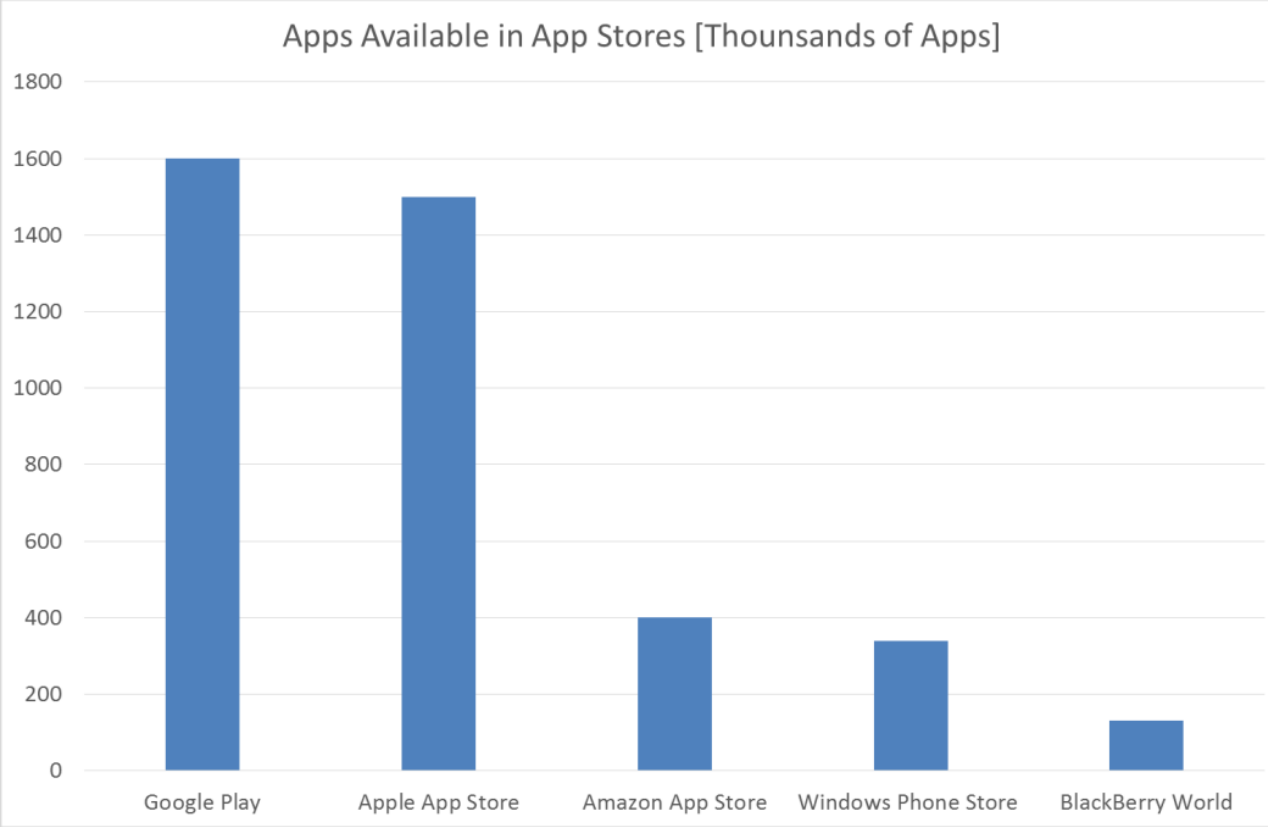


Figure 10. Apps offered in the official stores Google Play (Android), Apple App Store (iOS), Amazon App Store (Android/Kindle Fire), Windows Phone Store (WP), and Blackberry World (RIM). Data of July 2015; Source: Statista.

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.

With currently 1.86 billion smartphone users worldwide and a total population of about 7.4 billion, the global smartphone penetration is around 25 percent. 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 (see Figure 11, 12).

To estimate the smartphone penetration in a more detailed way in the age group below 18 (which is most relevant for educational institution applications of smartphones), there are no Europe-wide numbers available.

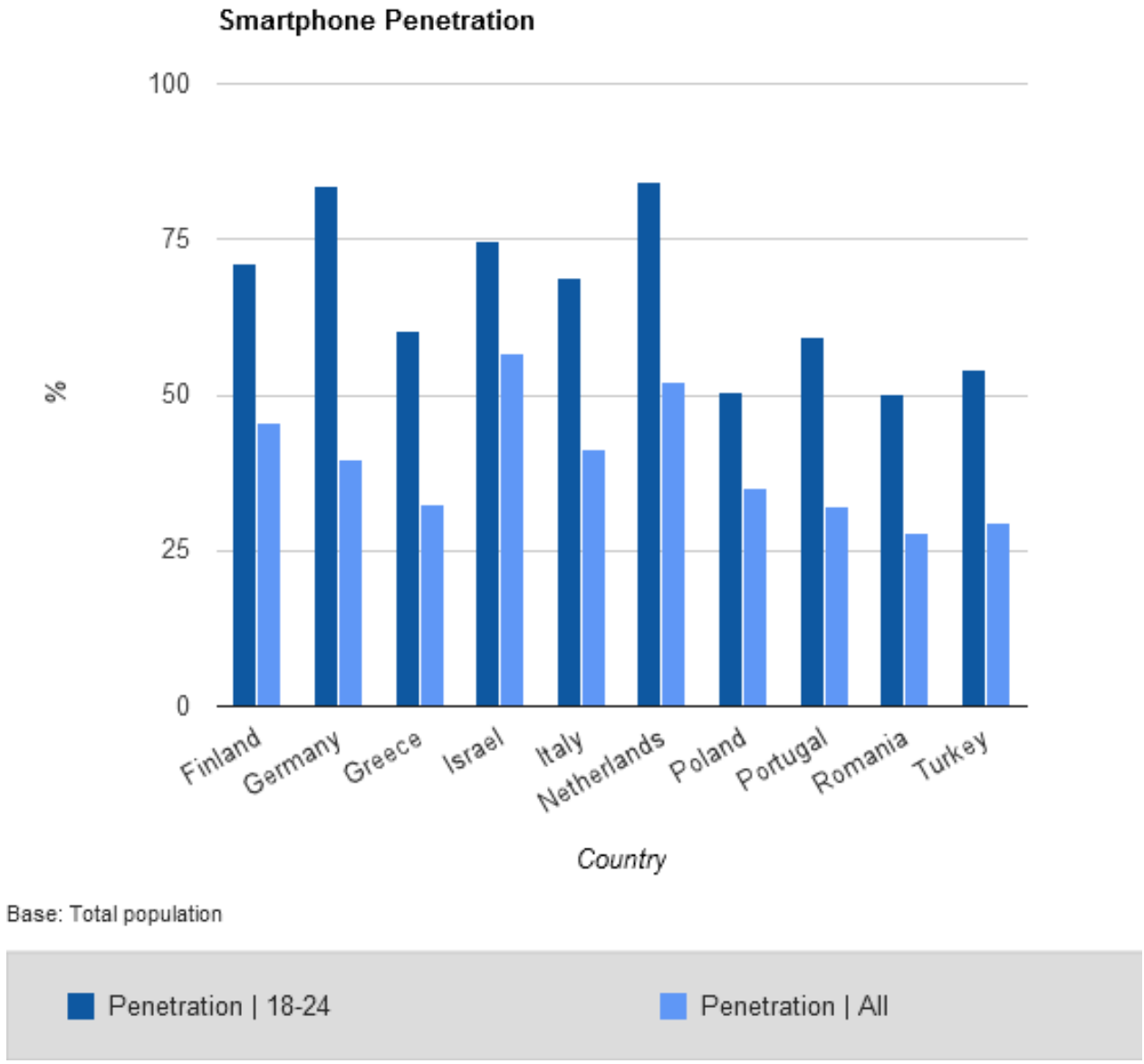


Figure 11. Smartphone penetration in selected European countries: comparing the penetrating in the age group 18-24 with the penetration in the total population (Data: Google's Our Mobile Planet report)

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 educational institutions.

Challenges When Using ICT at Educational institution

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.

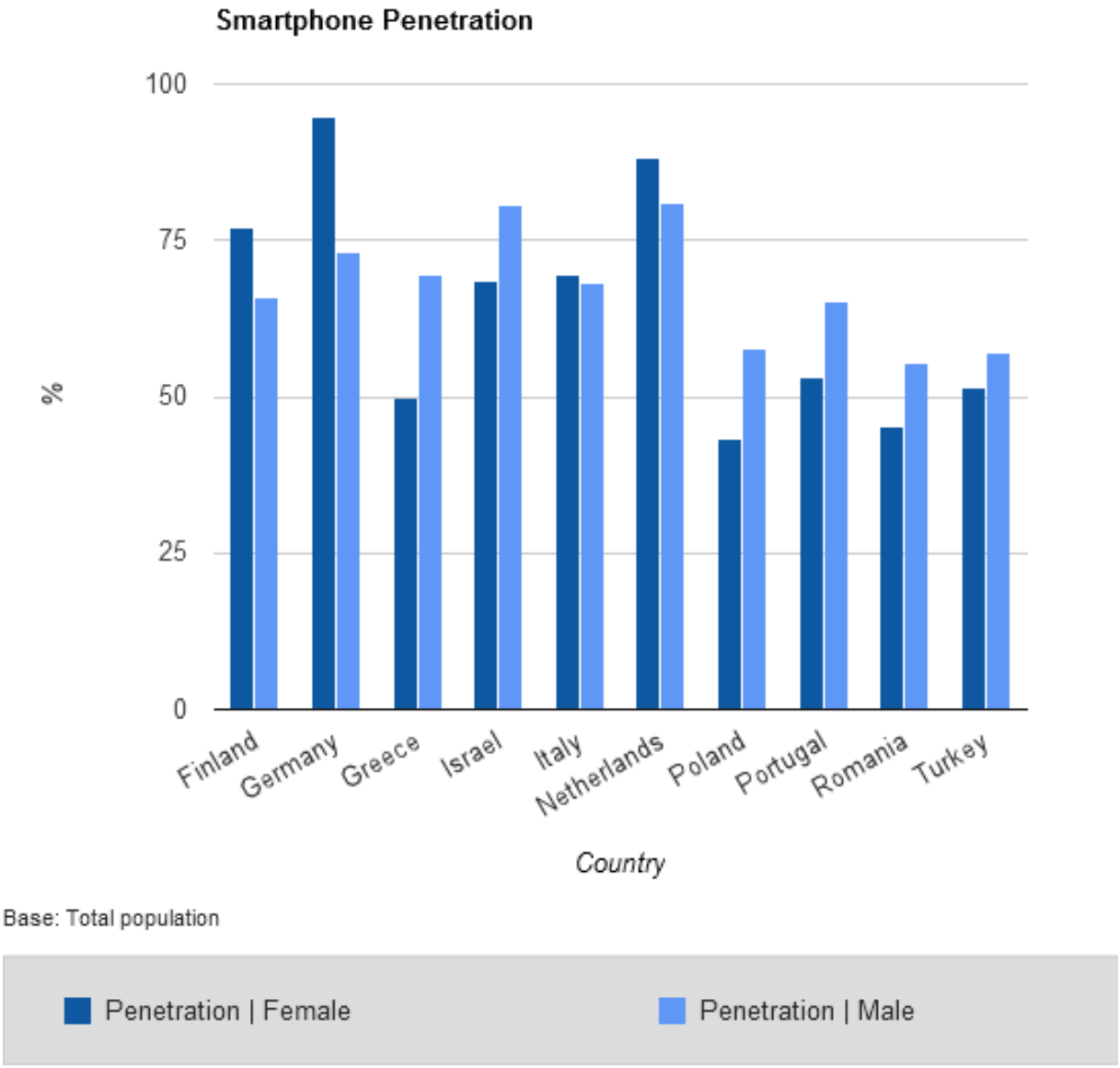


Figure 12. Smartphone penetration in selected European countries: gender differences in the age group 18-24. (Data: Google's Our Mobile Planet report).

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:

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 educational institutions thus hindering the general use of appropriate tools in class (see Figure 13).

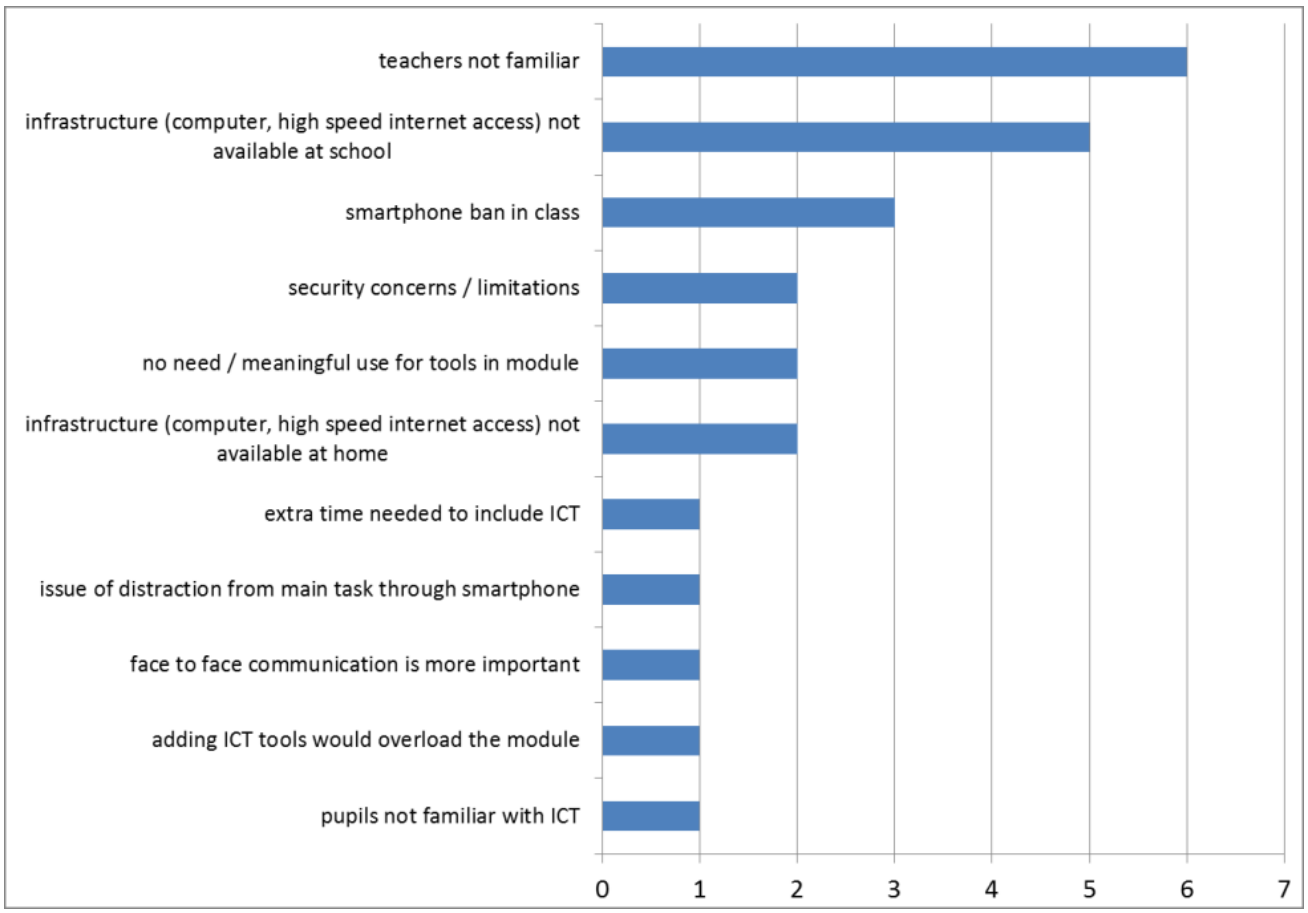


Figure 13. Reasons that impede the implementation of ICT tools in the teaching modules, answers from 10 developing groups in nine countries.

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.

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 educational institution (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 educational institutions. 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 educational institution is definitely not the standard yet.

The studies mentioned above as well as various discussions on the workshops and with teachers reveal that many educational institutions 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 educational institution. Especially the approach using students' smartphones requires a more comprehensive IT infrastructure than is available in many educational institutions today.

Being aware that creating a sound infrastructure at educational institution 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.

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 though 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

safe 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 educational institution.

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.

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 (see Table 4).

Table 4. 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

Continuation of the table 4

Category	Program / App	Android	iOS	Browser	Program install.	Page
	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
	Changers CO_2 Fit	X	X	(X)	-	24
Simulation	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
	Eat Low Carb	-	-	X	-	27
Mobile Office	Prezi (Viewer)	X	X	X	-	28
	Google Docs, Sheets & Slides	X	X	X	X	28
	CamScanner	X	X	-	-	29
Collaborative Work	Skype	X	X	-	X	29
	Mind42	X	(X)	X	-	30
	Google Docs	X	X	X	X	30
e-Learning System	Mahara ePortfolio	X	X	X	31	
	Edmodo	X	X	X	-	31
	GoConqr	X	X	X	-	32
Knowledge	Wikipedia Mobile	X	X	X	-	32
	Merck PTE	X	X	-	-	33

Category	Program / App	Android	iOS	Browser	Program install.	Page
	Formulas Free	X	X	-	-	33
	Physics Formulas Free	X	X	-	-	34
	Khan Academy	X	X	X	-	34
	Sky Map	X	X	-	-	35
Tools	Quick Graph	(X)	X	-	-	35
	Universal Converter free	X	X	-	-	36
	i-nigma	X	X	-	-	36
Exhibitions	QR Code Generator	(X)	(X)	X	-	37
	Glogster	X	X	X	-	37
	Open Exhibits PLAYER	-	X	X	X	38
	Open Exhibits SDK	-	X	X	X	38
Add-on	SPARKvue	-	X	-	-	39

Mindomo

Mind mapping

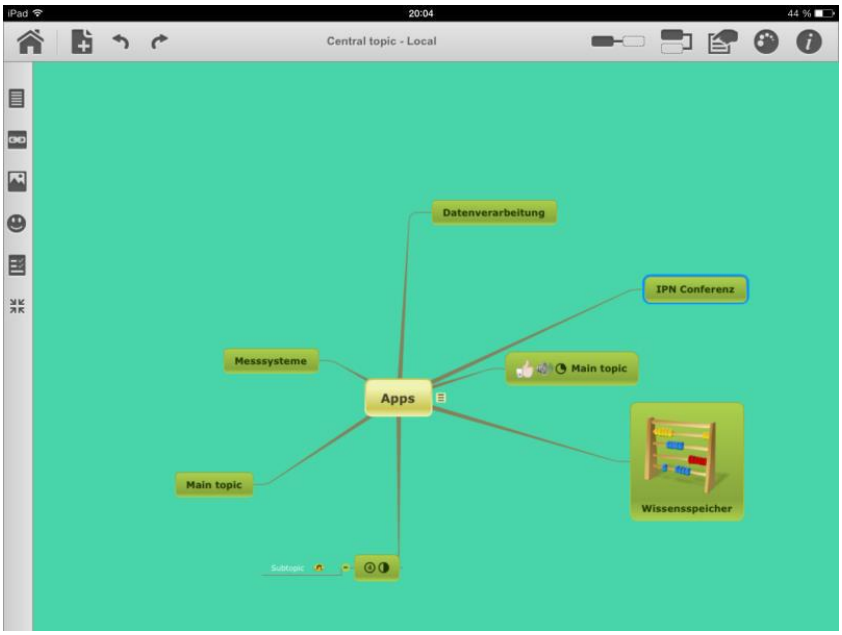
Operating system(s): Android, iOS

Language: English

Price: free; Author: Expert Software Applications Srl

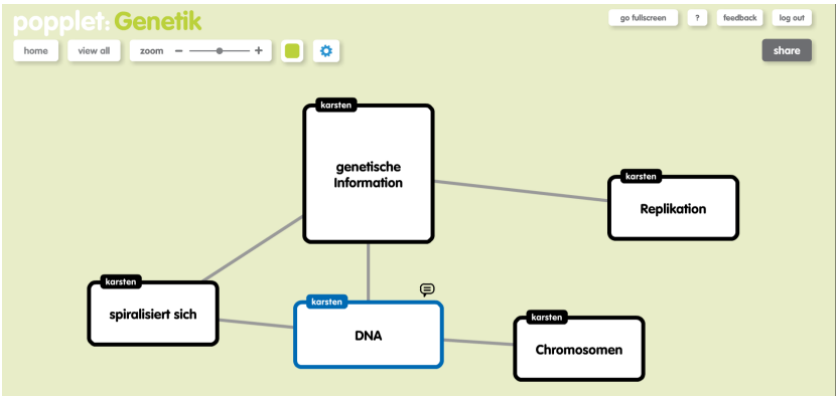
Alternative solutions: NeuronalMind42 (Browser, Android) / Simple Mind + (iOS)

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
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 brainstormming tool and at the same time a presentation tool. It is available as an app for iPad, iPhone and has a browser interface.

Groupboard

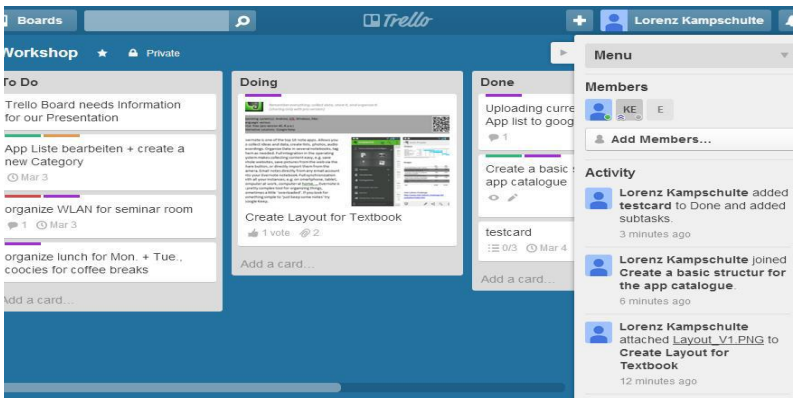
Interactive and collaborative whiteboard
Operating system(s): Android, iOS, Browser
Language: English
Price: free; Author: Yuansheng Chen
Alternative solutions: Twiddla (Browser)

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

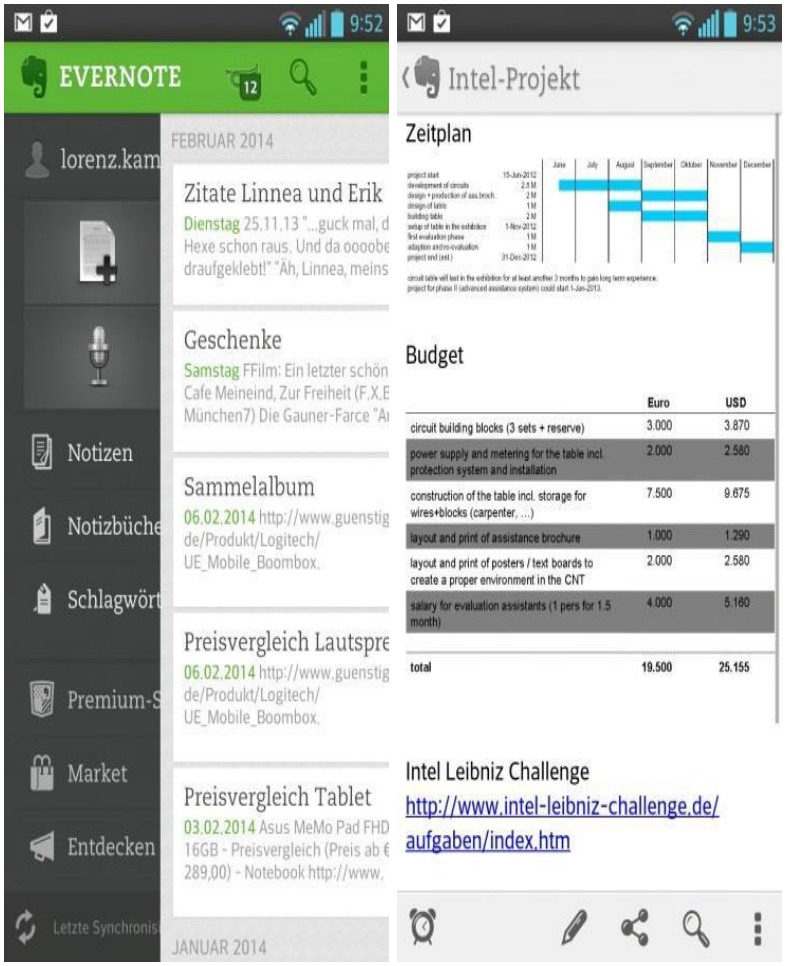
Organize a project, keep track of progress, work on tasks collaboratively
Operating system(s): Android, iOS, Browser
Language: English
Price: free; Author: Fog Creek Software
Alternative solutions: Edmodo

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

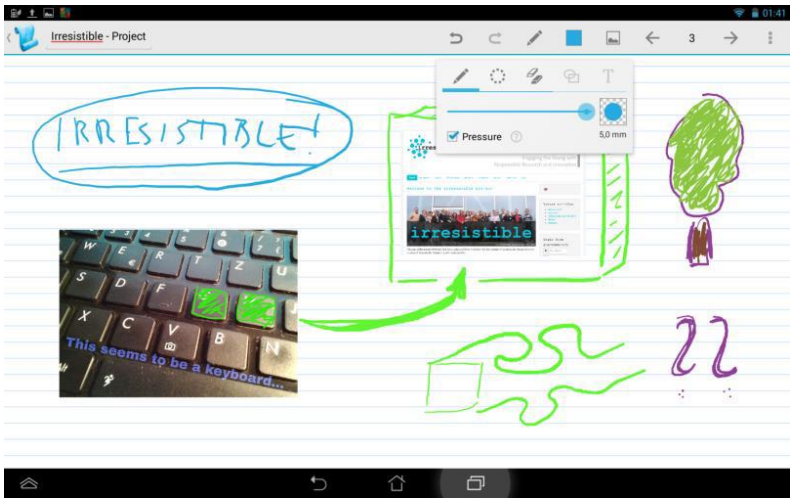
Evernote is one of the top 10 note-taking apps. Allows you to collect ideas and data, create lists, photos, audio recordings. Organize Data in several notebooks, tag them as needed. Full integration in the operating system makes collecting content easy, e.g. save whole websites, save pictures from the 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
Operating system(s): Android
Language: English
Price: free; Author: Steadfast Innovation, LLC
Alternative solutions: Smart Note (iOS)

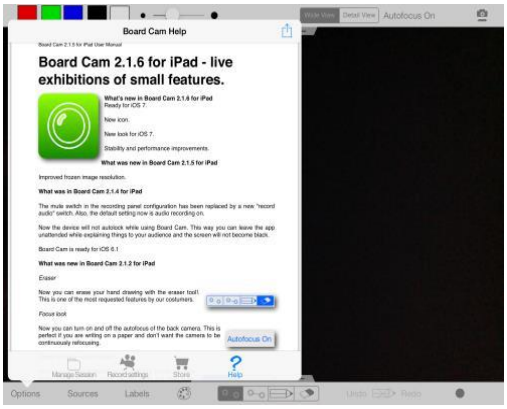
Squid is an easy to use App for sketching and creating simple collages, include photos (+ cut, rotate etc.). Create different sketchbooks with several pages. Very acute finger / pen pressure recognicion allows elegant sketching (depends also on the touchscreen of your device). Export single pages or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

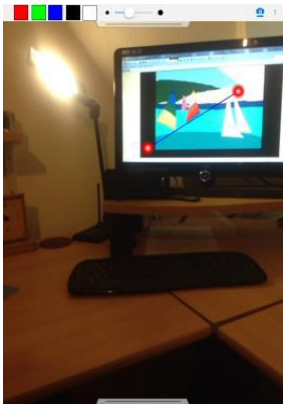


Board Cam Pro

Live notes as virtual 2nd layer on a running experiment
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.

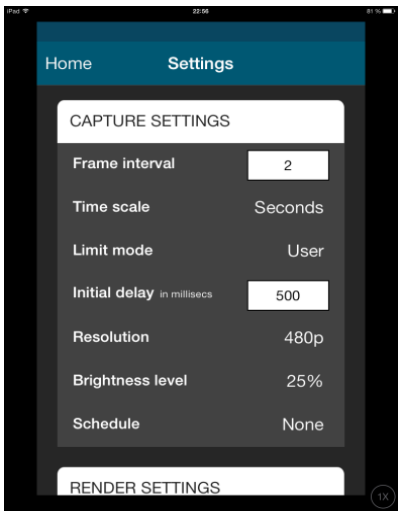




Lapse It

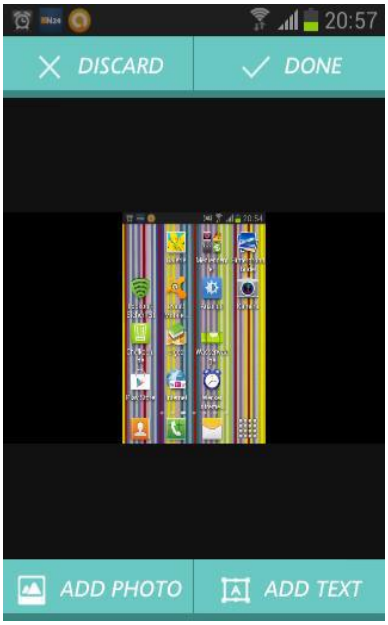
Time lapse & stop motion
Operating system(s): Android, iOS
Language: English
Price: free; Author: Interactive Universe
Alternative solutions: Droid Timelapse (Android)

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).



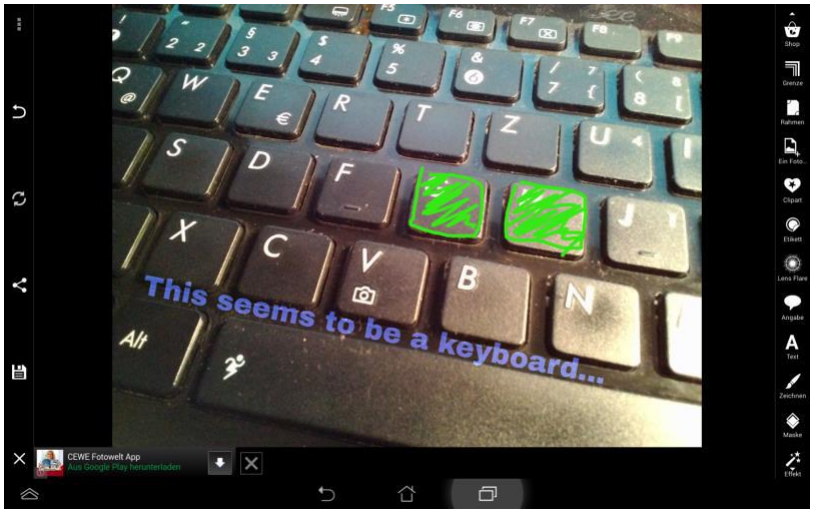
1 Second Everyday
Imagine a movie that includes every day of the rest of your life
Operating system(s): Android, iOS
Language: English
Price: free (for 1 Month, then 0.89€); Author: Cesar Kuriyama
Alternative solutions: 1 Second Daily Cam (iOS)

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
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
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, Face-book 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.

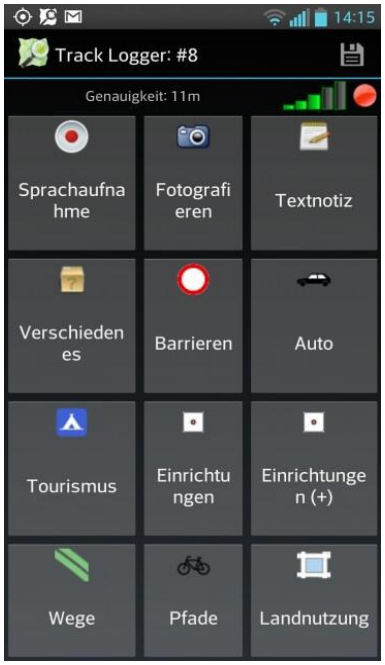
Photo Ruler ABC
Measure your surroundings
Operating system(s): iOS
Language: English
Price: free; Author: QL Software
Alternative solutions: Camera Ruler / ON 2D Measure (both Android)

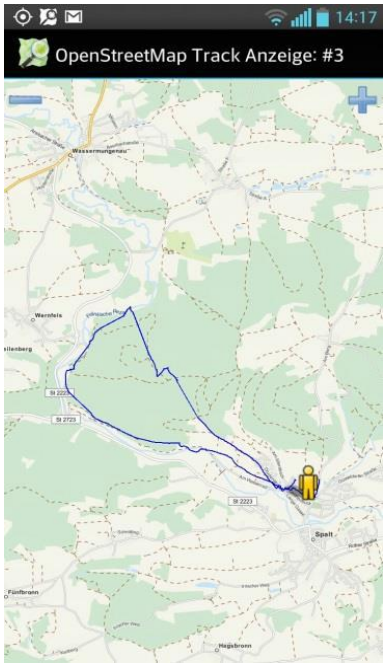
With Photo Ruler ABC you can easily measure dimensions from mm to m scale. It works by including a reference object like a coin, a CD / DVD or DIN A4 paper, into

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
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).



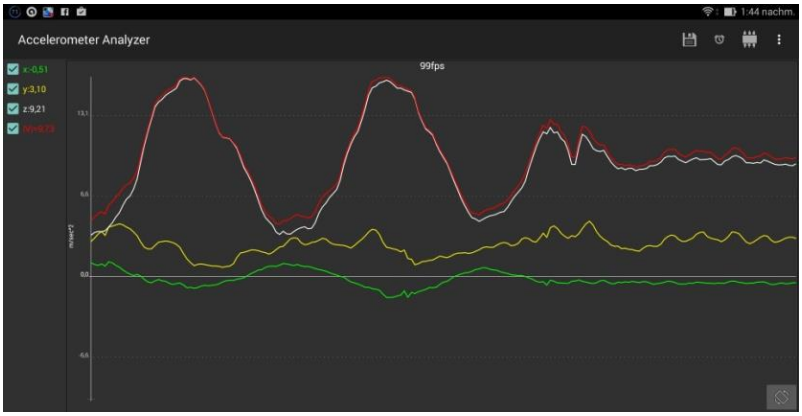


iMetalBox
Measurement tool box
Operating system(s): iOS
Language: English
Price: free; Author: Tue Nguyen Minh
Alternative solutions: Smart Tools (Android)

iMetalBox is a tool box including different measuring devices build on the sensors of

your smartphone. iMetalBox includes a Flashlight, Stoppwatch, 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).

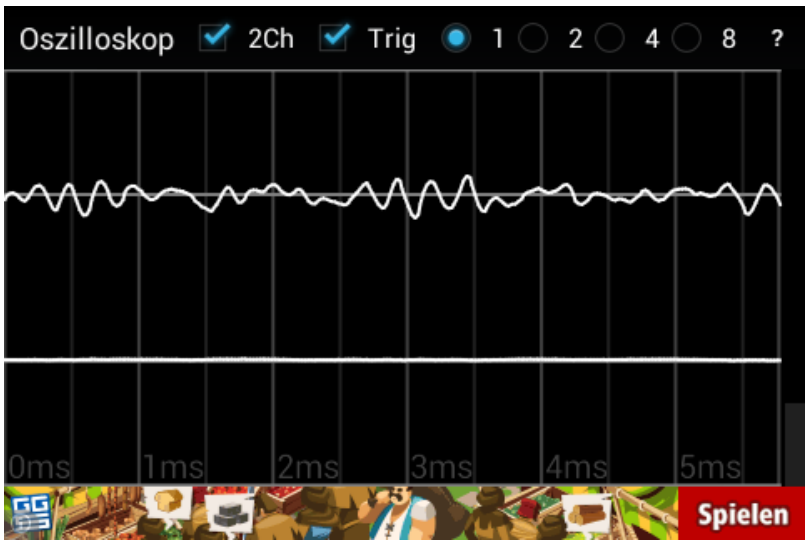
Accelerometer Analyzer
Use the internal acceleration sensors of your smart device
Operating system(s): Android,
Language: English
Price: free; Author: Sora Takayama
Alternative solutions: Sensor Kinetics / Sparkvue (both Android/iOS)



Accelometer Analyzer is a tool to log the signals of the accelerometers build in your smartphone. Accelogger reads out the accelerations in all three spatial directions (x,y,z in m/s²), 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 gyroscpoe, 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
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.

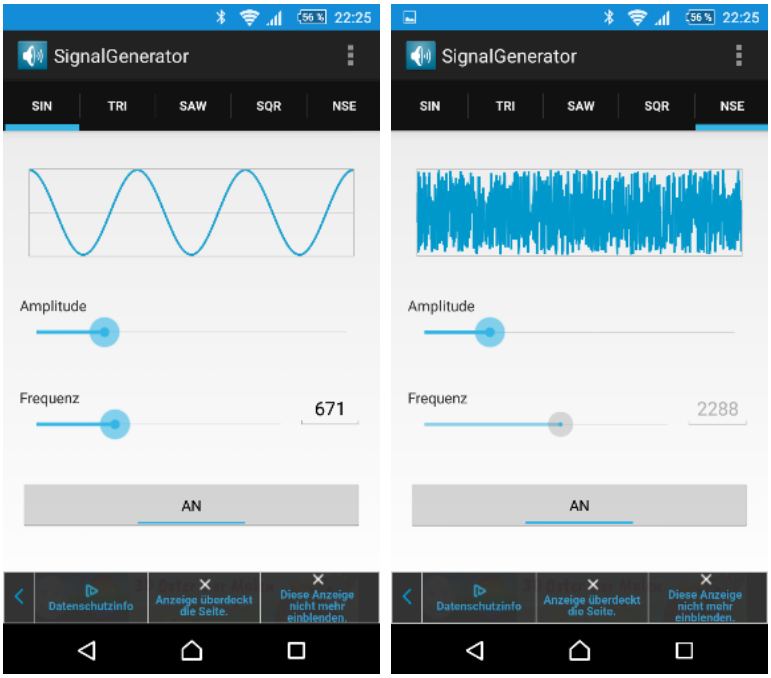


Signal-Generator

Signal Generator to create reference tones for sound frequency experiments

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

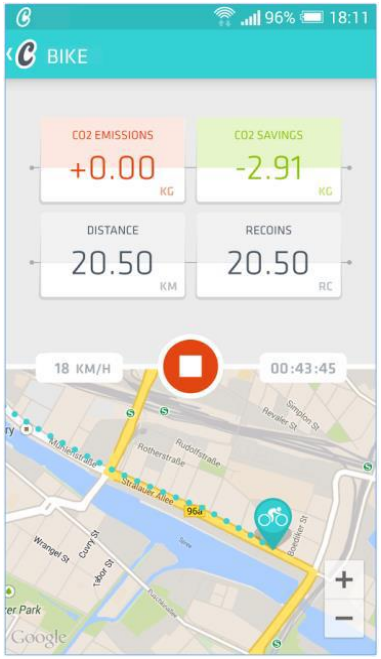
Measuring the light intensity

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.

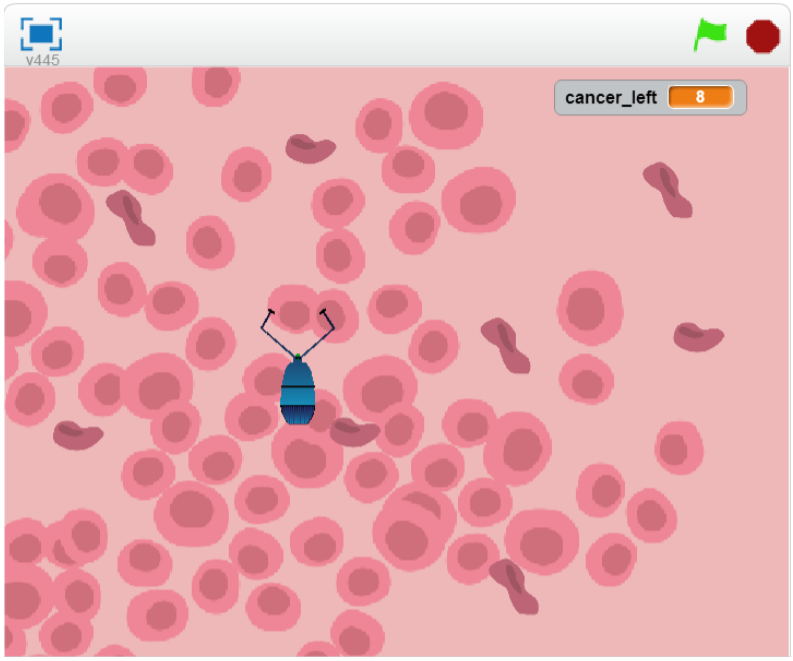
Changers CO2 Fit
Track how much CO2 you can reduce and collect ReCoins.
Operating system(s): Android, iOS
Language: various
Price: free; Author: Blacksquared
Alternative solutions: -

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.

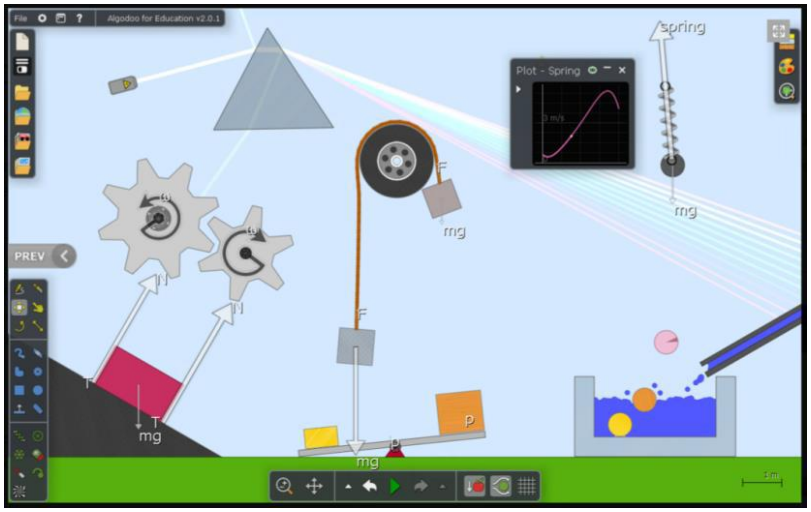


Scratch
Create stories, games, and animations
Operating system(s): Android, iOS, Browser
Language: various
Price: free; Author: Scratch Foundation
Alternative solutions: -

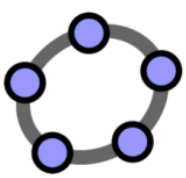
Scratch is a programming language and an online community where you can program and share interactive media such as stories, games, and animation with people from all over the world. The graphical programming language based on functional building blocks that are 'snapped' to each other was developed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



Algodoo
Physics 2-D Simulation
Operating system(s): Windows, Mac, iOS
Language: English
Price: free (iOS-Version 4.99€); Author: Algoryx Simulation AB.
Alternative solutions: Physics Sandbox Free (Android)

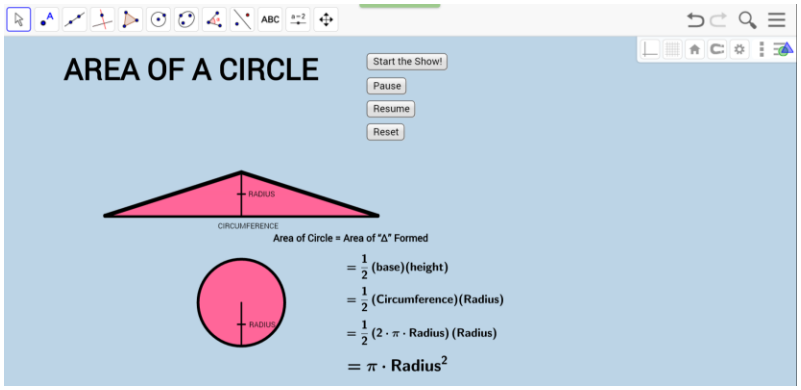


Algodoo is a 2D simulation software allowing a low-threshold and playful approach to engage with physics. From creating mechanical systems with ramps, gears and stimuli to filling water basins and testing if the created objects are swimming or sinking, to playing with light and optical tools - with Algodoo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



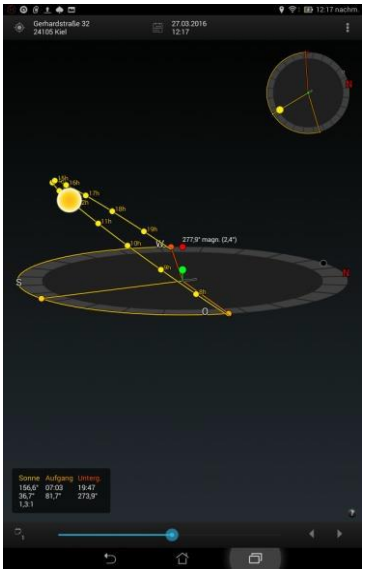
Geogebra
See, touch and experience math.
Operating system(s): Android, iOS, Browser
Language: English
Price: free;
Author: International GeoGebra Institute.
Alternative solutions: -

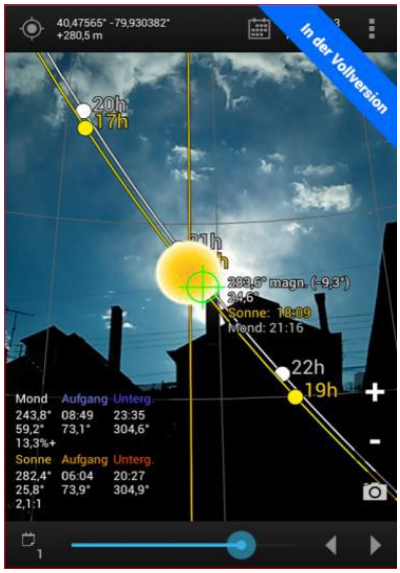
Geogebra is dynamic mathematics software for geometry, algebra, tables, statistics and analysis. It could be seen as a link between geometry and algebra. Interactive learning, teaching, and practice materials created with GeoGebra can be exchanged and shared freely on www.geogebratube.org. Students can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



Sun Surveyor
Follow the path of the sun
Operating system(s): Android, iOS
Language: English
Price: free; Author: Adam Ratana
Alternative solutions: Sun position and sunrise (Android)

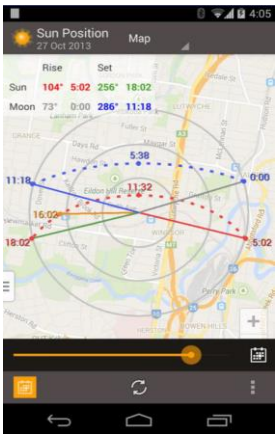
Sun Surveyor Lite predicts and visualizes sun, sunrise and sunset positions and times with a 3D Compass. Sun Surveyor Lite is thus useful for locating of venues for film and photography, for the orientation of solar panels, in architecture, horticulture, real estate, for geography geeks and more.





Sun Position and Sunrise
The universe in your pocket,
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.

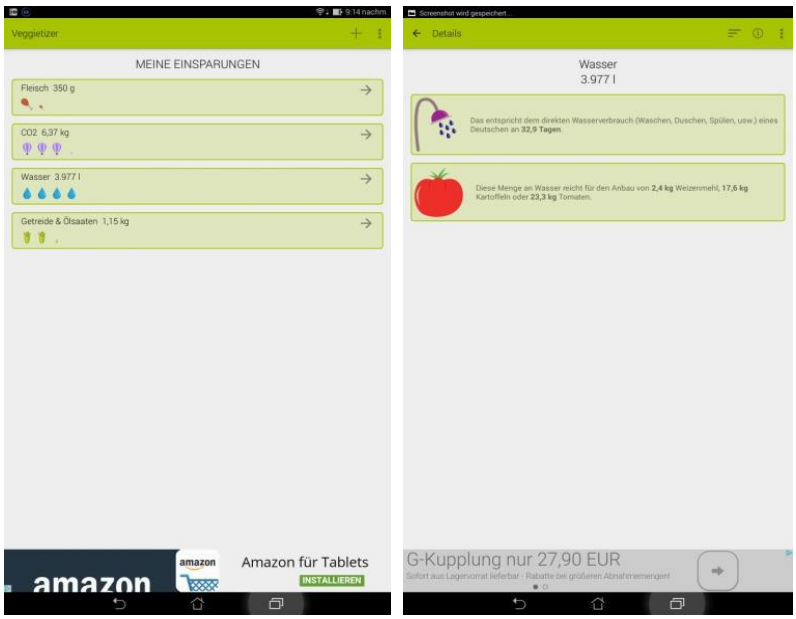


Veggietizer

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

Operating system(s): Android,
Language: various
Price: free; Author: Free Running 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.

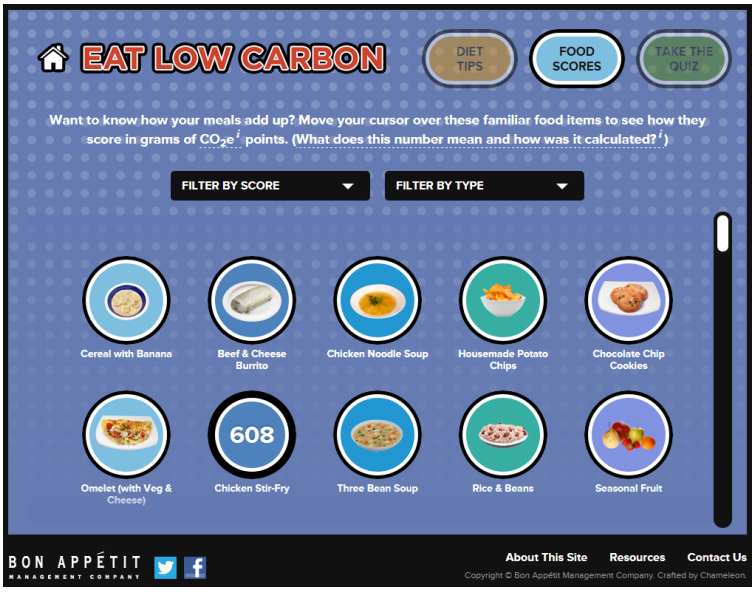


Eat Low Carbon

Food choices to reduce climate change

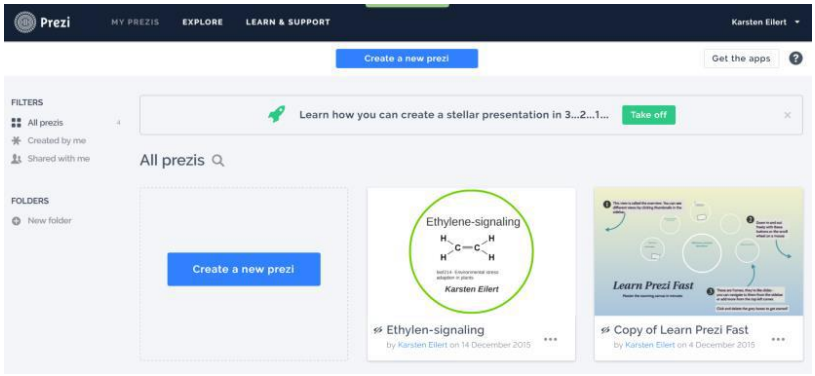
Operating system(s): Browser
Language: English
Price: free;
Author: Bon Appétit Management
Alternative solutions: -

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.



Prezi

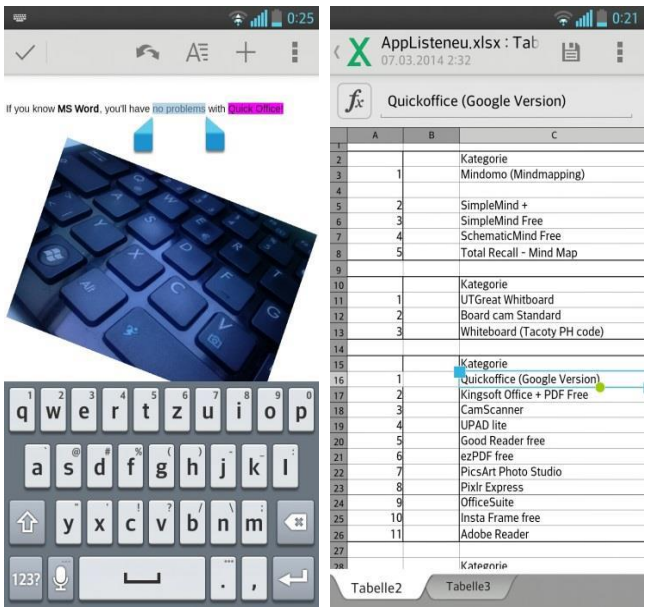
visual storytelling, not just a presentation
Operating system(s): Android (Viewer), iOS (Viewer) & Browser
Language: varios
Price: free; Author: Prezi Inc.
Alternative solutions: Google Slides



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
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
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)

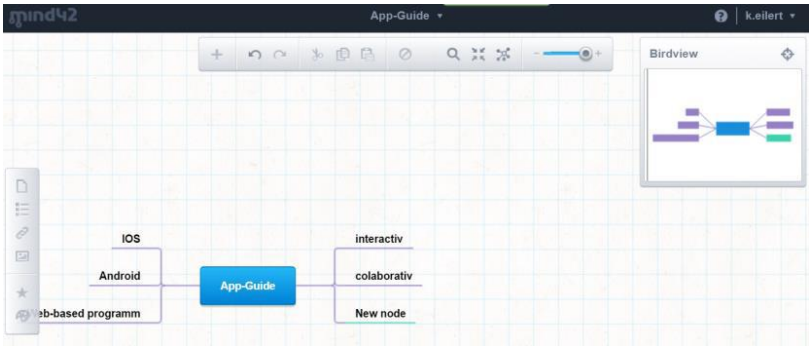
Scan documents, white-boards, blackbords, pictures etc. with your smartphone camera and directly create .pdfs out of it. Nice tool for cutting the page area and increasing readablity. The free version can export/share as .jpg without, or as .pdf with a watermark on the lower end of the page. The OCR 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
Operating system(s): Browser, Android, iOS
Language: English
Price: free; Author: Micosoft 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.

Mind42
Give your ideas a structure
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.

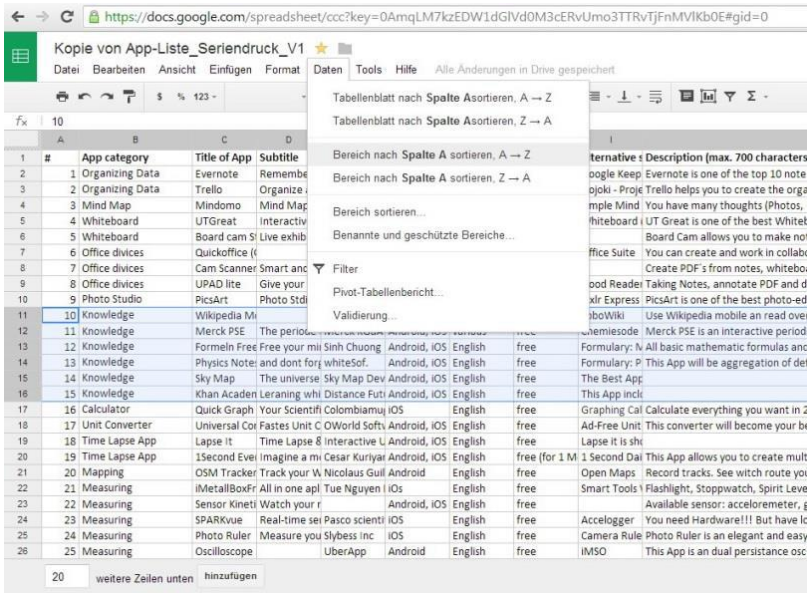


You just have to start your browser or the app on your smart device (Android: NeuronalMind42).
Free registration at mind42 is needed.

Google Docs

Simultaneously working on the same (web-)documents
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 accessablility 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.

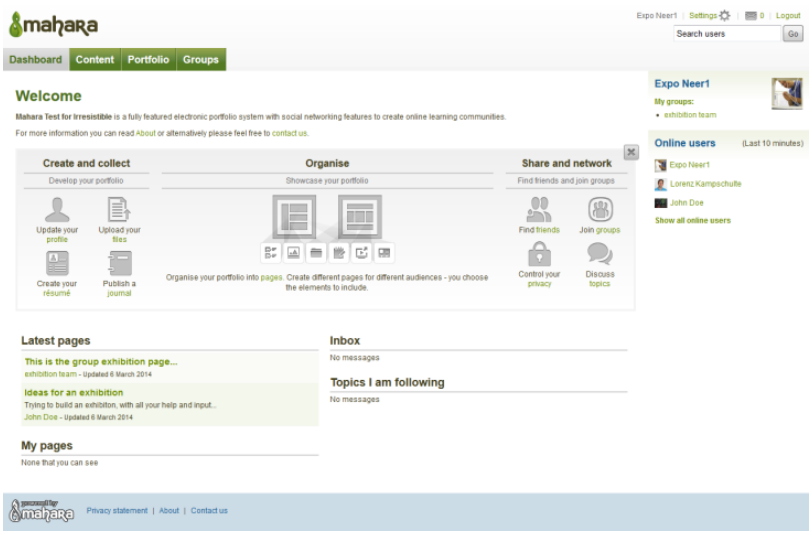


Mahara ePortfolio

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

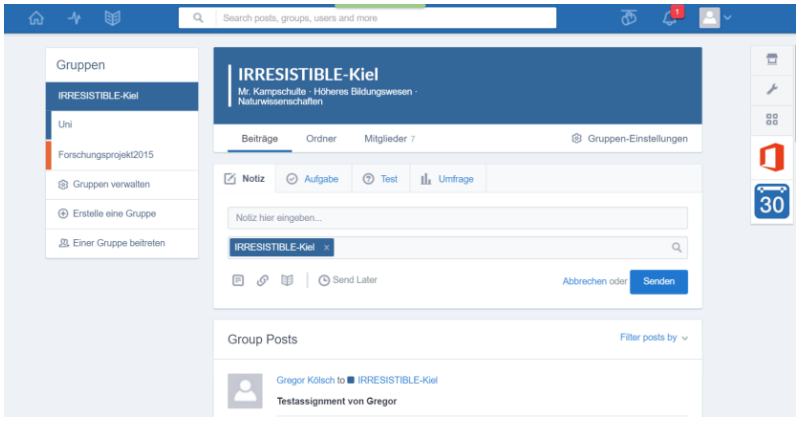


Edmodo

Create secure groups that take learning beyond the classroom

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.



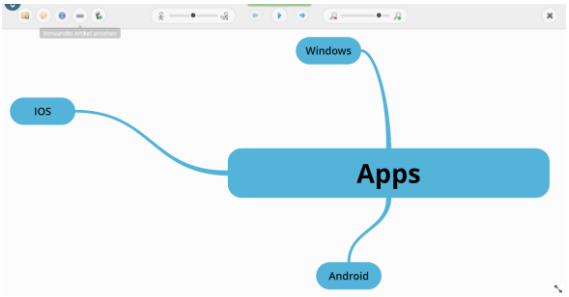
GoConqr

Interactive and collaborative whiteboard

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

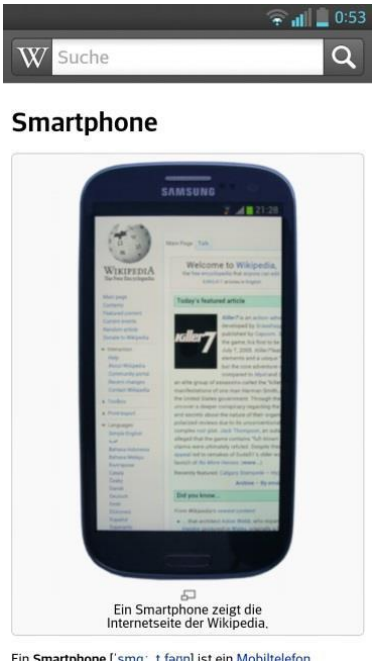
GoCondr is a platform that turns learning into an active and entertaining process. Teachers can create a connected and digital classroom for learning including resources, tests, homework and quizzes. Students can organize their learning in mind

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 progress.



Wikipedia Mobile
Wikipedia easily accessible in your pocket
Operating system(s): Android, iOS
Language: various
Price: free; Author: Wikimedia Foundation
Alternative solutions: LoboWiki (Android)

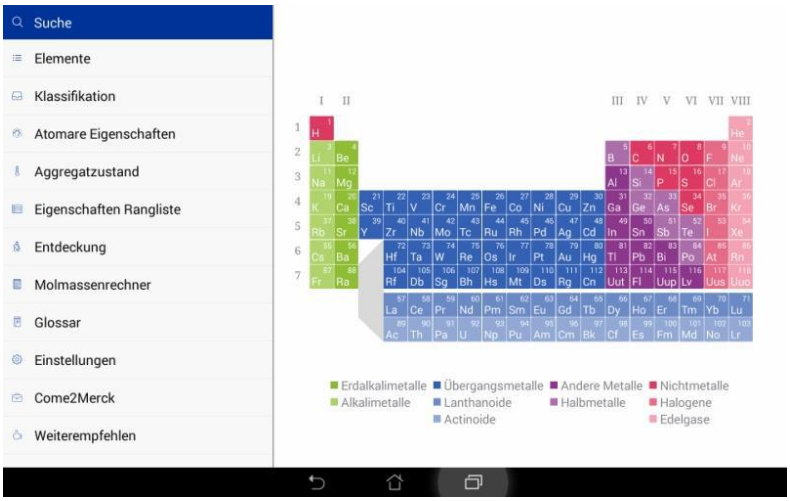
Use Wikipedia mobile and read over 20 million articels. Save articles to read later offline, search related articles. Share articles (links) in various ways. On aged phones, the app is much faster than using a browser.



Merck PTE
The periodic table, presented in a nice way
Operating system(s): Android, iOS
Language: various
Price: free; Author: Merck KGaA
Alternative solutions: Chemisode (iOS)

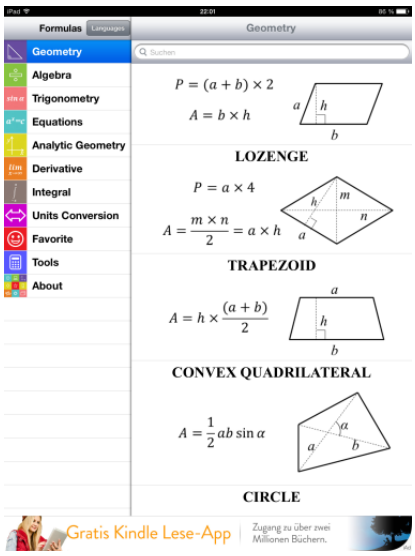
Merck PTE is an interactive periodic table with a clean and friendly design. Besides all relevant information usually part of a periodic table, the app includes element features, images, history of discovery, melting and boiling point – you even have a view of the PSE indicating the state of matter of each element at a given temperature. Further the app offers an integrated molar mass calculator. All content is stored

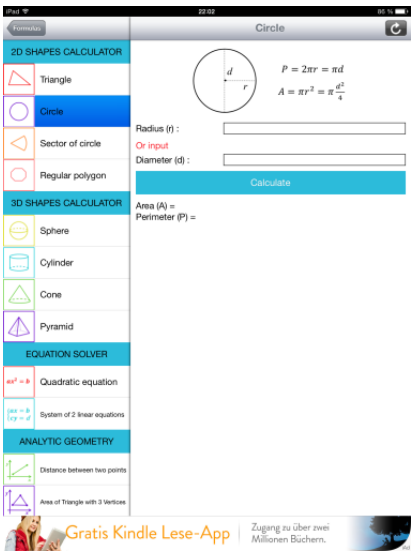
within the app, after download no internet connection necessary (due to legal restrictions this app is named EMD PTE in North America).



Formulas Free
All math fomulas in your pocket
Operating system(s): Android, iOS
Language: English
Price: free; Author: NSC Co.
Alternative solutions: Formulary: Math Free (Android/iOS)

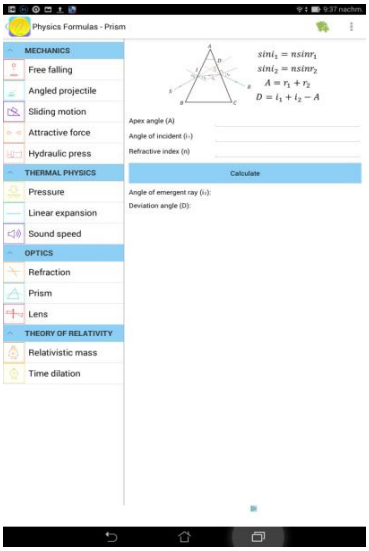
The app Formulas Free contains all basic mathematic formulas and many helpful gadgets like calculating the surface area or solving roots / equations. It also includes a simple unit converter. You can share every formula with friends via email, message or facebook.

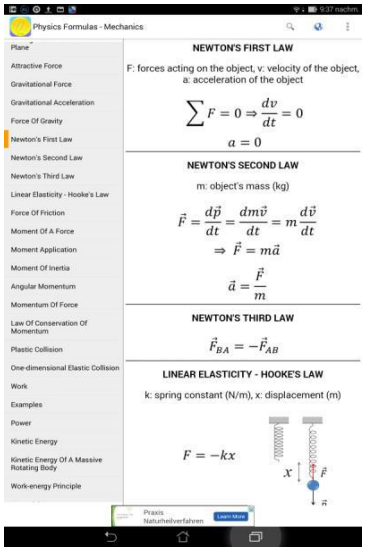




Physics Formulas Free
Physics formulary
Operating system(s): Android, iOS
Language: English
Price: free; Author: NSC Co.
Alternative solutions: Formulary: Physics Free (iOS)

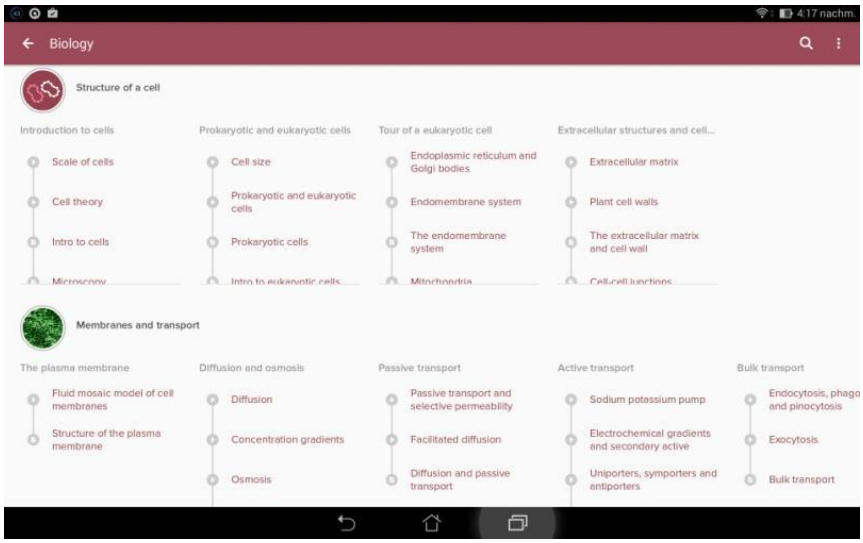
This app is an aggregation of definitions and formulas in basic physics knowledge, somewhere between fomulary and text book. It contains e.g. electricity, magnetism, electromagnetic waves, ray optics etc.





Khan Academy
Learning while watching
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.

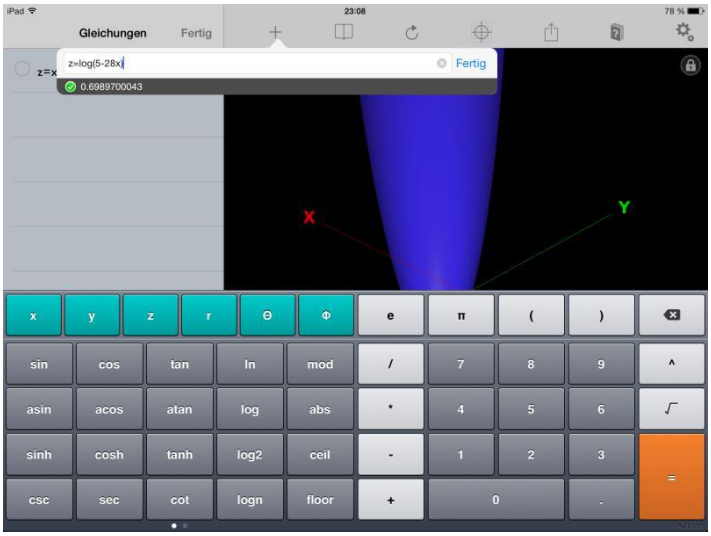


Sky Map
The universe in your pocket
Operating system(s): Android, iOS
Language: English
Price: free; Author: Android: Sky Map Devs, iOS: Mobius Entertainment
Alternative solutions: -

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
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
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

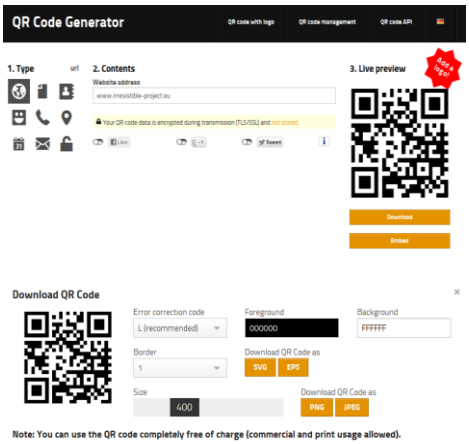
Operating system(s): Android, iOS
Language: English
Price: free; Author: 3GVision
Alternative solutions: Barcode Scanner (Android)

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.

QR Code Generator

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

Operating system(s): Browser
Language: English
Price: free; Author: ARSAVA GmbH & Foundata GmbH GbR
Alternative solutions: www.i-nigma.com/CreateBarcodes.html



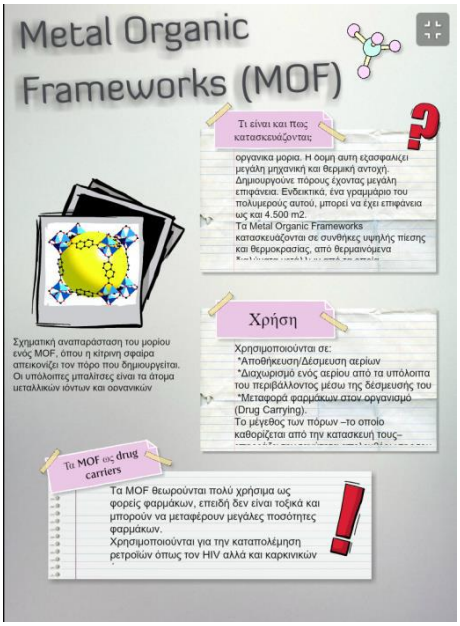
Create 2D barcodes online. Offers different content formats, e.g. text, URL, vcard, telephone, geolocation, WLAN access data etc.
Create codes with a resolution of up to 1000x1000 Pixel, download as .png, .jpg, .svg, .eps files.
Different colors are possible, unlimited use, no ads.

Glogster

An interactive poster-session

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.



Open Exhibits PLAYER

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 SDK

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.

SPARKvue
Real-time sensor-based data collection
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.

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 educational institutions 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.

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

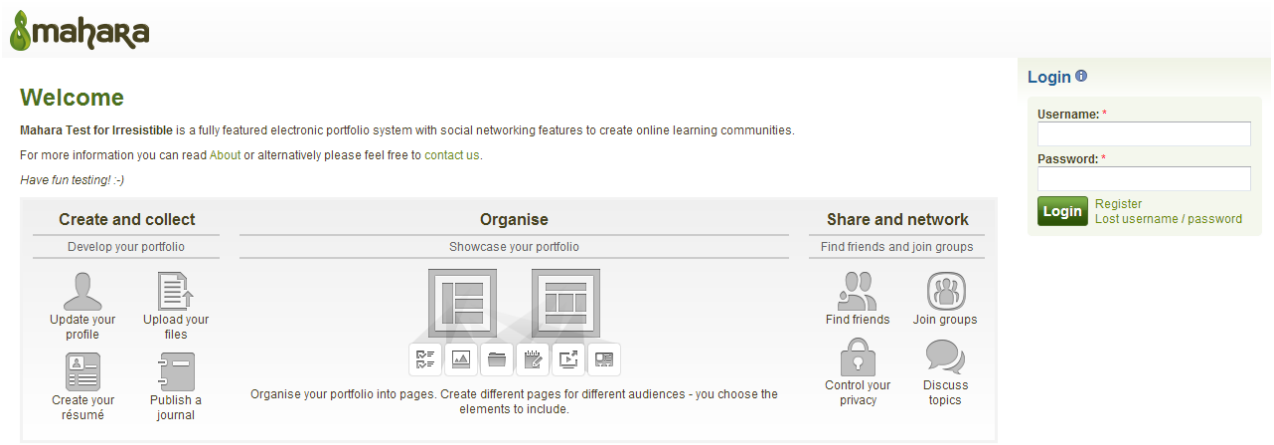
Artefacts	all data created and/or uploaded to Mahara are called artefacts
View	a view is a collection of artefacts, e.g. a journal, a page, a blog entry etc.
Collection	a collection is a set of pages that are linked to one another and have the same access permissions
Sharing	sharing of views and artefacts 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

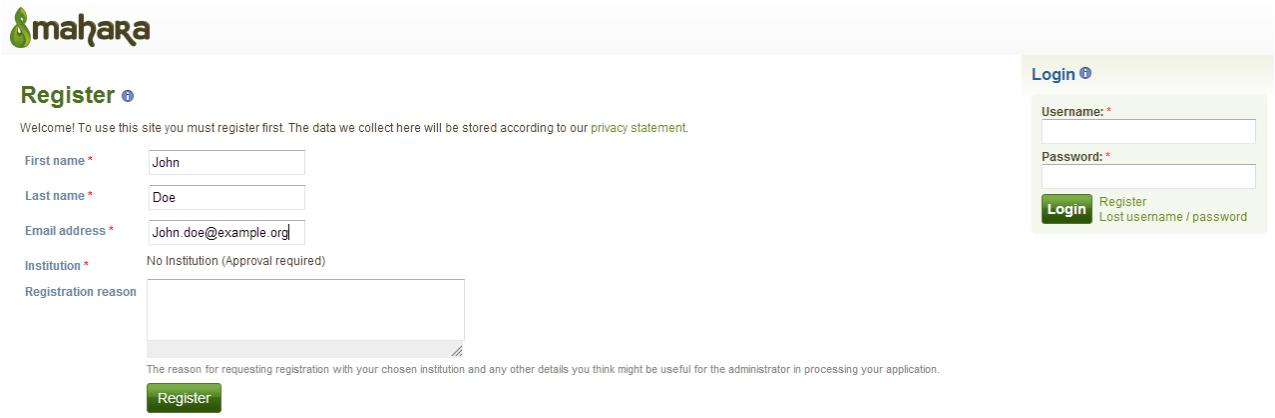
These HowTo's should allow you to get started with Mahara. Mahara Version 1.8 is the base for this manual.

HowTo: Set up an Account

Go to the main page.

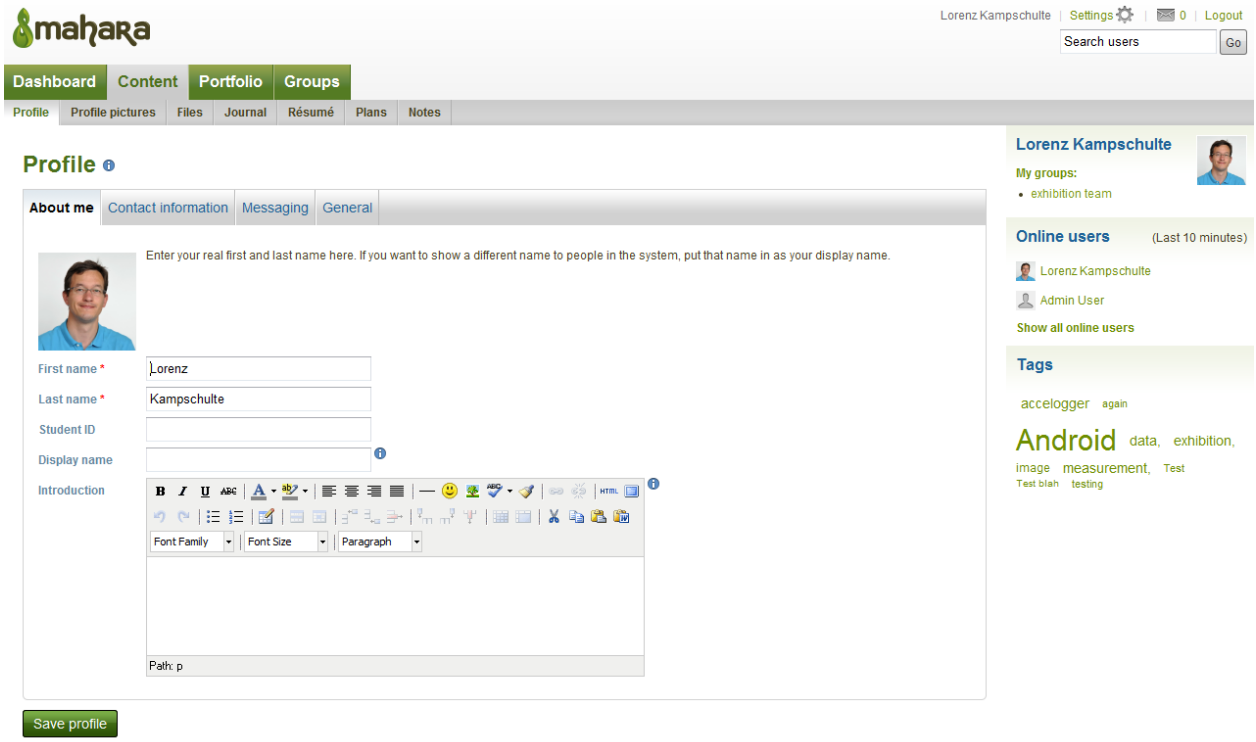


Click [Register]



Fill in your data, click [Register].

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

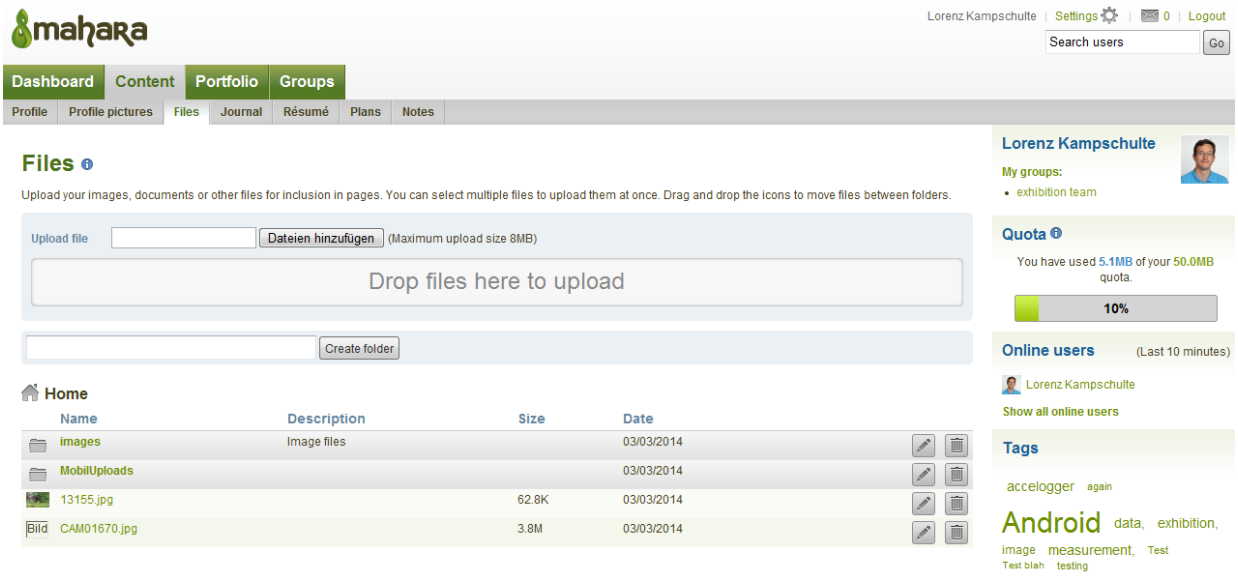
The [Content] tab holds all your personal data, e.g. profile, files, journal, resume, plans, notes etc.

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]

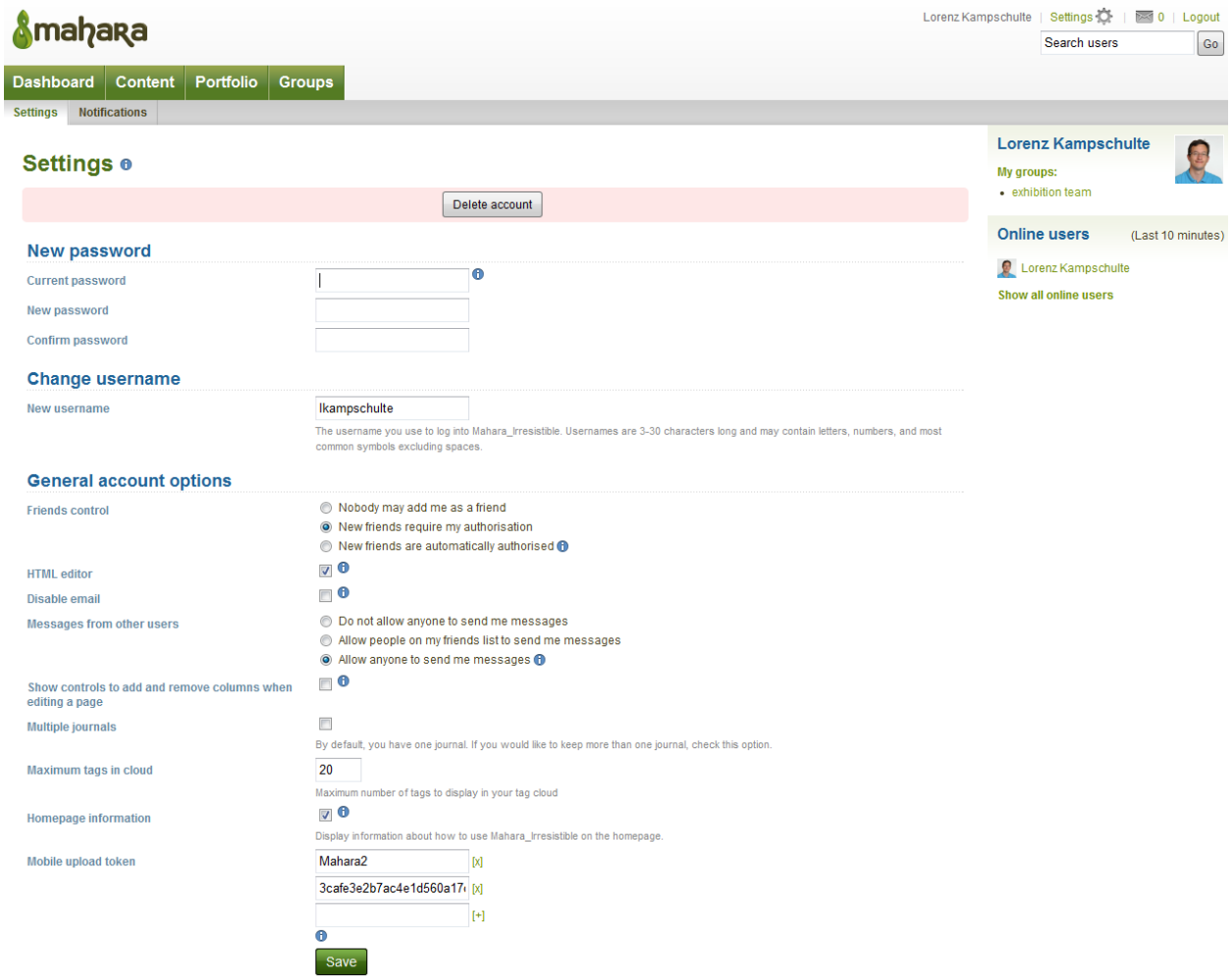


Just drag-and-drop the file on the [Drop files here to upload] field, or use the [Add file] button. In the lower part of the screen you have a list of all your files, can create folders and sort them. Hit the [Edit] button (pen symbol) to add a description and tags for your file.

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

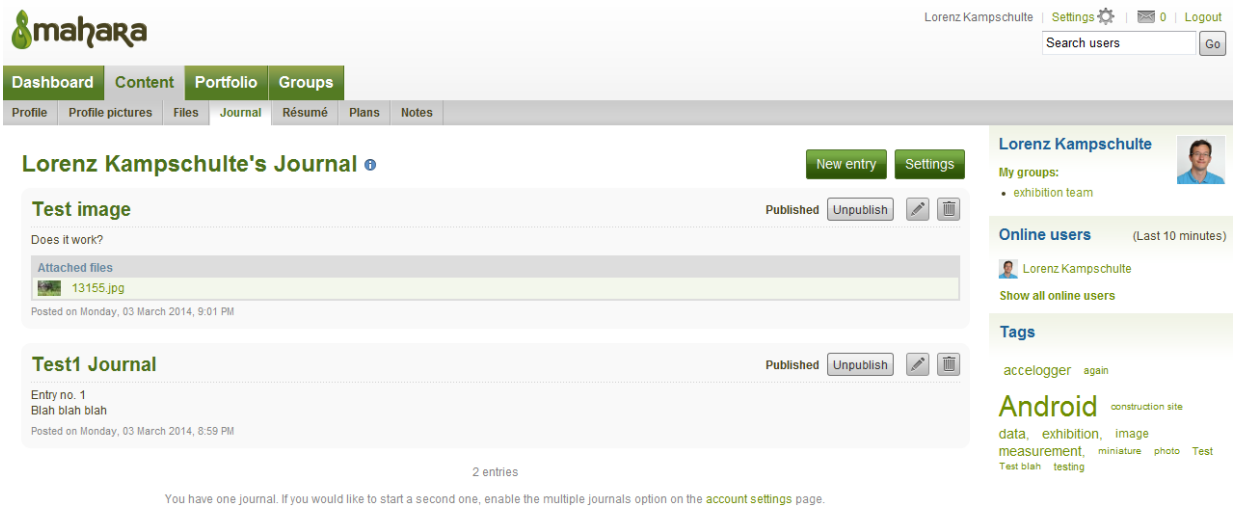
token you just set on the webpage of Mahara (i.e. “Mahara”). You also can choose which connection type should be used, change to [WiFi only].

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”. www.irresistible-project.eu.

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



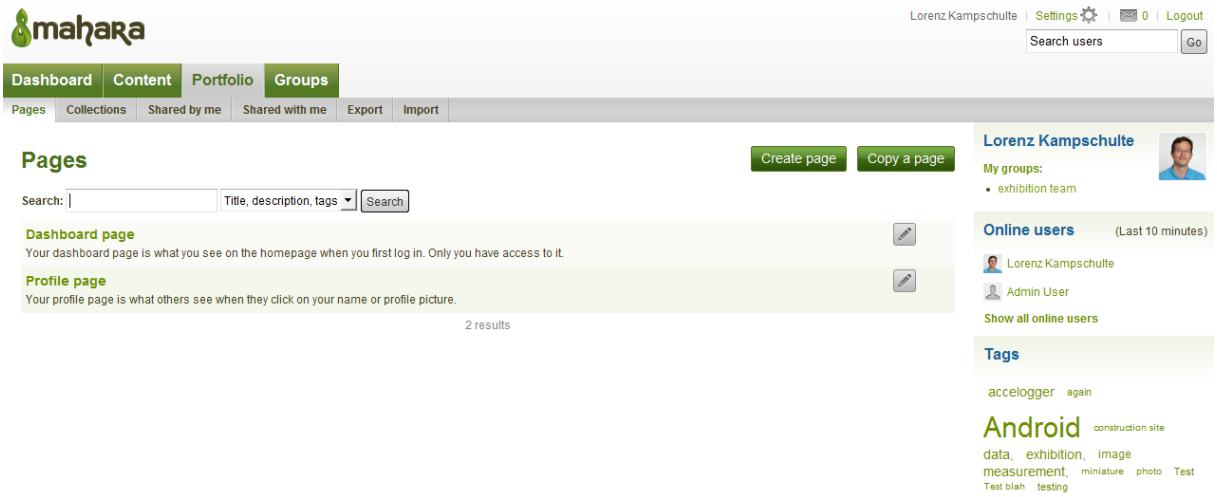
To create an entry, just hit the [New entry] button.

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.

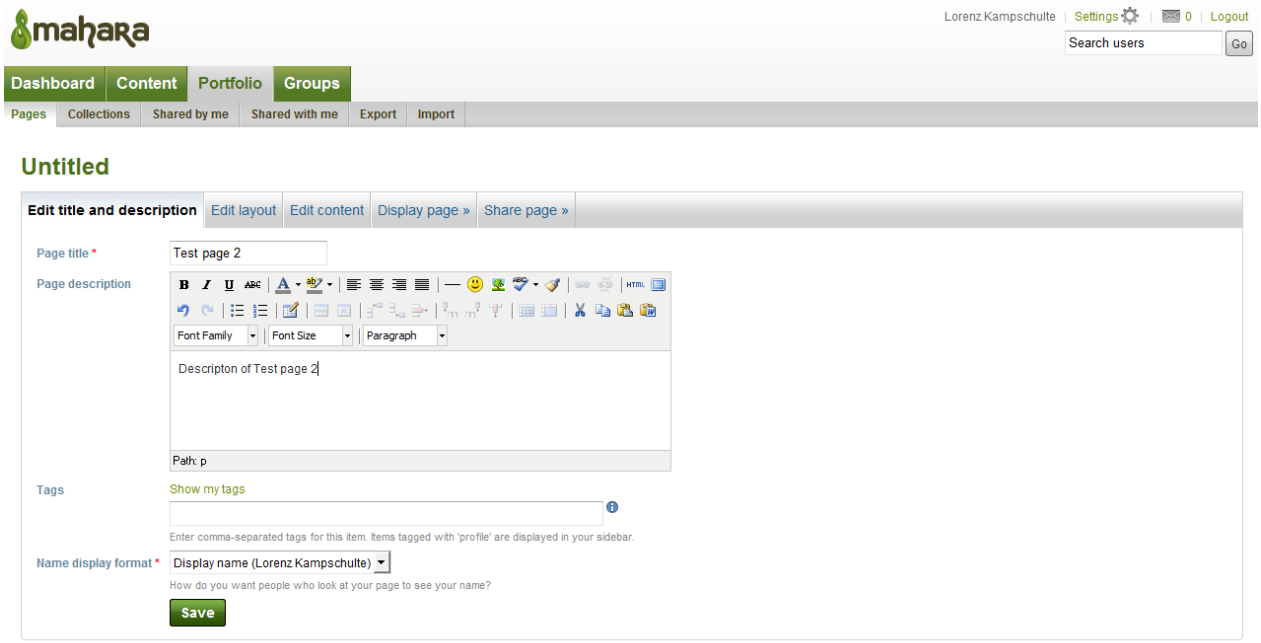
HowTo: Create a Page

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.

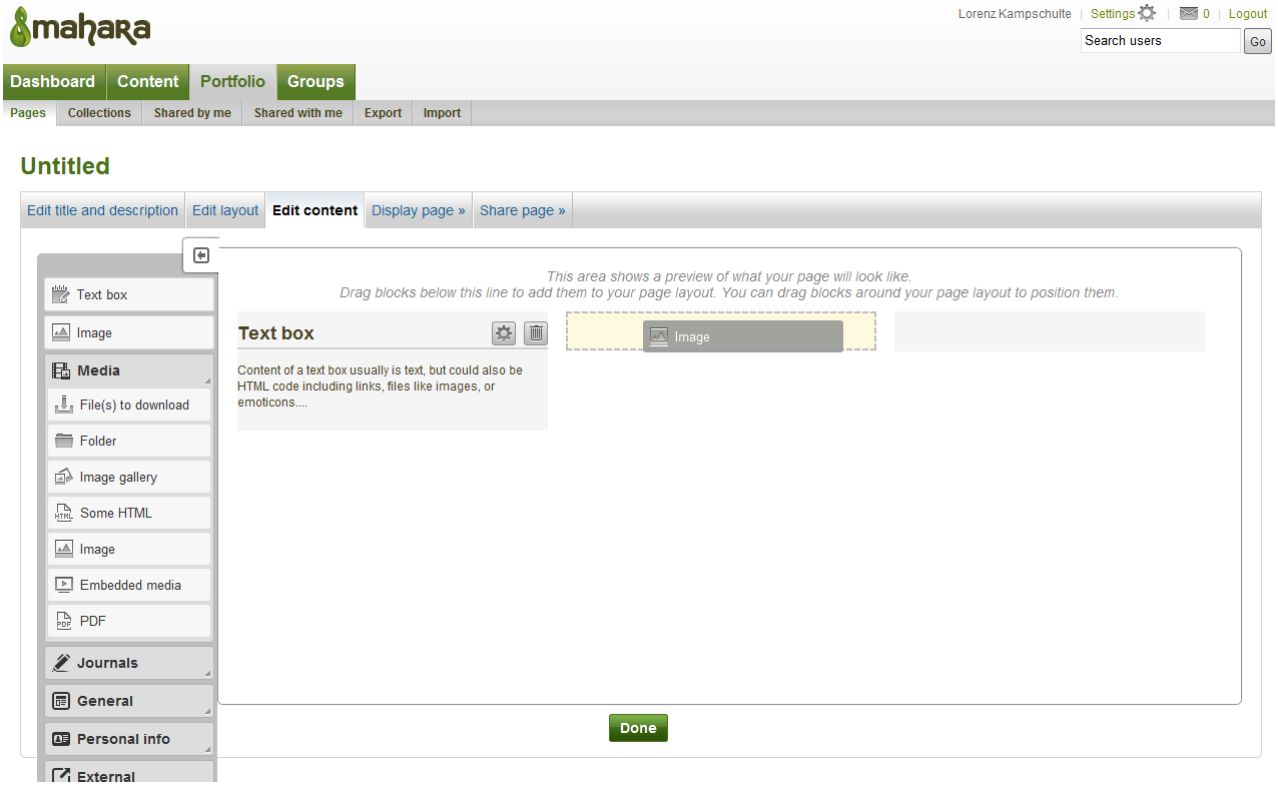
When you start with a page:



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=KWRv0QElLYVXcIdTpFAG thus masking the page ID.

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

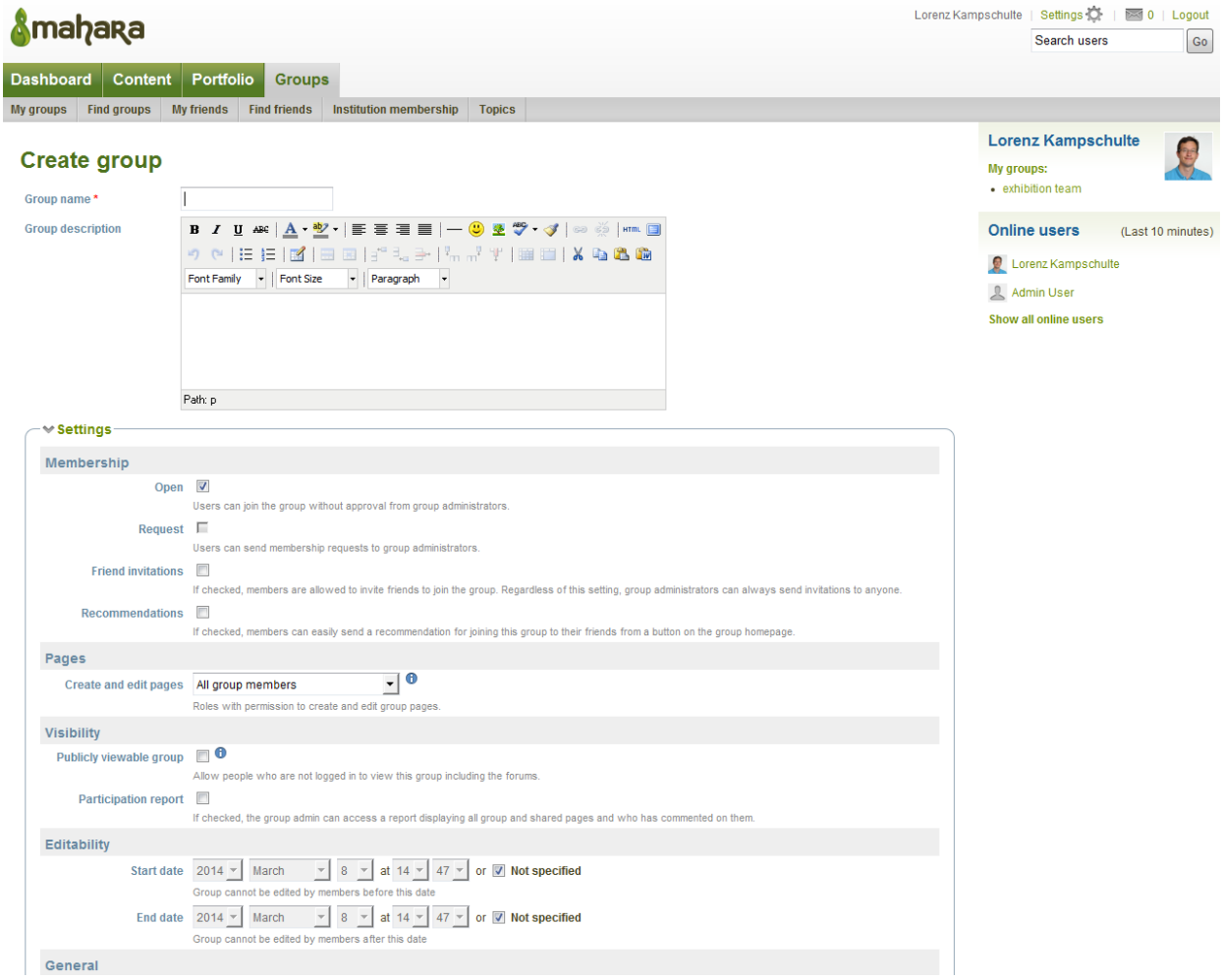
Collection:

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.

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]

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.



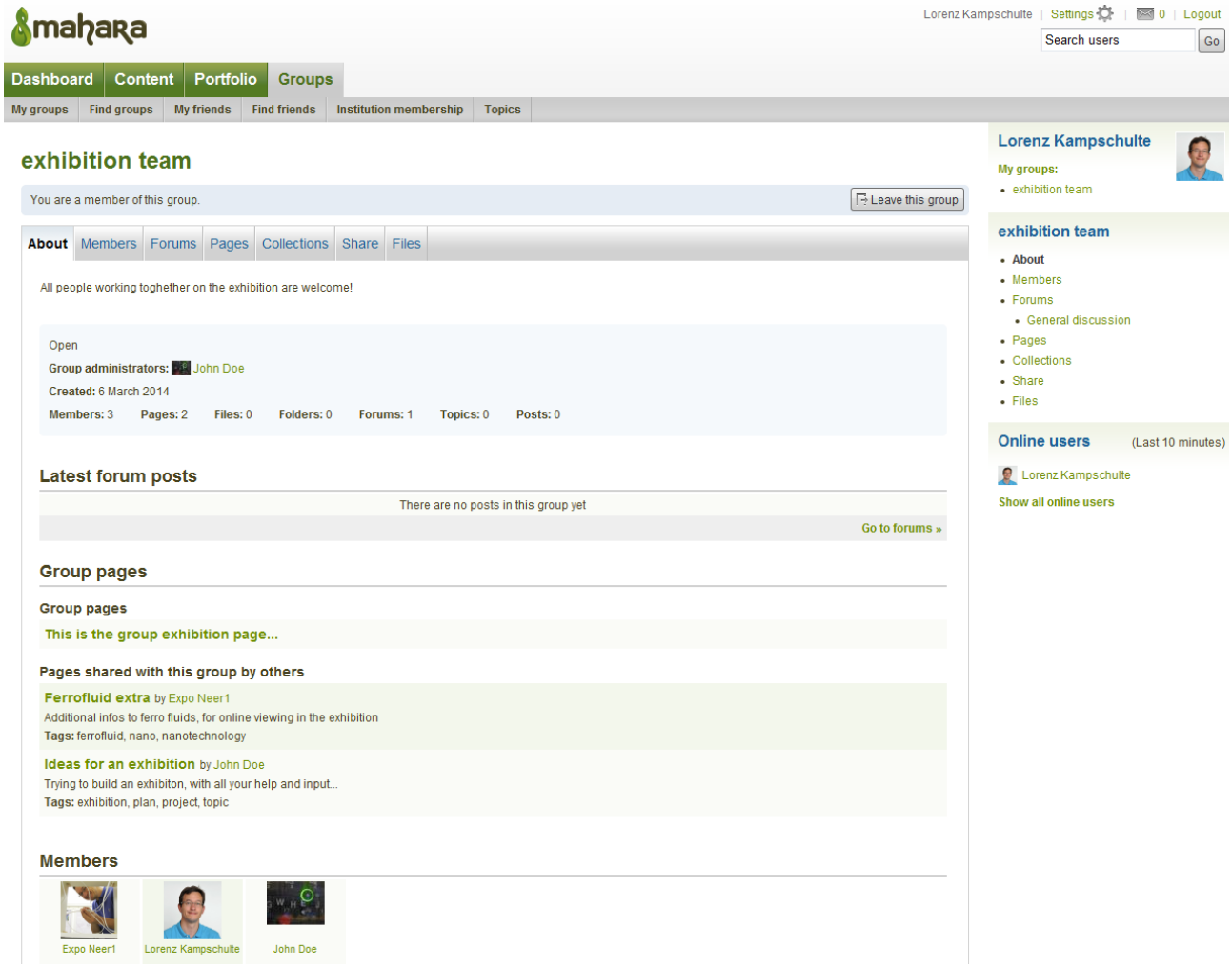
Hit the [Save group] button at the lower end of the page.

Each group has its own set of pages, showing members, statistics, and giving access to group pages, collections, and a shared file repository (each group has their own quota share).

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.



1.7 Examples of Using ICT in a Learning Unit

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 5).

Table 5. 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 educational institution 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 CO2 Footprints: Calculating and Comparing CO2 Footprints for Food and Travel	The topic of CO2 footprints instantly offers many starting points for RRI, e.g.: Knowing how they are calculated ('Science Education'), Regulations on CO2 emissions ('Governance'), contributors to the problem ('Engagement') etc.	Tracking individuals' CO2 footprint travelling to educational institution for one week, comparing and discussing results	Comparison and discussion of the CO2 footprint of female / male eating behavior (group work2)	Presentation of core results as a poster

Unit on Plastics: Introduction to Plastics using Mahara

This example illustrates a teaching sequence on plastics. It starts with a reference to plastic as part of our daily environment and then introduces the basics about the production and use of plastic materials. Towards the end, it raises questions about substituting plastics and other ways to reduce the immense problems 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 educational institution 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. Edmondo, 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 educational institution website (see Figure 14).

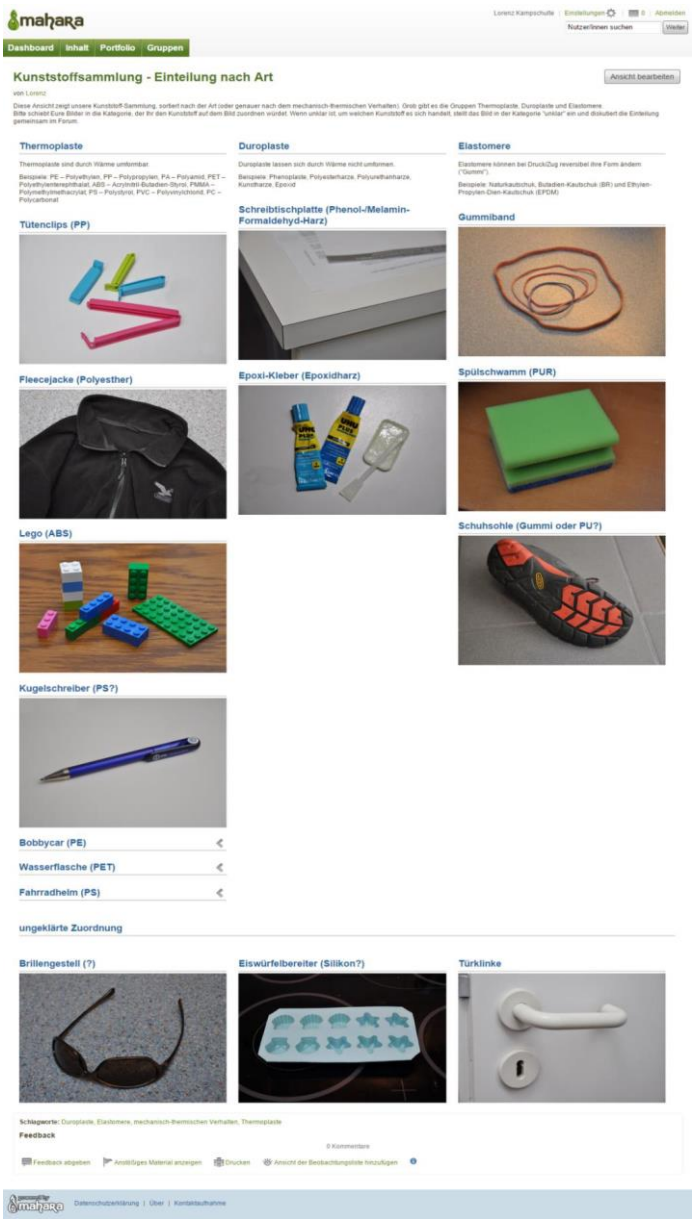


Figure 14. Example of a Mahara portfolio during the sorting process: students' photographs are grouped in four categories: thermoplast, duroplast, elastomer, unsettled.

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 - educational institution yard

Task: Find the best spot to place a 2 m² photovoltaic solar panel on your educational institution 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 educational institution yard and indicate your 1st and 2nd choice position. Draw a table and list the relevant factors for both positions.

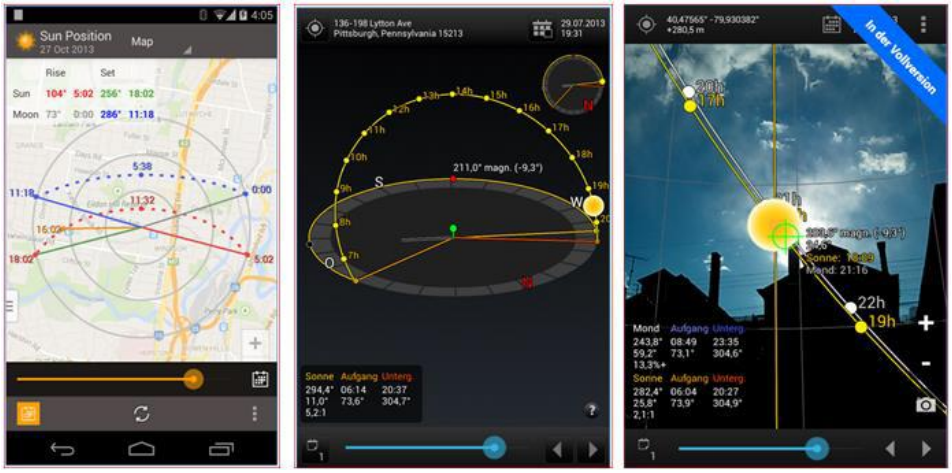
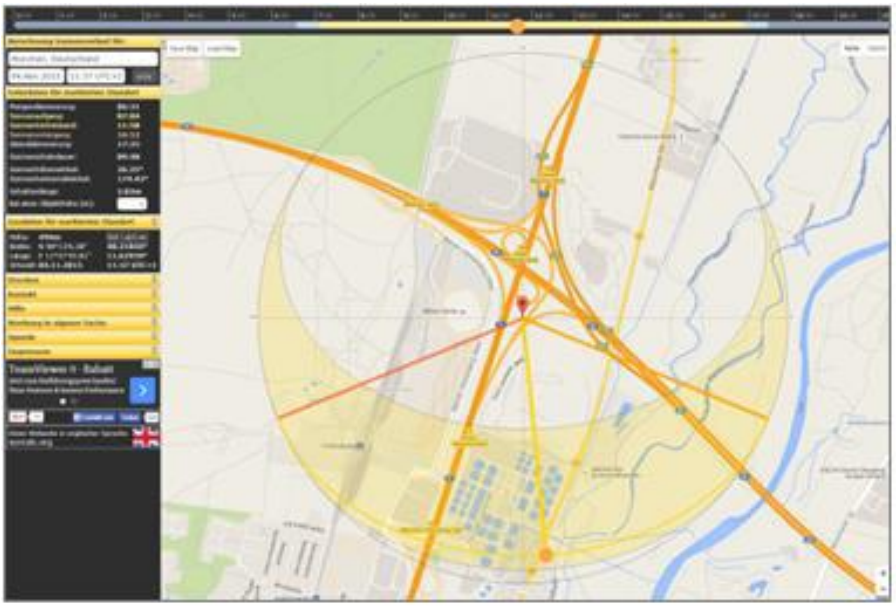


Figure 15. Screenshots of the apps Sun Position (left) and Sun Surveyor (middle and right) to determine the best position for a solar panel

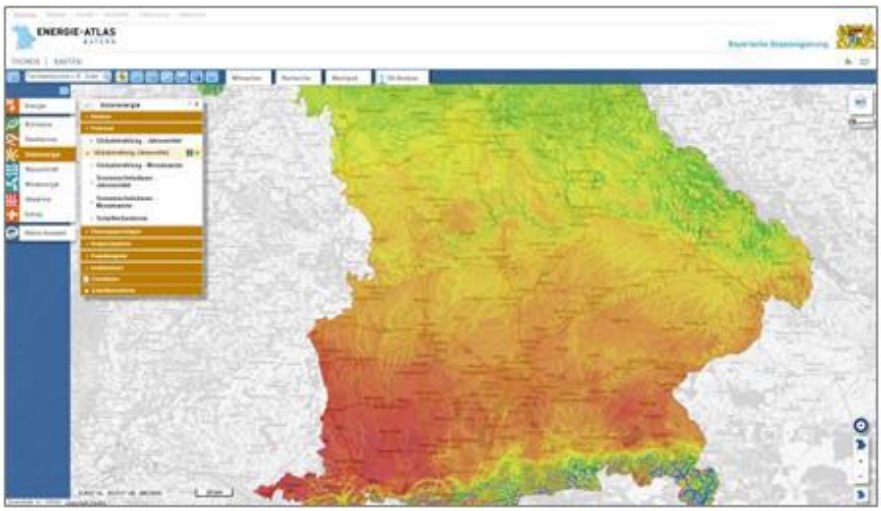
3. Group 2 - regional position

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 educational institution 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.



a)



b)

Figure 16. Course of the sun simulated on sonnenverlauf.de14 (left), map of global radiation for southern Bavaria13 (right).

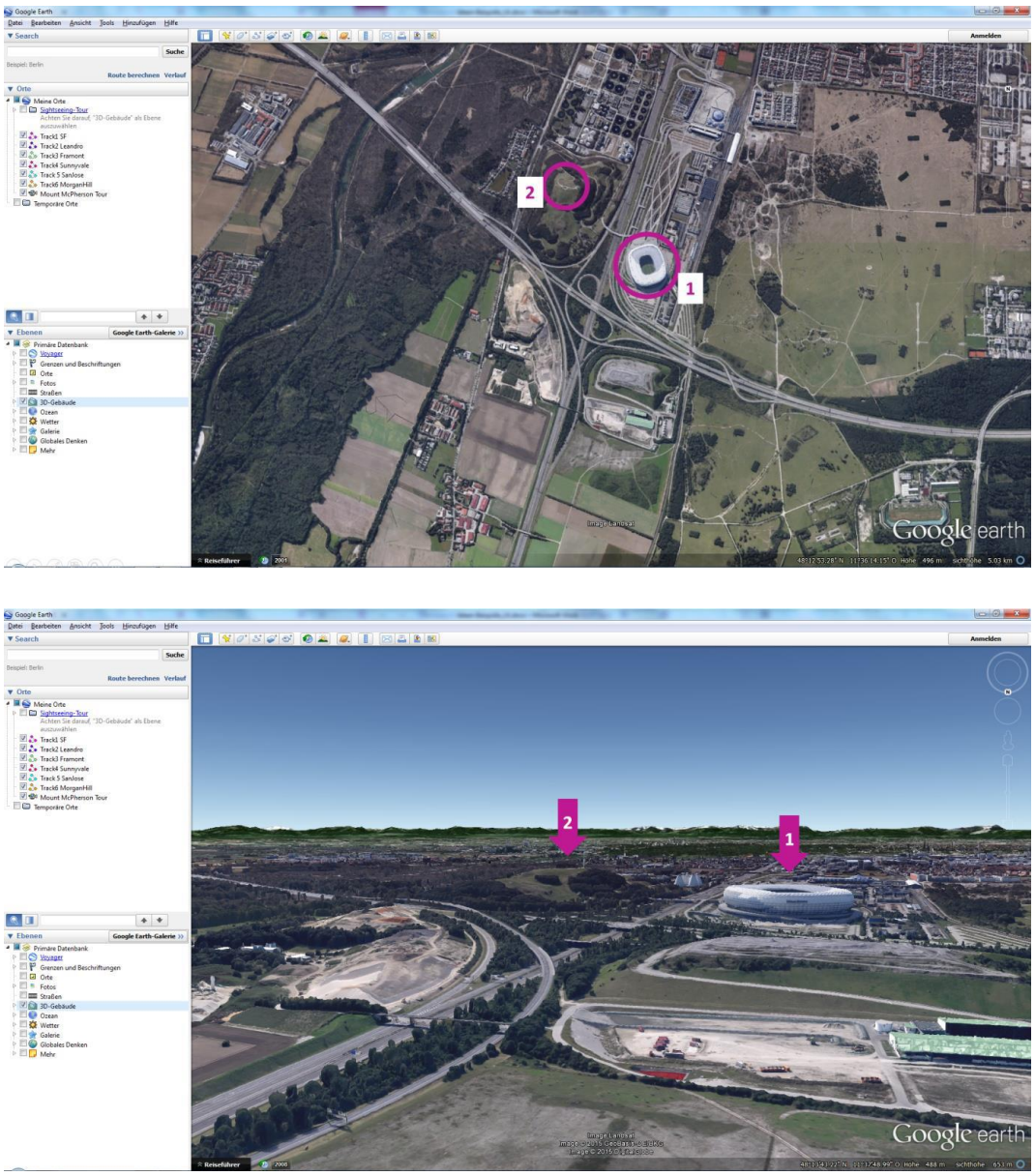


Figure 17. Two possible positions for a small PV solar power plant, visualized in Google Earth12: (1) on the roof of a football stadium, (2) on the top of a small hill close by

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.

Task: Find out the optimal orientation of a solar panel towards the sun under the current conditions. Search for a sunny spot on your educational institution 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.

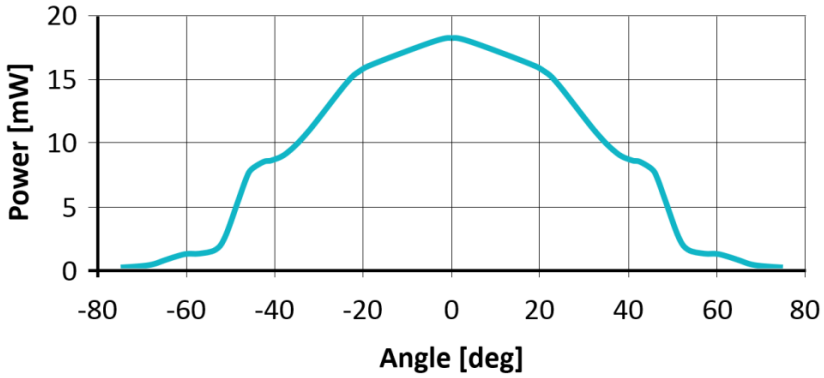


Figure 18. Angle dependent power of a typical solar cell.15

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.

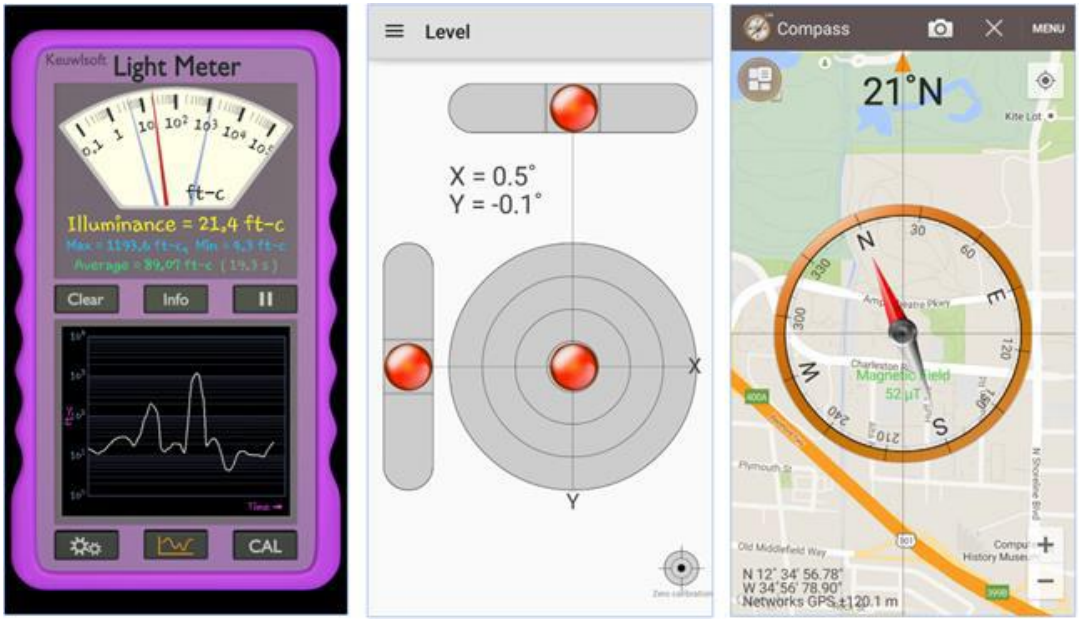


Figure 19. Screenshots of the apps Light Meter, Smart Level, Smart Compass

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 educational institution 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 educational institution (or all travelling) for one week, collect, compare and discuss the results.

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.

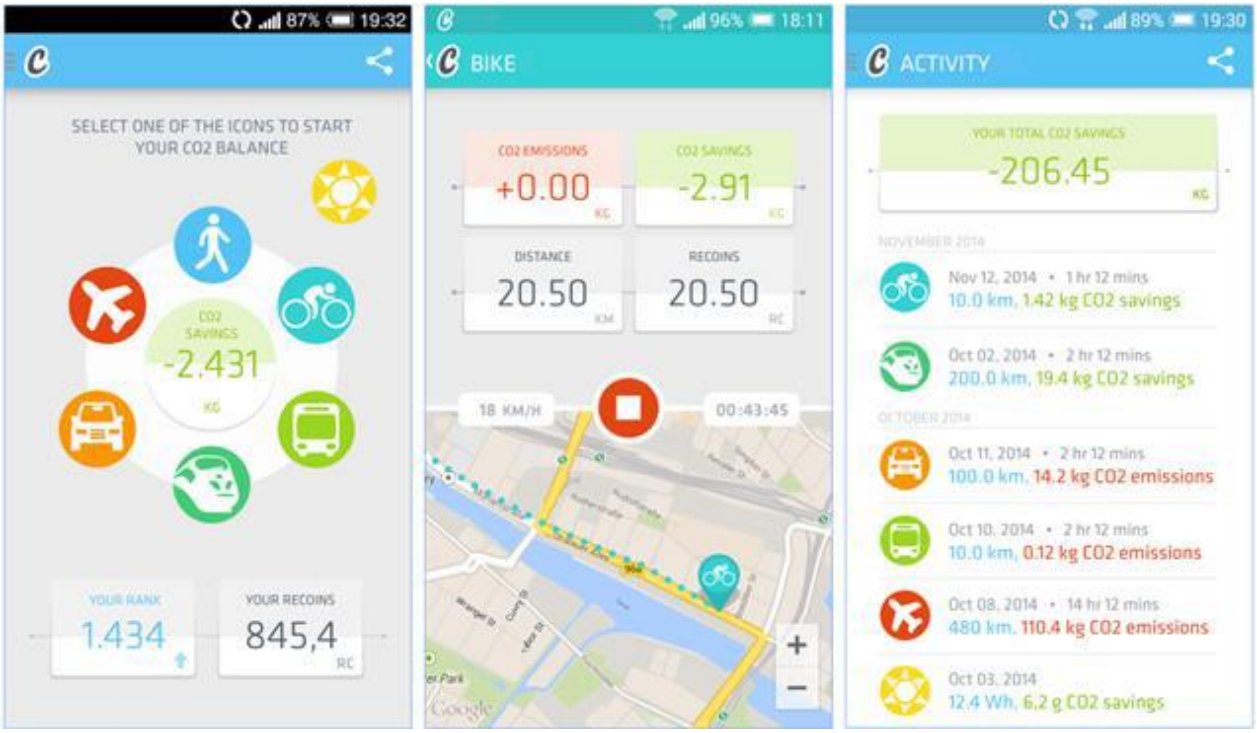


Figure 20. Screenshots of the app Changers CO2 Fit: start screen, travel screen, list of travel activities

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.

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.

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.

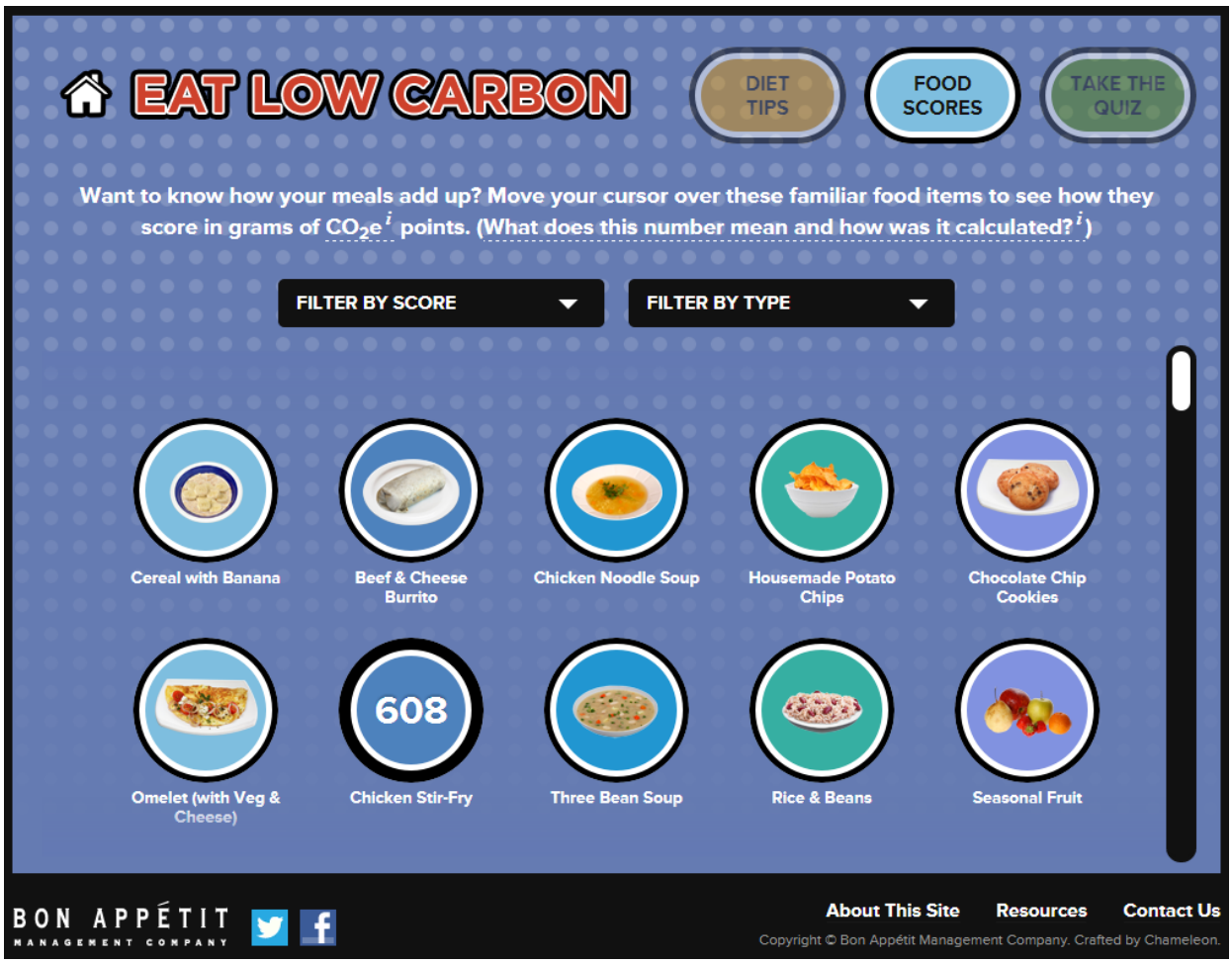


Figure 21. Screenshot of the website Eat Low Carbon. The page contains a huge variety of food and meals, hovering over the photo with the mouse indicates the grams of CO2e

- 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-guide25).

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

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 educational institution 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 (see Table 6).

Table 6. Overview of Best Practice Examples

Tool	Main use in the teaching module	Technical system the ICT tool was used with	Teacher Experience with the specific tool / in general
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
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
Skype	To conduct teleconferences with experts far away from the educational institution's region	Computers in classroom	Teachers had used Skype before but not in class for educational purpose
Popplet	Building a concept map that highlights the main characteristics of the topic	Students' computer at home OR computer-room at educational institution	Teacher had used Popplet before, some experience in using ICT tools, but outside of classroom
Apple iMovie	Tool to produce videos for exhibition as well as for reflection	Educational institution/University iPads	Teachers were skilled users of iPads
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
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
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

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

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.

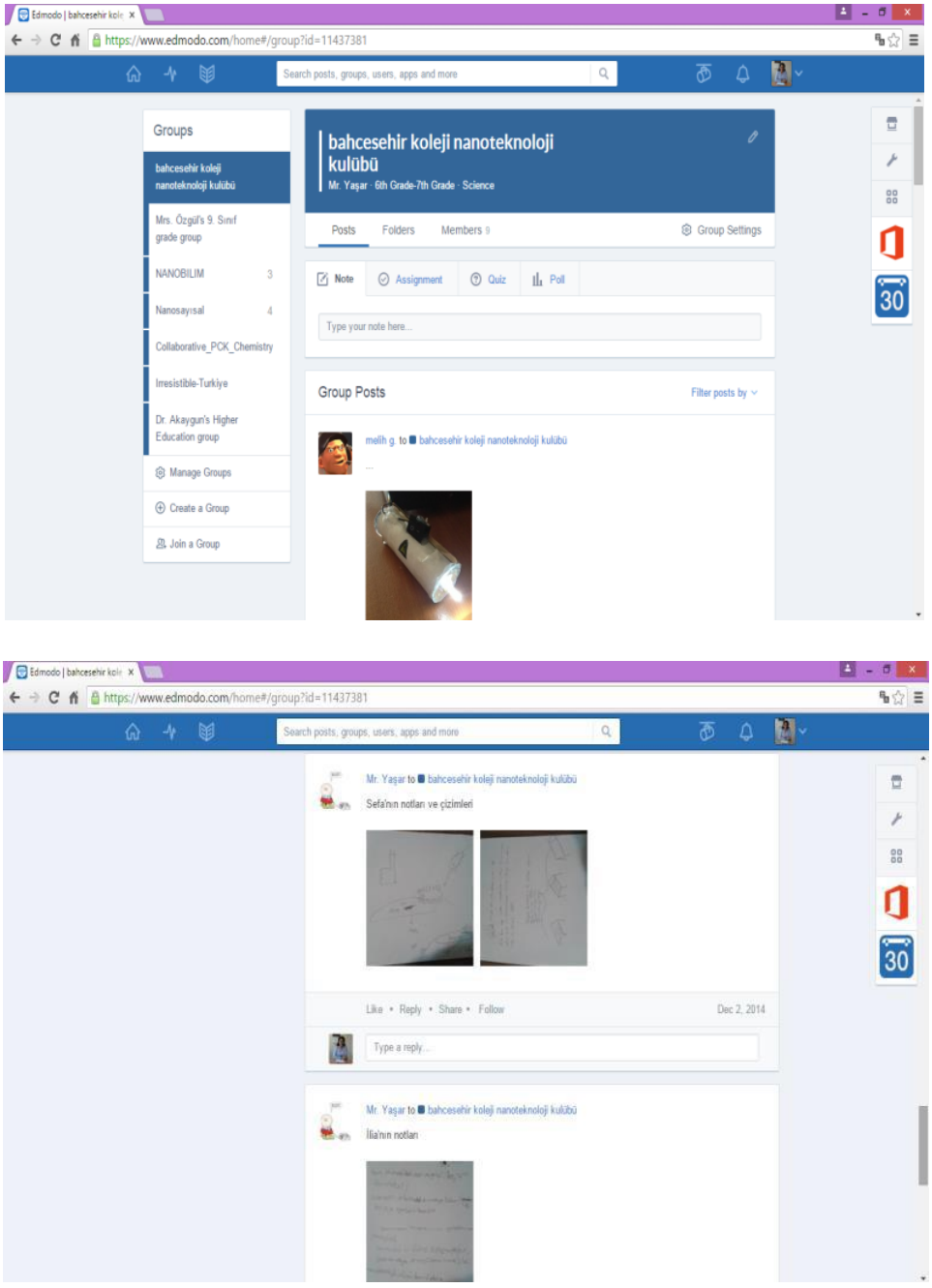


Figure 22. Examples of students work on the Edmodo platform

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- educational institution 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.

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

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 Educational institution's Region

Skype was used to conduct teleconferences with experts (science centers or science museums) far away from the educational institution'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 educational institutions 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 educational institutions 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 educational institution 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.

Popplet: A Tool for Building Concept Maps

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.

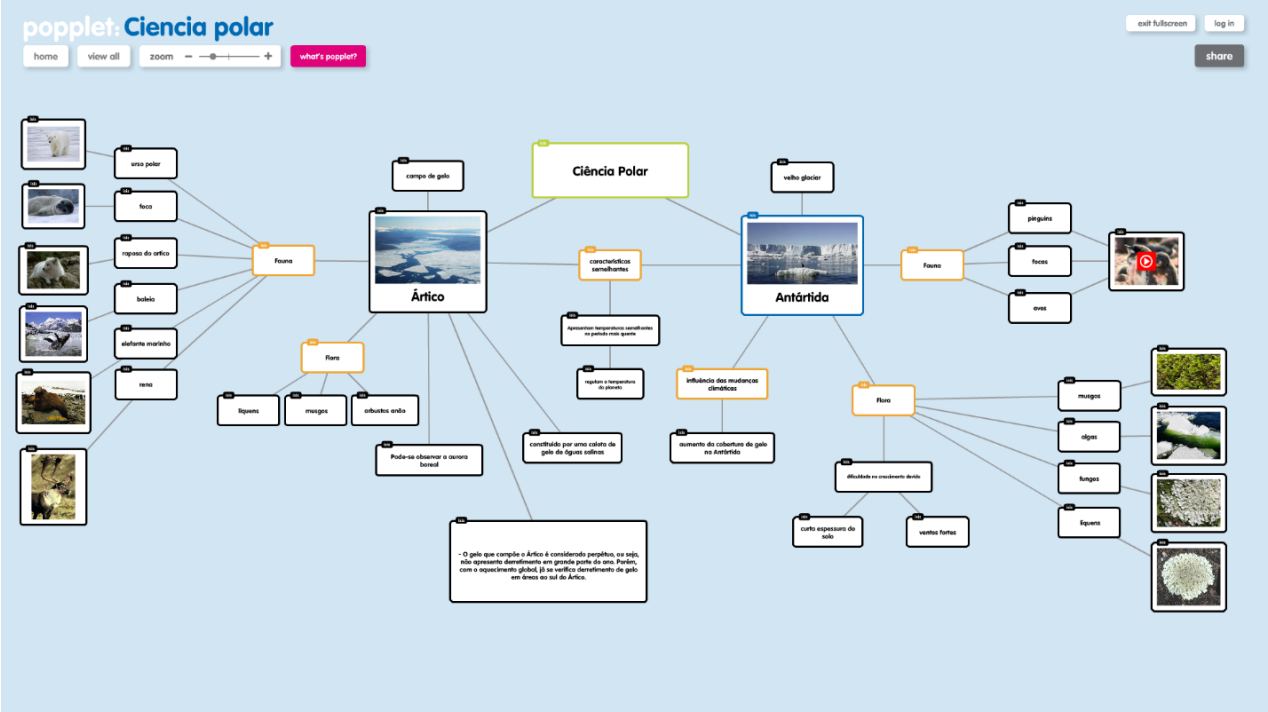


Figure 23. Popplet concept map created by students in a teaching module on Polar Science.

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

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?

a) Easy to make an exhibit without physical restraints; it can be shown online or as part of a physical exhibit

b) Video editing is motivating and easy for pupils, they are more familiar with video making than e.g. posters

c) 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

a) Trust the pupils to work as peer support for each other; some are bound to be very skilled movie editors and can help novices.

b) 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.

c) 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.

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

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.

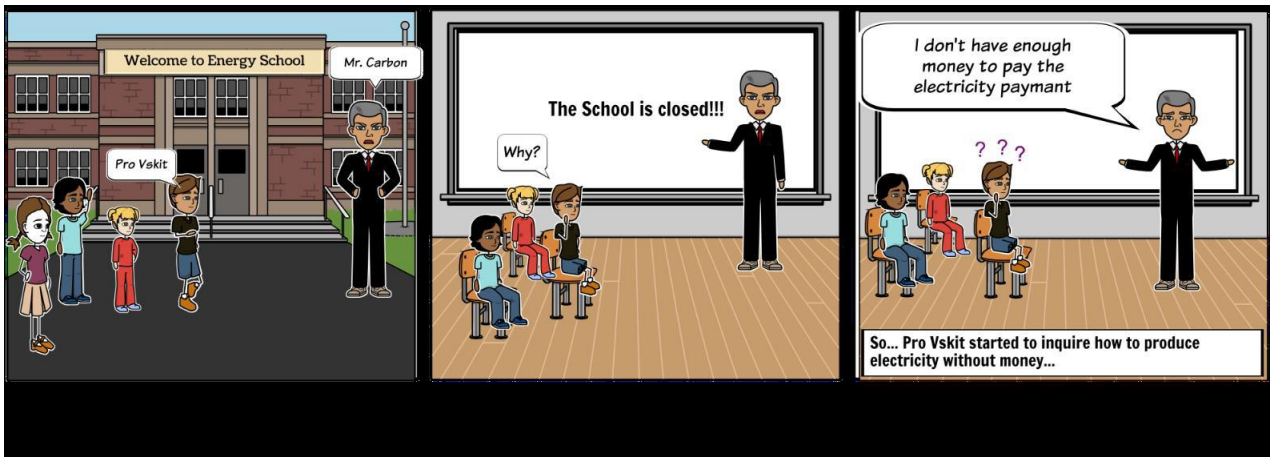


Figure 24. Comic strip created by students in a module on solar cells.

Scratch: an Online Application Used to Develop a Digital Game

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.

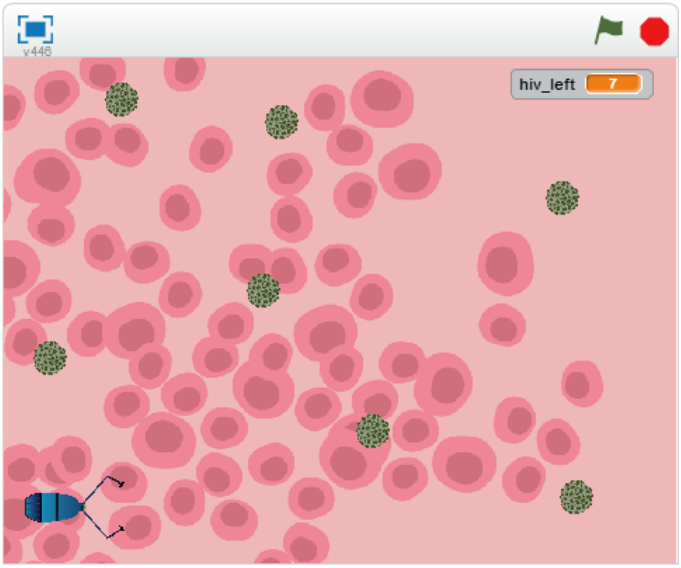
Since the idea of creating the game and integrating it in a museum style exhibit seemed highly promising but technically ambitions, the Technology Laboratory of the Eugenides Foundation supported the students in different ways: The selected images were modified and improved by the graphic designers of 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: educational institutions, 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.



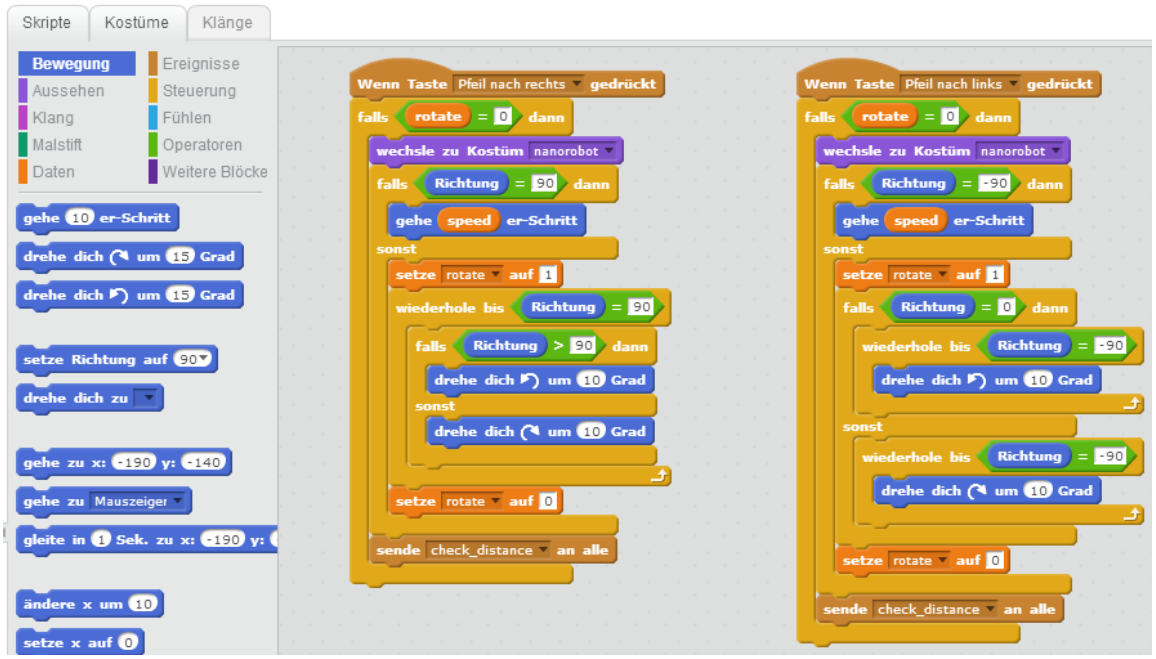


Figure 25. The Scratch application "Fighting HIV" programmed by the students as well as some of the code.

Glogster and Scratch: Designing Interactive Digital Posters

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 educational institution 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.

The best practice examples were analyzed with a special focus on the two main challenges when using ICT at educational institution 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 educational institution 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.

2 Recommended readings

2.1 Recommended readings for social and humanitarian sciences

To the teacher:

Below you can find the full length articles dealing with the topic of the manual. These articles can be used both for group discussions or individual reading.

The scope of questions and assignments are presented below in the form of memo (see Figure 26):

1. Read the article.
2. Present the general outline of it.
3. Analyze the role of ICT in the given area of study.
4. Emphasize the main idea of the article.
5. Compare with other articles of the given field. Find similarities and contradiction in methodology, views or technical aspect.
6. Share your opinion with partners.
7. Fill in the table below:
8. Use the “Insert technology” for working over the article.

Information I knew before	Information I got to know	Information I would like to learn about

9. Write the abstract of the article.
10. Present keywords for the article.

Figure 26. The memo for the work over the article.

To the student:

The articles are considered to be the inseparable part of ICT learning. Recommended readings section is obligatory and is aimed at widening the outlook as well as forming ICT competences in various fields.

The memo given above presents the directions and recommendations for the reading.

This memo can be used both inside and outside of the classroom.

The articles must be read with the help of dictionaries, well discussed and analysed.

Special attention must be paid to the structure of the article and the place of ICT in the content of every aspect of study.

Here below are some of the impact-factor having articles mainly issued for the purpose of transmitting information and thoughts provoking in the process of scientific research.

The necessity to include these works has the rationale in trying to achieve the goal of bringing together practice and theory in the field of ICT implied to various aspects of research.

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Technology (ICTs) for effective teaching of social studies in secondary educational institutions in Delta State

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INTRODUCTION

The training of teachers in different subject areas as a discipline involves various methods of approach and operations. The discipline social studies, centres on systematic study of the principles and skills pertinent to all aspects of operations, resources and administration. As new concepts of learning have evolved, teachers are expected to facilitate learning and make it meaningful to individual learners rather than just to provide knowledge and skills. Modern developments of innovative technologies has provided new possibilities for teaching professions, but at the same time have placed more demands on teacher to learn how to use these new technologies in their teaching (Robinson and Latchem, 2003) These challenges ask teacher to continuously retrain themselves and acquire new knowledge and skills while maintaining their job (Carlson and Gadio, 2002) Then what can be done to help teacher meet these challenges? Indeed, we are left with no option other than to train them.

The integration of ICTs in teaching of social studies as a subject in secondary educational institutions came as a burning need on how to improve on the physical, social, political, cultural, scientific and technological environment that we live in. Social studies as a subject is relatively new in Nigerian Educational institutions. Though social studies has been in use since 1905 in America, but the subject was accorded official recognition in the report of the committee on social studies of the commission on the re-organization of secondary Education on the national Education Association of the united states: therefore in 1916, the earliest definition of social studies emerged. It was defined as those whose subject matter relates directly to the organization and development of human society and to man as a member of social groups 1916(Cross 1958).

Preston (1963) noted that social studies are those portions of the social sciences that are selected for use in teaching. Michaelis (1956) writing on the concept of social

studies, stated that it embraces materials which are related to human relationships drawn from history, geography, political science, economics, anthropology, sociology, science and the arts. Children build competence in basic social processes and skills essential in democratic living. To this end, Ololobou‟s(1986) posited that social studies is anchored on effective citizenry of an organized, integrated study of man and his environment, both physical and social, emphasizing cognition, functional skills and desirable attitudes and actions. Social studies is a response towards a goal-oriented education that is geared towards sensitizing young people to solving personal and community related problems that require the use of ICTs hence this research.

It is universally accepted that social studies students need the chance to develop faith, self-expression and confidence. Also they need the ability and skill to learn about themselves, the societal problems and the wider communities in which they live. Social studies education has the following objectives to attain:

i. Creating an awareness and understanding of our evolving social and physical environment as a whole in its natural, man-made cultural and spiritual resources together with the rational use and conservation of those resources for national development.

ii. Developing a capacity to learn and to acquire certain basis skills including not only those of listening, speaking, reading and writing and of calculation, but also those skills of hand and head, together with those of observation, analysis and inferences which are essential to the forming of sound social, economic and political judgment.

iii. Ensure the acquisition of that relevant body of knowledge and information which is an essential pre-requisite to personal development as well as to a positive personal contribution to the betterment of mankind

iv. Developing a sympathetic appreciation of the diversity and inter-dependence of all members of the local community and the wider national and international community.

v. Developing in students positive attitudes of togetherness, comradeship and co-operation towards a healthy nation, the inculcation of appropriate values of honesty, integrity, hard work, fairness and justice at work and play as one‟s contribution to the development of the nations.

vi. Promotion of an understanding of the social problems of their locality and finding possible solutions to them

vii. Development of the ability to think reflectively and come to independent conclusions

viii. Creation of awareness that discipline is essential for an orderly society and

ix. Demonstration of flexibility and willingness to accept necessary changes within a system. that is, education, government, or law, for the good of all.(Federal Republic of Nigeria,1977, Adaralegbe 1981, Aina Adeyoyin, Obilo and Ahmadu 1982).

Osakwe and Itedjere (1993) stated that the objectives of social studies education in Nigeria may be categorized into three broad areas namely, information learning,

skills attitude and values learning. Writing further, they said that there is no general consensus as to the goals of social studies, but that there is a general notion that social studies has some influence on the beliefs, and values of its learners and that it invariably produces good citizens for the overall development of the nation.

The Role of social studies Education in National Development in Nigeria as stipulated by (Okobiah 1984)

The Indispensable Role of social studies education in National development can be delineated thus:

(i) The prime concern of social studies education is the production of effective citizens. Effective citizenships connotes, among other things:

- Sensitivity to one‟s environment
- Active participation in the polity
- Democratic-oriented mind and practices
- Willingness to assume and perform civic responsibilities.
- Obedience to the laws of the land
- One equipped with intellectual skills essentials for rational decision-making and sound judgment
- Dogged defense of one‟s rights
- Ability to understand, respect and accommodate other individuals
- Habits essential for effective social living
- Positive relationship with the political class
- Harmonious co-existence with other members and groups in one‟s polity;
- Possession of nationalist and patriotic spirit geared towards societal improvement.

These citizenship ideals, norms and values essential for National development are inculcated by social studies education. The study on Madubuike (1985) has confirmed this. It is only effective and productive citizens, who are products of social studies education, who would in the predominant climate of selfism and in the midst of Nigerians mad hunt for materialism, contemplate to contribute to national development.

(ii) Social studies education, more than any educational institution subject, emphasizes affective learning. Okobia (1984:96) lends import to this when he quipped that: "…as far as social studied….(is) concerned, the other skills become important as far as they hope in facilitating the development of…values…." Some of the indispensable values and attitudes for national development which social studies education inculcates in the learners are co-operation, dedication, hard work, interdependence, tolerance, true sense of nationhood, loyalty, commitment, unity of purpose, patriotism and integrative nationalism.

What are ICTs

Information and communication technologies (ICTs) is a term which is currently used to denote a wide range of services, applications, and Technologies, using various type of equipment and software, often running over telecom networks (Heathcote, 2000). ICTs include well known telecom service such as telephone and fax. Telecom service used together with computer hardware and software from the

basis of a range of other service , including email, the transfer of files from one computer to another, and in particular , the internet, which potentially allows all computers to be connected, thereby giving access to source of knowledge and information stored on computers worldwide (Heathcote 2000). Its Application includes videoconferencing, teleworking, distance learning, management information system, stock taking; technologies can be said to include a broad array ranging from „old" technologies such as radio and TV to „new" ones such as cellular mobile.

There is now a great deal of evidence that the diffusion of Information and Communication Technologies (ICTs) over recent decades has helped to enhance the relative demand for skilled labour (Berman, Bound and Machin, 1998; Acemoglu, 2002). Indeed, the skill-biased nature of the ICT „technological revolution" is one reason why pay-offs to ICT investments at firm and industry level have taken time to develop, in contrast to some previous new technologies such as assembly-line equipment and organization which were complementary with low-skilled labour and thus capable of being implemented relatively quickly (Caselli, 1999). While many studies of the relationship between ICTs and skilled teachers are in demand since the mid-1990s, there has been a tending focus on the impact of ICT utilization. This has therefore highlighted the role of highly-educated or skilled workers in facilitating early adoption of new technologies (Nelson and Phelps, 1966; Welch, 1970; Schultz, 1975; Bartel Peter and Rexwhite 380 and Lichtenberg, 1987). In a recent study of the relationship between information technology and the demand for educated workers at industry level in the US, Chun (2003) distinguishes carefully between the adoption and use effects of information technology and finds that both have contributed substantially to the increased relative demand for college graduates. ICT as aids to teaching and learning of social studies in educational institutions

The role of Information and communication technology in teaching and learning of social studies is rapidly becoming one of the most important and widely discussed issues in contemporary education policy (Rosen and Michelle, 1995). Most experts in the field of education agreed that when Information and communication technology is used in the teaching and learning processes, it will improve and boost the ego of the educational institutions to a large extent. To this end, Poole (1996) has indicated that computer illiteracy is now regarded as the new illiteracy. This has actually gingered a new and strong desire to equip educational institutions with computer facilities and qualified personnel necessary to produce technologically proficient and efficient students in developed countries of this world. Singapore educational institutions provide a rich diversity of experiences to help students grow holistically. Apart from the academic curriculum, students can develop themselves in music, arts and sports through co-curricular activities. Participation in community service is part and parcel of educational institution life. These help nurture in students qualities such as creativity, confidence and perseverance which are life skills essential in a rapidly changing world. These form integral part of social studies curriculum (Rosen and Michelle, 1995). It is known that good teachers and educational institution leaders form the cornerstone of Singapore's education system.

Education software is becoming sophisticated, as such it is dynamic, hyperlinked, multimedia in nature, and interactive. ICT has allowed learning to take place in many modes: online, self-paced, personal or collaborative. Many popular educational software products have enjoyed wide acceptance. An edutainment approach is often used in making lessons more lively and fun, especially for young children. ICT applications for education are also made for classroom management, timetabling, activity planning, personnel administration, and communications with parents. In Singapore, the Ministry of Education keeps a repository of teaching and learning resources for sharing among educational institutions.

E-learning encompasses learning enhanced and delivered by ICT. ICT for delivering learning is very similar to ICT for e-commerce or e-business. E-learning may imply self-study, instructor-led events or small group collaboration. Software for e-learning of social studies includes:

- Asynchronous Web-based Software (for example, Blackboard(TM))

Table 7. Welliver‟s instructional transformation model for ICT usage in teacher education

Familiarisation	Teachers become aware of technology and its potential uses.
Utilization	Teachers use technology, but minor problems will cause teachers to discontinue its use.
Integration	Technology becomes essential for the educational process and teachers are constantly thinking of ways to use technology in their classrooms
Reorientation	Teachers begin to re-think the educational goals of the classroom with the use of technology
Revolution	The evolving classroom becomes completely integrated with technology in all subject areas. Technology becomes an invisible tool that is seamlessly woven into the teaching and learning process.

- Synchronous Web-based Software (for example, Centra (TM))
- Services by ASP (for example, Hewlett Packard Virtual Classroom(TM))
- Voice Over Internet Protocol (VOIP) Products (for example, CUSeeMe (TM), Picturetel (TM))
- Learning Portals (for example, PeopleSoft Campus Portal(TM))
- Personal Collaboration Tools (for example, MS-Messenger(TM))
- Teamware (for example, MS Exchange(TM) Conference Server)
- Streaming Media (for example, RealVideo (TM), Quicktime (TM))
- Authoring Tools (for example, Macromedia e-Learning studio(TM))

The first generation of e-learning systems included only authoring tools. The second generation included classroom management systems, along with lesson content management systems. Together, this came to be known as Learning Management Systems (LMS). Third generation systems introduced real time virtual

classrooms. The advantages of e-Learning include reduction in cost and time, the ability to overcome distance, and the convenience of sharing material and courseware. E-learning makes globalization of educational quality an achievable reality. To individual learners, e-learning provides benefits such as multimedia richness and efficiency, and the possibility of self-paced study anytime, anywhere. Teachers benefit from the ability to update and distribute materials easily.

Integrated Virtual Learning Environment, (IVLE,) is a learning management system used in the National University of Singapore (NUS). IVLE which can be used as well by teachers in teaching social studies in secondary educational institutions in Delta state offers a wide range of features such as discussion forums, chat rooms, class group setups, bookmarks, calendars, work-bins and project tools. Lecturers at NUS use IVLE tools to communicate with students and manage course material. For instance, a work-bin is used for uploading lecture notes and receiving assignment submissions from students; announcement boards are used to disseminate information effectively; and discussion forums allow communication and knowledge sharing among tutors and students, with everyone on an equal basis. This is usually shown in screenshots of IVLE home, work-bin and discussion forum in IVLE during the process of such exercise. In a learning environment such as IVLE, together with a wide selection of professionally developed educational software and a reliable central depository management system, teachers are directly teaching facts less and less and are telling students more and more the method of learning.

Teachers are becoming facilitators in the learning environment. ICT enables interactivity and the reach of its network. It facilitates the learning by collaboration, interaction and participation in virtual teams. The content of education will shift further away from rote learning towards discovery, research and collaboration. Apart from improving their teaching methods, ICT gives teachers access to master teachers or mentors through computer networks. A mentor can conduct a workshop which teachers anywhere can participate in as long as they are connected. World-class universities like MIT are already making their lesson packages available on the Internet. This work adopted the Welliver‟s Instructional Transformation Model (Welliver 1990) that institute teachers progressing through five hierarchical states in order to integrate ICT effectively. Table 1 below shows these five states.

The Welliver model presumes that integration of ICT proceeds in a linear manner from the initial familiarization with the technology to the utilization of technology, then moves towards the beginnings of manipulation and eventually to more innovative ICT usage.

Every educator looks at integrating technology and its challenges from a different perspective. They tend to focus solely on how it affects them in terms of their workload, impact on students, their current skills/knowledge, time management, motivation and vision. It is the author‟s belief that the barriers to efficient technology integration can be overcome through effective leadership, training and a commitment to enhancing teaching and learning using technology. Shelley (2004, pp. 6.10-6.11) argues that with proper training in using technology teachers:

- Create relationships between active learning and active teaching

- Develop an appreciation and an understanding of the potential of technology
- Learn to be authors of multimedia software
- Develop leadership skills and become role models for successful integration.
- Understand the power of technology integration
- Design integrated curriculum activities
- Learn the benefits of technology in the classroom
- Develop ownership of the technology through authentic experiences
- Learn to motivate students with technology
- Achieve success by becoming informed and reflective decision makers
- Become advocates for technology integration

These criteria for effective use of technology suggest that there are a number of complex interactions between the user and the technology and that these interactions are not explicitly linear, as suggested by Welliver.

ICTs and Teachers of social studies Education:"If a country is to be corruption free and become a nation of beautiful minds, I strongly feel there are three key societal members who can make a difference. They are the Father, the Mother and the Teacher. " - Dr. A.P.J. Abdul Kalam, Former President of India.

The knowledge revolution and role of the teacher

Burnett (1994) posited that "the pace of technological revolution and emergence of a knowledge society can change the traditional role of the teacher and the students". Traditionally, the teacher used to be the source of knowledge for the students. There is some cooperation among students to explore new knowledge. In many cases, the teachers do not possess adequate knowledge to supplement the view of the student and the main source of knowledge remains limited to text book. Therefore the development of ICTs changes the epic centre of knowledge. At present, in a number of cases the student is more informed than the teacher. Furthermore, there is likely to be confusion in the teachers mind about his/ her new role in relation to the use of these technologies that is, teachers find themselves in a situation where they are no longer the principal source for delivery of information. In the new phase of the knowledge revolution, the source of knowledge has shifted from a one source to a different source. In other words, we can say that there is a decentralization of the knowledge source. This has an overall impact on the development of learning abilities among the children. There is a need to facilitate training on ICTs for teacher both at the pre-service level and in service level.

ICT - a solution for the improvement of the expertise of teacher

ICT enabled distance education is poised to rule the world. This would not only strengthen the elementary education needs of the country but would also increase the dependence of education on ICT. Technological development always warrants transition to newer Peter and Rexwhite 382 technologies by jeopardizing the cost effectiveness of the distance education programme. Retaining the already existing technologies for a considerable period of time and subsequently embracing new technologies should have fine balancing, so as to improve also the quality of education.

India is one among the few countries in the world, which has not allowed the expenditure on education to shrink over the years. The increase in expenditure on elementary education alone over the last four Five Year Plan periods has been more than the increase in expenditure on education as a whole. With all the inputs around, there is only hope for enhancing the quality of education at the elementary stage (Visscher, Wild, Smith, and Newton, 2003).

Role of Teacher in Enhancing Learning Achievement of the student

Education, as we know is instrumental in ensuring that the future generation is well informed and competent. Unfortunately, because the quality and accessibility of education varies so greatly between regions, the educational institution system of our country often fails to deliver the level of education necessary to ensure such competency. Many educational institutions have limited resources for buying books, stationery, furniture and other classroom materials. Teachers lack adequate qualification and training to engage their students in learning. Their lesson plans are most often outdated or irrelevant. These jeopardize the available quality of education. ICT enabled distance education, to a great extent, can combat this problem. Because the present day distance learning is ICT-enabled, most of the programmes include computer and Internet training to facilitate the use of essential technology.

The acquisition of fundamental ICT skills among teachers and students helps knowledge sharing, thereby multiplying educational opportunities. However, all teachers are not willing to introduce new technologies to themselves first and subsequently to their students. In order to implement ICT-driven distance education programmes, the teachers must first understand and be comfortable with the technologies. They must be given opportunities for acquisition of a new knowledge. This can begin by promoting computer-training programmes for teachers. Monetary incentives can be offered as means of motivation. The use of ICT can effectively enhance learning where traditional models have failed. While these technologies offer advantages, they also pose challenges. Several studies have been conducted in the west about the use of ICT in Middle and High Educational institution students. One such study is by Martin Carnoy which is entitled- Education: Possibilities and Challenges-2004-05 Academic Year. According to him, "Using ICT as a supplement to improve test score results, may, however, be seen to be more effective than traditional teaching one, hence is much more applied." He also comments about the use of ICT for teacher and administrator training. „Private firms such as Sylvan quickly saw the potential of ICT as an in-service training medium for teachers, and this now forms an important part of Sylvan"s extensive ICT learning systems… An entirely different approach to teacher improvement is web access to course content, lesson plans and network to other teachers. This database or content, approach is used by Net Educational institutions and the IBM foundation. Both these organizations focus on using ICT as teacher training for course content rather than improving pedagogy."(UNESCO, 2000) It can be seen that Distance Learning Technologies have been employed in the education of teachers both at pre-service level and at the in-service level. UNESCO has published a summary of case studies conducted in nine countries in different parts of world and most of these studies reflect the

necessity of having multi-prong strategies for teacher education and to improve their expertise. For example, „in China television has been tremendously used for teacher education. In India, there is a multimedia approach for teacher education. In UK, due to heavy shortage of teachers of Mathematics and Science, the Department of Education invited tenders…the Open University was successful in this and the result was Open University‟s Post Graduate Certificate of Education (PGCE) programme, where ICT plays a large role in enabling interaction between students, tutors, regional support centres and programme providers.

ICTs and Teacher Education

There are varieties of approaches to professional development of teachers in the contextual usage of ICTs in education. Professional development to incorporate ICTs into teaching and learning is an ongoing process and should not be thought of as one „injection‟ of training. Teachers need to update their knowledge and skills as the educational institution curriculum and technologies change. Two aims of teacher training are fundamental: teacher education in ICTs; and teacher education through ICTs.

Teacher education in ICT

The most obvious technique for professional development for teachers is to provide courses in basic ICTs knowledge and skills. It is necessary for teachers to become skilled in operating the new technologies and in exploiting them effectively as educational tools. Teachers must master the use of information – skills of research, critical analysis, linking diverse types and sources of information, reformulating retrieved data – if they are to teach their pupils to develop these same skills. There is need for more emphasis placed on training in pedagogy, as opposed to the current trend in many education systems where the major focus is on specialized knowledge in specific curricular subjects. Teachers must be adequately equipped with more didactic competencies so as to assume their new role as experts in the learning process.

Teacher Education through ICTs

ICTs can support effective professional development of teachers. Using ICTs as tools for training of teachers is as important as introducing the basics of ICTs to the prospective teachers. As sources of information and expertise, as well as tools for distance communication, ICTs can offer many new possibilities for teacher education. Teachers may through the regular use of these technologies. Use of new media, new rules of communication - even a new language - have to be learned.

Role of ICT in bringing efficiency of delivery mechanisms

Westera and Sloep (2001) stipulated that “Efficient delivery mechanisms is an important component of overall educational institution management”. As such, ICTs can provide the efficiency of delivery mechanisms of educational services by supplementing conventional delivery mechanisms in the following manners:

- Technology‟s capacity to reach learners in any place and at any time has the potential to promote revolutionary changes in the educational paradigm. This means eliminating the premise that learning time equals classroom time. Students can be

encouraged to revisit the lessons/topics to reinforce learning without active intervention by teachers.

- Another illustration of efficiency is the domain of virtual laboratories. All educational institution systems want to provide labs because science is empirical. But few educational institutions have furnished them with equipment and supplies and fewer yet are willing to risk using them. Technology allows for video and digital demonstrations as well as digital simulation of laboratory activities in a very real manner; but without the risks and costs associated with laboratory experiments. Simulations will not replace hands-on activity completely. Rather, they prepare the learner to conduct real-life experiments in the same manner as flight simulations prepare the student pilot for test flying.

- Multimedia-enabled learning modules can be developed by a group of master teachers and instructional designers, which can then be shared with all educational institutions to assure quality standards of learning delivery.

- Concerns about costs are always raised in discussions related to technology. Depending on the technology used, startup costs can be high but economies of scale are significant. That is, the more the technology is used that is,. when more students use the product, the unit costs of producing educational content ware decrease proportionately. Trade-offs must be considered as well when evaluating technology‟s initial costs. Since over two decades ago, ICT was introduced into classroom practice and it has gained much attention and ever growing confidence in its effectiveness.

ICT is believed to be more than the core of the Information Society. It is supposed to be paramount to the education of knowledge workers (Pelgrum, 2001). Although benefits of ICT use in education have been acknowledged (for example Hayes, 2005; Vichitvejpaisal et al., 2001; Higgins, 2003; Meijer, van Eck, and Felix, 2008) teachers do not seem to integrate it into their teaching activities (Cuban, 2001; Varank, and Tozoglu, 2006; Yang, and Huang, 2008) and, thus, the use of digital learning materials (DLMs). Failure to motivate teachers to use DLMs could make the development of such materials seem less rewarding or attractive. The lack of newly developed materials could in its turn lead to an increased underuse of DLMs, hereby completing a vicious circle. In the Netherlands, the Wikiwijs initiative aims at disclosing open DLMs for use in all strata of education. The effectiveness of this initiative depends largely on the actual use of DLMs in education. Therefore, important determinants of using ICT in education and the lack of ICT in classroom practice will be further investigated in the context of teacher‟s usage of DLMs. More precisely, concerning DLM use basing on the Integrative Model of Behavior Prediction (IMBP: Fishbein, 2000; Fishbein and Yzer, 2004; Yzer, Capella, Fishbein, and Hornik, 2004).

Developing a theoretical model of Digital Learning Materials (DLMs) usage based on the Integrative Model of Behaviour Prediction (IMBP)

The IMBP constitutes the theoretical framework on which this current study is based. This model integrates the “theory of planned behaviour” (Ajzen, 1991), the “social cognitive theory” (Bandura, 1986), and the “health believe model” (Janz and Becker, 1984) and contains a number of critical factors which determine educational

ICT use. A discussion of the IMBP will be followed by a brief review of literature in support of the application of this model in the domain of the advancement of the integration of ICT in teachers‟ pedagogical practices. In the IMBP, dispositional variables are key determinants with respect to a specific behaviour, here teacher‟s usage of DLMs in education. Although the model takes into account organizational variables, the main focus of the IMBP is on individual level characteristics. Attitude, self-efficacy and perceived norm are the most important dispositional variables in the IMBP. When combined, these factors are conjectured to influence behavioural intention which, in turn, is related to the actual behaviour.

According to the model, the intention-behavior relationship may be moderated by environmental variables (such as the non-availability of DLMs or the proper ICT infrastructure) and by teacher‟s actual ICT knowledge and skills. Furthermore, IMBP considers the positive and negative outcome beliefs teachers have should they use DLMs (for example, DLMs give more variations during class and DLMs require more class preparation) to be antecedent variables of attitude. The antecedent variables of subjective norm concern teachers‟ normative beliefs that important people (for example colleagues and parents) may think that they should use DLMs. Finally, self-efficacy antecedent variables concern the convictions (that is,. the efficacy beliefs) teachers have that they can use DLMs and that they can overcome the impediments to use DLMs. An adaptation of the IMBP for the current domain (that is,. the advancement of the integration of ICT in teachers‟ pedagogical practices). This shows that the variables are grouped into proximal, distal and ultimate variables. Proximal variables include all the dispositional variables and, therefore, the terms dispositional and proximal are interchangeable. The distal variables encompass all the variables at the level of teachers‟ characteristics and educational institution organization, and the ultimate variables the determinants at the level of local, regional, and governmental organization.

A comprehensive review of the literature by Mumtaz (2000) resulted in a number of contextual as well as some dispositional variables influencing teachers‟ use of ICT. Contextual variables include the environmental variables (in IMBP moderating the relationship between behavior intention and actual behavior), the distal, and ultimate variables (in IMBP, the effects of these variables are mediated by the dispositional variables), but exclude the individual level characteristics. The most influential contextual variables according to the Mumtaz study were access to resources, quality of the ICT infrastructure, perceived ease of use, incentives to change, support and collegiality in the educational institution and educational institution and national polices. Individual level characteristics found to be of importance were commitment to professional learning and background in formal computer training. A more recent study by Tondeur, Valcke and van Braak (2008) attempting to integrate both educational institution and teacher level characteristics in an explanatory model of ICT use, found that gender and previous computer use were significant predictors of the adoption of ICT for pedagogical use. Contextual educational institution level characteristics and contextual environmental variables found to be of importance were similar to the previously cited study (Mumtaz, 2000)

and included availability of ICT (hardware and an Internet connection in the classroom), educational institutions‟ openness to change, presence of a educational institution ICT policy and availability of ICT support. In a recent review of antecedents of laptop use among educators (Moses, Khambari, and Luan, 2008), it was found that gender, lack of time, technology competence as well as administrator and ICT support are important predictors of actual ICT usage. Moreover, this study also acknowledges the impact of attitude. Other authors (Cuban, 2001; Teo, Lee, and Chai, 2007; Kersaint, Horton, It has been argued that technology for teachers of social studies as a professional development is not a panacea - it is only a tool (Haddad 2002). To use this tool effectively and efficiently, teachers of social studies need visions of the „technologies‟ potential, opportunities to apply them, training and just-in-time support, and time to experiment.

Only then can teachers of social studies be informed and confident in their use of new technologies (Bowes, 2003). Computer technology is becoming both more useful and more cost effective for many fields of teaching. And yet only you, the teacher, can determine whether these methods will prove effective in your classroom. Whatever you decide, remember that technology complements, but does not fundamentally alter, the elements of teaching (Uddin, (2003).

ICTs are a major in shaping the new global economy and producing rapid changes in the society. Within the past decade, the new ICT tools fundamentally changed the way people communicate and do business. They have produced significant transformations in industry, agriculture, medicine, business, engineering and other fields. They also have the potential to transform the nature of education-where and how learning takes place and the roles of students and teacher in the learning process (Bowes, 2003). Teachers education institution may either assume a leadership role in the transformation of education or be left behind in the swirl of rapid technologies change. For education to reap to its full benefits of ICTs in learning, it is essential that pre-service and in-service teachers have basic ICT skills and competencies.

Teachers of institutions and programs must provide the leadership for pre-service and in-service teacher and model the new pedagogies and tools for learning. They must also provide leadership in determining how the new technologies can best be used in the context of the culture, needs, and economic conditions within their country (Bowes, 2003). To accomplish these goals, teachers of institution must work closely and effectively with primary and secondary educational institution administrators, politicians and other important agencies, teacher unions, business and community organizations, and other important stakeholders in the educational system. Teachers of education institutions also need to develop strategies and plans to enhance the teaching – learning process within teacher education programs and to assure that all future teachers are well prepared to use the new tools for the learning (Bowes 2003). To this end, Bowes lay credence that “This is more crucial because the young generation is entering a world that is changing in all spheres‟ scientific and technological, political, economic, social and cultural. The emergence of the

„knowledge-based" society is changing the global economy and the status of education (Bowes, 2005).

These new possibilities exist largely as the result of two converging forces. First the quantity of information available in the world- much of if relevant to survival, and basic well-being-is exponentially greater than that available only a few years ago, and the rate of its growth is accelerating. A synergistic effect occurs when important information is coupled with a second modern advance - the new capacity to communicate among people of the world. The opportunity exists to harness this force and use it positively, consciously, and with design, in order to contribute to meeting defined learning need (European Commission, 2001)

Using ICTs Resources for Teaching: Computers and related electronic resources have come to play a central role in education. Whatever your feelings about what some have called the digital revolution, you must accept that many, perhaps most, of your students are fully immersed in it. At the very simplest level, you will rarely receive a paper or other assignment from a student that has not been written with the help of a computer. Most of your students will have considerable experience with the Internet and will, whether you like it or not, make use of it for much of their academic work. Many of them will be accustomed to using e-mail as a normal form of communication. But it is not just students who find electronic resources valuable.

Teachers can benefit from these resources as well, by employing a series of useful tools. We stress the word "useful" because electronic resources complement, but seldom replace, more conventional teaching techniques. Electronic tools can make classes more efficient; lectures more compelling, informative, and varied; reading assignments more extensive, interesting, and accessible; discussions more free ranging and challenging; and students' papers more original and well researched. Only you, however, can judge if these techniques advance your own teaching goals (Dymond, and Oestmann, 2002).

Five Promising Uses of New Technology

Of the many electronic teaching techniques that instructors have found useful, we have chosen five that we believe seem particularly likely to help significant numbers of teachers. All of these techniques demand an investment of time if they are to succeed, and your willingness to use them should be balanced carefully against other, perhaps more important, teaching priorities. But for each technique, there are both simple and complex ways of proceeding, and we will try to make clear the respective advantages and disadvantages. The five ways in which we suggest teachers consider using ICTs resources involve tasks that you will usually have to perform in any case. New technologies can help you perform them better and more easily:

Administration: The routine administration of courses (advertising a class, providing copies of the syllabus, assigning discussion sections, and getting out course news) can be more efficiently handled with a course home page, electronic discussion groups, and e-mail lists. These tools can also dramatically improve the continuity and the community aspects of courses, helping students to engage with and learn from each other and even from people outside the course.

Readings/sources: The Web and CD-ROMs provide a wider variety of secondary and primary sources (including visual and audio sources) than has previously been available. With your guidance, your students can now gain access to materials that were once accessible only to experts because they were too cumbersome to reproduce for classroom use or too expensive for students to purchase. By taking their own paths through these sources, students can bring their own evidence and arguments into lectures and discussion sections, as well as write on a wider range of research topics.

Papers/presentations: Rather than performing assignments and taking exams from the teacher alone, students can perform more independent exercises in publishing, exhibit building, or assembling and presenting teaching units and other materials for their peers. A web archive of several terms' work can make the course itself an ongoing and collaborative intellectual construction.

Lectures: A computer with presentation software can provide a single tool for augmenting lectures with outlines, slides, statistical charts and tables, images, music, and even video clips. In addition to printing them as handouts, you can save in-class presentations in a web-compatible format for later review and discussion.

Discussion: Electronic discussion tools such as e-mail, conferencing software, and on-line chat services can seed discussion questions before the class meets, draw out your shy students, and follow up on discussions or questions on the reading between classes. For courses without face-to-face discussion sections, these tools can bring the course to life over great distances and help overcome scheduling difficulties.

The Necessary Tools: What you need will depend, of course, on what you want to do. Most teachers have computers, and most have at least some access to e-mail and the Internet. In many educational institutions and universities, most students do, too. Many teaching opportunities are likely to be available to you, therefore, using equipment you and your students already have. Other techniques require more advanced technologies that you may or may not wish to purchase on your own, and that your institution may or may not make available to you. It should be obvious, therefore, that you should make no plans for using electronic tools before making sure that both you and your students will have access to the necessary technology.

Conclusion

But owning, or having access to, technology is usually only a first step. Even more important is learning how to use it. This is one of the biggest challenges facing anyone who wishes to use electronic tools, because the knowledge is not always easy to acquire. Many people, of course, are highly skilled in computer technology and know how to teach themselves to do almost anything. But many other people have limited computer skills, are easily intimidated by new and unfamiliar tasks, and tend to avoid doing anything that requires them to learn something very different from the things to which they are Peter and Rexwhite 386 accustomed. If you fall in the latter group but wish to expand your ability to use electronic tools, you need to find help. Some institutions offer extensive assistance through their computer centers or their

information technology services. Some departments have staff members or graduate student assistants who are hired to handle computer-related problems.

There are also many excellent reference works to help you learn about various electronic tools. Just as you must be sure that you have the necessary technology at your disposal before you decide to use electronic tools in your teaching, so you must also make sure that you have access to the necessary help in learning to use it. Keep in mind, finally, that the technology associated with computers and the Internet changes with breathtaking speed. Although certain skills will remain useful to you over long periods of time, there will be many things that will have to be relearned time and time again. The rapidity of change in this field can be bewildering and intimidating. But it is also the source of some valuable innovations that can be of great use to you. The importance of ICT is quite evidence from the educational perspective. Though the chalkboard, textbooks, radio/television and film have been used for educational purpose over the years, none has quite impacted on the educational process like the computer. While television and film impact only on the audiovisual faculties of users, the computer is capable of activating the senses of sight, hearing and touch of the users. ICT has the potentials to provide higher interactive of users to develop their individual intellectual and creative ability. The main purpose of ICT "consist just in the development of human mental resources, which allow people to both successfully apply the existing knowledge and produce new knowledge" (Shavinina, 2001).

There is no doubt that teachers and students in secondary educational institutions in Delta state will have incredible resources available if they have access to the Internet. The introduction of Information and communication technology into secondary educational institution curriculum will bring a shift in the way teachers and students learn and interact. However, the integration of ICTs into teaching and learning in secondary educational institutions in Delta state, there must be proper and adequate funding of the education. For some time now, there has been a steady decline of government budgetary allocation to education. The greatest challenge to the state and federal government is to ensure that budgets resulting from dwindling revenue and the need to satisfy other sectors of the economy do not adversely effect education. Delta state need to invest heavily in the Internet business and create enabling environment for secondary educational institutions students to participate in downloading available and useful knowledge in the Internet.

Secondary educational institution students in Nigeria as a whole are already behind their peers in developed countries, thus widening the global digital divide. Nigeria should join the world links of development (world), a program initiated by the World Bank in 1997. The program has been establishing computer laboratories and bringing internet connectivity to secondary educational institutions in developing countries around the world. It is also training teachers in these countries to acquire skills necessary to integrate information and communication technology into their classroom practices. The world program links secondary educational institutions around the world in order to improve education, enhance cultural understanding and

develop requisite skills in youth which will prepare them for the job markets in the 21st century.

Recommendations

Before introducing new teaching techniques, therefore, it is wise to make a quick inventory of your own and your educational institution's electronic teaching resources. You will not want to discover halfway through a project that there are major obstacles such as insufficient equipment, inadequate support, or negative professional incentives. Answering a few simple questions can help you determine how practical and promising your planned innovations in electronic teaching are likely to be. While some answers may lie as close as your departmental colleagues, others might require conferring with departmental administrators, or computer support organizations

Educational institutions should make sure they have a web page. What courses have material on-line? Which departments and faculty have web pages? Where are they stored? (One source for help in understanding how your institution's web site works is the person who is in charge of constructing it, usually known as the webmaster. If your educational institution has a web site, look at the bottom of the home page or on the credits page of the site to find the e-mail address of your webmaster.)

Provide different kinds of computers and Internet access to students. Do most students own their own computers? If not, are there long waits for access? Twenty-four-hour computer labs? Provisions for off-campus students? What software is on these computers? And what Internet browser (and version) do students typically use?

Make provision for your educational institution to purchase standard software package to manage the creation of course web pages. These tools offer simple fill-in-the-blank on-line forms to allow you to place standard course material on the Internet, after which the program creates the course home page for you. If not, is there a educational institution style sheet or recommended format for course pages? Does your educational institution recommend or support any particular software for web pages? For presentations, word processing, spreadsheets, and databases?

Recruit staff with ICT skills to assist instructors with educational technology. Are there any work-study students or teaching assistants trained for new media support? What handouts or on-line guides have been prepared for electronic teaching? That educational institution should make provision for classrooms designed for multimedia presentations. Do any classrooms have Internet access? Are classes that are making use of this technology given extra technical or financial support?

Special funds or professional recognition for innovative uses of technology in teaching be given to educational institutions in order to have colleagues working on grants that support electronic teaching. What is the attitude of your department and of educational institution officials to this activity?

The institution should have a plan for on-line course materials. Does the educational institution have distance learning plans (methods by which students with on-line access can take courses remotely)? How is your department's teaching and funding going to be affected by these plans?

The use of the Internet should be made compulsory to staff and students. The new media is so new that no clear guidelines have been established for determining fair use and copyright policies for on-line teaching materials. In general, however, the same copyright rules that govern photocopied packets and other more familiar teaching tools are likely to apply to on-line material. You should, however, identify the office or officer at your institution responsible for monitoring such policies.

The on-line materials should be made accessible to all staff and students. Investigate your institution's policies (or ask for one to be made) on whether you or the educational institution owns your on-line materials. This is especially important if you are investing considerable creative time and energy, making heavy use of institution equipment and staff, or may wish to take the material with you to another institution.

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2.2 Recommended readings for natural science area

Available online at www.sciencedirect.com
Science Direct
13th International Educational Technology Conference

Use of Information Communications Technology (ICT) in Malaysian science teaching; A microanalysis of TIMSS 2011

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Selection and peer-review under responsibility of The Association of Science, Education and Technology [25].

1. Introduction

Information and communication technology (ICT) includes a wide range of approaches to teaching based on various traditional and innovative instructional theories. Although instructional technology can be used to support student-centered inquiry-based learning, however simply installing computers and using computer software in educational institutions has done little to change the didactic teaching methods that is prevalent instructional approach in educational institutions (Cohen & Ball, 1990; Cradler, 1994; Cummins, 1996; Goodlad, 1993; Lim, 2007; Niederhauser & Stoddart, 2001; Stoddart & Niederhauser, 1993; Van Dusen & Worthen, 1992, 1995).

Malaysia education system has emphasized the use of ICT in classroom. Educational institution inspectorates, educational institution management and lecturers of universities and institutes always ensure the use of ICT in the classrooms. All educational institutions were supplied with computers and computer laboratories under *Program Komputer dalam Pendidikan* (Computer in Education Programme) and ICT Literacy Programme for secondary educational institution (Curriculum Development Centre, 2007). Besides that, science and mathematics teachers also received personal laptop and educational software under *Pengajaran and Pembelajaran Sains dan Matematik dalam Inggeris* (Teaching and Learning Science and Mathematics in English hereafter state as PPSMI) policy since 2003. Prior to this, these subjects were taught using the Malay language, the national language for Malaysia. The move from Malay to English as a teaching medium is to take advantage of the vast resources available in English worldwide. To overcome the lack of English proficiency of teachers, Curriculum Development Centre (CDC) of the Malaysian Ministry of Education developed several educational softwares which

were teaching courseware. All Malaysian educational institutions were supplied with the teaching courseware and are easy to be accessed by teachers.

According to Niederhauser and Stoddart (2001), educational software can be grouped into two categories. Software that draws on the didactic tradition is grouped in the Skill-based Transmission category, while software that can be used in more constructivist ways in the Open-ended Constructivist category. Two types of traditional skill-based transmission software were identified; namely Drill-and-Practice and Keyboarding. Software included in these categories draw on objectivist behavioural principles of learning aimed at helping students internalize basic facts and skills. According to Niederhauser and Stoddart, this category of software is used to introduce content in hierarchical steps, present stimuli, provide immediate feedback and reinforcement, allow for repetition and practice, and monitor students' progress. There are three types of openended constructivist software; namely Interactive and Educational Game, Exploratory, and Tool programmes.

The use of information communication technology (ICT) was one of the instructional activities investigated in *Trends in International Mathematics and Science Study (TIMSS)* 2011. TIMSS is a series of international assessments of students' achievement in mathematics and science and this assessment is done once in every four years among participating countries. TIMSS's report provides vital information on key curricular, instructional, and resource-related factors that can impact teaching and learning process in Mathematics and Science (Martin et al., 2012). Malaysia has participated in TIMSS since 1999.

In 2011, national representative samples of students in 63 countries and 14 benchmarking entities (regional jurisdictions of countries, such as states) participated in TIMSS. Countries and benchmarking participants could choose to participate in the Year 4 assessment or the Form 2 assessment, or both. Forty five (45) countries and fourteen (14) benchmarking entities participated in the Form 2 (Grade 8) assessment. However, Malaysia had chosen to only participate in the Form 2 assessment.

Science assessment framework for TIMSS 2011 consists of a content dimension specifying the subject matter domains to be assessed within science (for example, biology, chemistry, physics, and earth science at Form 2) and a cognitive dimension specifying the cognitive domains or skills and behaviours (that is, knowing, applying, and reasoning) expected of students as they engage with the science content. The content domains differ for the Year 4 and Form 2, reflecting the nature and difficulty of the subjects taught at each level. At the Form 2 level, physics and chemistry are assessed as separate content domains, and receive more emphasis than at Year 4, where they are assessed as one content domain i.e. physical science. The cognitive framework, however, is the same for both levels, encompassing a range of cognitive processes involved in learning science concepts and engaging in scientific inquiry right through the primary and lower secondary educational institution years.

2. Malaysian Science Result in TIMSS

Malaysia average achievement in the Form 2 content domains of biology, chemistry, physics, and earth science showed differing strengths and weaknesses. Although Malaysia has an overall science average scale score of 426 in TIMSS 2011, but we scored higher in physics with a score of 435 (see Table 8). The overall average scores for biology and chemistry were 427 and 426 respectively. The problem was the earth science domain which we only scored 401. Although our content domains score were slightly different, the most important aspect is to analyse the problems in our science education and improve the overall results.

Table 8.Malaysia overall and content domains average scale score

Rank.	Country	Overall Science Average Scale Score	Average Scale Score for content domains			
			Biology	Chemistry	Physics	Earth Science
1	Singapore	590(4.3)	594(4.8)	590(4.7)	602(4.2)	566(4.5)
2	Chinese Taipei	564(2.3)	557(2.5)	585(3.9)	552(4.5)	568(2.9)
3	Korea, Rep. of	560(2.0)	561(2.4)	551(2.2)	577 (2.8)	548 (3.2)
21	Turkey	483 (3.4)	484 (3.7)	477 (4.0)	494 (3.7)	468 (3.5)
27	Thailand	451(3.9)	460 (4.3)	436 (4.6)	430 (4.5)	466 (4.1)
32	Malaysia	426 (6.3)	427 (6.2)	426 (6.6)	435 (6.6)	401 (6.5)
40	Indonesia	406 (4.5)	410 (4.7)	378 (4.9)	397(5.4)	412(5.6)
( ) Standard errors appear in parentheses. Some results may appear inconsistent due to rounding.						

There are four domains at Form 2; biology, chemistry, physics, and earth science. The same three cognitive domains; knowing, applying, and reasoning, were used at both the Year 4 and Form 2. Knowing covers the students' knowledge of science facts, procedures, and concepts. Applying focuses on the students' ability to apply knowledge and conceptual understanding in a science problem situation. Reasoning goes beyond the solution of routine science problems to encompass unfamiliar situations, complex contexts, and multi-step problems. (Martin et al., 2012).

In general, participants in TIMSS 2011 with the highest overall science average scale score also had the highest achievement in the cognitive domains, although most countries showed a relative strength in one cognitive domain or another (see Table 9). Malaysian students were strong in the reasoning domain (439 average score), average in the applying domain (424 average score), but weak in the knowing domain. This is quite different from other countries. Malaysian students were found to be able to do higher order thinking, but were knowledgeably weak.

Besides students' science achievement in content domains and cognitive domains, TIMSS 2011 also evaluated five assessments and their effects on a student's achievement.

Table 9. Comparisons of Countries' Achievement in Science Cognitive

No.	Country	Overall Science Average Scale Score	Cognitive Domains		
			Knowing	Applying	Reasoning
1	Singapore	590(4.3)	588(4.9)	589 (4.4)	592 (4.5)
2	Chinese Taipei	564 (2.3)	569(2.7)	570(2.7)	551(2.9)
3	Korea, Rep. of	560(2.0)	554(2.9)	561(2.0)	564(2.2)
21	Turkey	483 (3.4)	490 (3.8)	478 (3.4)	483 (3.4)
27	Thailand	451(3.9)	443(4.7)	451(4.1)	453(4.2)
32	Malaysia	426 (6.3)	403(7.0)	424(6.2)	439(5.8)
40	Indonesia	406(4.5)	402(5.4)	398(4.7)	413(5.2)
() Standard errors appear in parentheses. Some results may appear inconsistent due to rounding.					

The five assessments that were evaluated are: home environment support for science achievement, educational institution resources for teaching science, educational institution climate, teacher preparation and classroom instruction.

This article will focus on the use of ICT in Malaysian science teaching resources. In addition, this article will also discuss other classroom resources and activities employed in science lessons such as the use of textbooks, workbooks or worksheets, and science equipment and materials.

Method

Data were extracted from the results of TIMSS 2011. Only data on the 'types of resources used in science lesson' and 'how computers were used during science lessons' were analyzed. Descriptive statistics was used in the analysis to describe the types of resources used in their science lessons, and the various strategies employed in using computers in teaching science.

Findings

1. Use of computer software for science instruction

The result of TIMSS 2011 revealed that 33% of Malaysian students were taught by teacher using computer software for science instruction. This was about doubled the international average (16%). Please see Table 10. However, the Malaysian students' science achievement was still low (score of 426). From the result, it can be inferred that Malaysian science teachers used computer software for science instruction; however, it appears that only marginal benefits are derived as reflected in the students' achievement.

In the classroom resources and activities for teaching science, we found that textbooks were the main resources used by the science teachers as the basis of science instruction. The percentage of Malaysian students (83%) who were taught with these methods was higher than the international average (74%).

Table 10.Resources Teachers Use for Teaching Science
Reported by Teachers

Country	Percent of Students Whose Teachers Use							
	Textbooks		Workbooks or Worksheets		Science Equipment and Materials		Computer Software for Science Instruction	
	As Basis For Instruction	As a Supplement	As Basis for Instruction	As a Supplement	As Basis for Instruction	As a Supplement	As Basis for Instruction	As a Supplement
Malaysia	83 (2.5)	16 (2.3)	39 (3.8)	61 (3.8)	40 (3.4)	59 (3.4)	33 (3.8)	59 (3.8)
International Avg.	74 (0.4)	24 (0.4)	35 (0.5)	60 (0.5)	43 (0.5)	54 (0.5)	16 (0.4)	61 (0.5)
( ) Standard errors appear in parentheses. Some results may appear inconsistent due to rounding.								

Science equipment and materials were the next most frequently used with 43% of the international average. Workbooks or worksheets were less frequently used (35% of international students on average) but still heavily used in some countries. Computer software was less frequently used as a basis for instruction; which is only 16% on average. All of the following materials except textbooks were popular as supplementary instructional resources at the Form 2 level: workbooks or worksheets, with 60% of students; science equipment and materials, with 54%; and computer software, with 61%.

The result also revealed that Malaysian science teachers were more didactic than their international counterparts in teaching science. Majority of students (83%) were taught with textbooks as the basis for instruction. Less than 50% of the students were taught with workbooks or worksheets, science equipment and materials, and computer software as the basis for instruction. Please see Table 3. These findings showed that Malaysian teachers are influenced by the Confucian education culture where a greater proportion of science lessons are centred on learning from textbooks and memorizing facts. This is different from the Australian education system which has a longer historical influence from social-constructivist theorists such as Bruner and Vygotsky. Teaching in Australian educational institutions involved a greater

proportion of activities such as designing and doing science experiments, and working in small groups (Ying et al., 2012).

2. Computer Activities during Science Lessons

According to TIMSS 2011, countries are investing in technology as a way to enhance teaching and learning. Availability of computers and other technology in the science classroom can facilitate successful implementation of the curriculum. According to the Contextual Framework outlined in TIMSS 2011 Assessment Frameworks, computers and the Internet provide students with ways to explore concepts in-depth, trigger enthusiasm and motivation for learning, enable students to learn at their own pace, and provide students with access to vast information sources.

Internationally, on average, less than half (46%) of Form 2 students had computers available during their science lessons, ranging from 12 % in Ghana to 84% in Kazakhstan. Students with computers available during their lessons had slightly higher science achievement than students without computers available. On average, one-third (28–39%) of Form Two students, were asked to do the following on at least a monthly basis: look up ideas and information, do scientific procedures or experiments, study natural phenomena through simulations, process and analyze data, and practice skills and procedures. We found that only 17% of Malaysian students had computers available during their science lessons (see Table 11). Furthermore less than one-fifth (14-17%) of Malaysian Form 2 students, were asked to do the following on a monthly basis: look up ideas and information, do scientific procedures or experiments, study natural phenomena through simulations, process and analyse data.

Table 11. Computer Activities During Science Lessons Reported by Teachers

Country	Computers Available for Science Lessons			Percent of Students Whose Teachers Have Them Use Computers At Least Monthly				
	Percent of Students	Average Achievement						
	Yes	Yes	No	To Look Up Ideas and Information	To Do Scientific Procedures or Experiments	To Study Natural Phenomena through Simulations	To Process and Analyze Data	To Practice Skills and Procedures
Malaysia	17 (3.3)	447 (13.1)	21 (6.8)	17 (3.2)	15 (3.0	17 (3.2)	15(3.0)	14 (2.9)
International Avg.	46 (0.5)	481(1.0)	475 (0.8)	39 (0.5)	28 (0.5)	30 (0.5)	31 (0.5)	33 (0.5)
( ) Standard errors appear in parentheses. Some results may appear inconsistent due to rounding.								

Although computer software was used for science instruction, teachers seldom cultivate cognitive skills of their students. Malaysian science teachers used computer software didactically and as a result of this, students are weak in knowing, applying and reasoning (see Table 9).

Discussion

TIMSS 2011 revealed that the science results for Malaysian students dropped drastically when compared to the results of TIMSS 2007. Although PPSMI was abolished in 2012 (Curriculum Development Centre, 2011), many teachers are still using the teaching courseware which were developed by Malaysian Ministry of Education. This could explain the higher average scale score obtained by our teachers in using computer software as compared to the international average score. They used the teaching courseware frequently as it was developed by the Ministry of Education.

Singapore also has its own ICT programme and is called as the Masterplan for ICT in Education (MP1) which was launched in April 1997. Clear objectives were set in the policy. The main goal of MP1 was not only to ensure that educational institutions integrated ICT in their curriculum but also developed a culture of thinking, lifelong learning, and social responsibility (Singapore Ministry of Education, 1997). The ministry emphasized the use of Internet, software designed for the curriculum, open tools such as word-processing, spread sheets, and mind mapping packages, and learning management systems. The use of ICT in Singaporean education then changed from information receiving towards finding, collecting and synthesizing relevant information, and from learning to problem solving and communicating ideas effectively. Singapore teachers supported learner autonomy of the students by providing them with worksheets and checklists, and engaged them in dialogues to scaffold the learning processes. (Lim, 2007)

However in Malaysia, the microanalysis of TIMSS 2011's data on how the students use computers revealed that less than one-fifth (14-17%) of the Form 2 students used it to look up for ideas and information, do scientific procedures or experiments, study natural phenomena through simulations, process and analyse data, and practice skills and procedures. This shows that most teachers did not use the computers to enhance their students' cognitive skills. This could be related that the low average scale score obtained by our students in the science domain. As described by Niederhauser and Stoddart (2001), ICT-based learning, can be used in the didactic tradition and constructivist ways. In the Malaysian scenario, ICT was used as this tradition. On the other hand, constructivism in science teaching was highlighted in many studies (Cheung & Toh, 1992; Yager, 1991). If students construct new knowledge out of the experiences that they encounter, then it makes sense for the teacher to grasp some part of their experience and connect it to the knowledge to be taught. In order to ensure students' understanding requires active involvement, ample opportunities to practice what has been learnt should be given. Though the emphasis is on the student, constructivism does not dismiss the active role of the teacher or the value of expert knowledge. Constructivism modifies that role, so that teachers help students to construct knowledge rather than reproduce a series of facts. The constructivist teacher provides tools such as problemsolving and inquiry-based

activities with which students formulate and test their ideas, draw conclusions and inferences, and pool and convey their knowledge in a collaborative learning environment (Toh et al., 2004)

Thus, our students were not trained or instructed to obtain maximum benefit from the use of computer. There are computer softwares such as the tool software programmes (e.g. the spreadsheet, Internet and graphic organizer) that can support learners in their learning as they find, organize, manipulate and present information. However, the instructional value of these programmes lies in how they are used. Students can use the Internet to access information, a spreadsheet to organize data collected in experiments, a graphics package to prepare diagrams and charts, a word processor to organize and present textual information, and a multimedia presentation programme to prepare and present a final report. Such activities promote independent and group interaction in completing tasks (Niederhauser & Stoddart, 2001) , thus support learner autonomy to achieve students' engagement in higher-order thinking.

Conclusion

It is evident that TIMSS 2011 revealed that Malaysian science teachers used computer in their sciencecinstruction however they seldom cultivate cognitive skills of their students. Malaysian science teachers used computer software didactically and as a result of this, students are weak in knowing, applying and the skill of reasoning. This issue need to be addressed in the science teacher education programme; both pre-service and inservice level. Besides that, all educational institutions should have sharing sessions of successful or unsuccessful ICT-mediated lesssons at educational institution among the teachers. These sessions can provide ideas to the teachers how to conduct computerbased lessons and motivation that if others people can do it, we can also do it. They need to be trained in using ICT in constructivist ways in order to provide a flexible learner-directed workspace. The computer should be seen as a tool for learning, rather than a teaching machine.

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2.3 Recommended readings for technical sciences field

http://www.infodev.org/articles/use-specific-ict-tools-education [26]

Use of specific ICT tools in education

A Knowledge Map on Information & Communication Technologies in Education

Guiding Questions:

What is known about which ICTs are most useful to benefit education? What do we know about the usefulness, appropriateness and efficacy of specific ICTs (including radio television, handheld devices, computers, networked computers and the Internet) for educational purposes? What do we know about the use of open source and free software in education?

Current knowledgebase

What we know, what we believe - and what we don't

General

• The Internet is not widely available in most LDCs; radio and TV are Broadcast technologies such as radio and television have a much greater penetration than the Internet throughout much of the developing world, and the substantial gap is not expected to be closed soon.

• Radio and TV can have high start-up costs, and reinforce existing pedagogical styles Educational initiatives that utilize radio and television typically have quite high initial start-up/capital costs, but once they are up and running, on-going maintenance and upgrade costs are much lower (making initiatives utilizing radio and TV for distance learning in the educations sector particularly appealing for donor support in many cases). One-to-many broadcast technologies like radio and television (as well as satellite distribution of electronic content) are seen as less 'revolutionary' ICTs in education, as their usage is seen as reinforcing of traditional instructor-centric learning models, unlike computers, which many see as important tools in fostering more learner-centric instructional models.

• Radio instruction has been used widely and is reasonably well studied Radio instruction in formal education has been well studied, especially the links between the use of radio in combination with educational institution-based educational resources and a variety of pedagogical practices.

• TV has been used with success in a few places Television has been utilized successfully as a mechanism for reaching out-of-educational institution youth in a number of countries, especially in Latin America and China, and the results of such projects have been widely disseminated.

• In some cases, where markets have been liberalized, ICTs are used to distribute educational content regionally within a country Market liberalization has in many countries allowed for the development of locally- (as opposed to centrally-) controlled distribution channels that utilize ICTs (like radio and the Internet, and to a lesser extent television) to create and broadcast educational content more targeted to

the needs of specific communities, and as a result have a greater flexibility to employ local languages.

• CAI is not highly regarded by experts and in OECD countries, but still receives much interest in LDCs The usefulness of computer-aided instruction (CAI), in which computers are seen as simple replacements for teachers, has been largely discredited, although there appears to still be great interest in CAI in many LDCs where computers are being introduced.

• It is unclear where to place computers to make sure they are used most efficiently There is very little research on the most appropriate placement of computers in educational institutions, or in the community, used to achieve various learning objectives.

• Multi-channel learning is a useful concept The emerging practice of 'multi-channel learning', which focuses on enriching the educational experience by engaging all resources that are available to help effect incremental change by coordinating the various ways to connect learners with information, knowledge, and stimulation, and to mediate those interactions, provides valuable insight into how blended learning approaches can be delivered and tailored in areas of great resource scarcity.

• Satellite is much hyped, but under-studied While satellite broadcasting of electronic educational resources is thought to hold much promise, there are few case studies of successful implementation of satellite broadcasting to small LDCs.

• New Internet technologies hold promise, but are not yet operational Emerging Internet technologies, especially recent and emerging wireless protocols (including 802.11, and shortly WiMax), are thought to hold much promise for providing connectivity to remoter areas, but projects utilizing such technologies are for the most part in pilot or planning stages, and face many regulatory hurdles.

• Mobile Internet centres (vans, etc.) are being deployed as a way to reach rural areas A number of educational initiatives utilizing mobile Internet centres have been piloted in the past decade, but little cost and impact data has emerged from such projects.

• Community telecentres are a hot topic, but successful, replicable models have not yet emerged Community telecentres (sometimes based in educational institutions) have be touted as important tools to provide access to learners (including teachers engaged in personal enrichment and professional development opportunities) to ICTs outside of formal educational institution settings.

• The use of handheld devices is just now receiving serious widespread attention Little research has been done on uses of handheld devices (including personal digital assistants and mobile phones) in education.

• 'Free software' holds promise, but costs and impact are still not well documented The uses of 'free' software is widely touted as a cost effective alternative to the uses of proprietary software (especially Microsoft products), but research in this area is largely advocatory in nature.

Comments

General comments

• We know that technology changes - rapidly - and newer, more cost effective and more powerful technologies will continue to emerge of potential use in education. At the same time, evidence shows that, once installed in educational institutions, ICTs continue to be used for the life of the functioning life of the technology, whether or not newer, more cost effective and powerful technologies emerge (especially as upgrade paths are seldom part of initial planning).

• Much of the publicly available information about the effectiveness of particular ICT tools is generated by the companies who market such products and related services.

• While it is clear that it is the application of various ICTs that are the most important determinants of the effectiveness of such tools in education, the choices of tools are quite varied and each has its own advantages and disadvantages. Policymakers and donor staff are often bombarded by information and studies from vendors on the suitability of their products or services, and there is a need for further, independent research on the appropriateness on specific tools with potential to help meet education-related MDGs.

Some areas for further investigation and research

What models exist for the effective utilization of ICTs to support on-going professional development for educators? What are the best practices for mainstreaming pilot projects involving interactive radio instruction (IRI) at the Ministry of Education, and how are such projects managed and maintained over time?

Where should computers reside if they are to have the greatest learning impact in education? Is the use of ICTs as in-class presentation mechanisms a cost-effective use of technology?

How have/can handheld devices (including SMS-enabled mobile phones) be used to support education (especially related to the professional development of teachers and educational institution administration), and what are the emerging best practices?

How can existing community and interactive radio networks outside the education sector be used to benefit education? What successful models exist for opening ICT facilities in educational institutions to the wider community?

Does the use of so-called "open source software" offer compelling benefits in education? What models exist on effective public-private-community partnerships in education for ICT equipment provision and maintenance?

Conclusion

The given manual is just an attempt to present the scope of tasks implied when dealing with ICT. It is also dedicated to the aims and objectives outline as well as the competencies to be formed at future teachers during the process of ICT study.

It must be stated that the previous year was marked by the prominent event in the scientific world connected to ICT - Central Asia Symposium on ICT in Education (CASIE) 2016: Unleashing the Potential of ICT for Skills Development (27-29 June 2016, Astana, Republic of Kazakhstan).

This event was focused on developing a well-educated and skilled society. As relevant education and labor-market responsive training systems are of great importance, the Central Asian countries discussed the ways in which to increase their competitiveness and examined challenges of the sector, while exploring the ways in which ICTs can contribute to addressing challenges unique to this context.

Additionally, the focus on skills development has been given considerable attention in the Education 2030 agenda, where it is identified as one of the priority areas in achieving the Sustainable Development Goal 4 (SDG4) on education. In this regard ICT has been considered as a supporting resource to pave the way towards lifelong learning, quality education, diversified learning pathways, and reach marginalized and underserved communities. In light of this theme and the potential of ICT, CASIE 2016 focused on 4 areas, specifically 1) providing open, flexible and blended learning opportunities for all, 2) supporting practice-oriented authentic learning experiences, 3) strengthening data-informed education and training policy development, and 4) promoting partnerships for mainstreaming ICTs in education and training [27].

According to Prensky (2001), contemporary students are digital natives as they have using technology since their childhood and they are all "native speakers" of the digital language of computers, video games and the Internet. On the other hand, those who were not born into the digital world but have adopted technology at a later stage of their lives are called digital immigrants. Digital native students and digital immigrant teachers lie at the center of several educational problems we're facing at present. 'Digital natives' brains are likely to be physically different as a result of the digital input they received while growing up' (Prensky, 2001).

Digital immigrant teachers assume that learners are the same as before and they have not changed, hence, the assumption that the same teaching strategies will be as effective with today's digital natives. However, according to Prensky (2001) this assumption is no longer valid. Moreover, digital immigrants don't believe that their students can successfully learn with educational tools such as television (Prensky, 2001). Accoding to Prensky (2001) digital natives are used to receiving information really fast, they like to multi-task, they prefer graphics before texts, they function best when networked, they are motivated with frequent rewards and they prefer games to serious work. Thus, Prensky (2001) proposes that digital immigrant teachers should devise new methodologies for all subject areas, at all levels, while using students as their guides [28].

So, this manual was aimed at presenting the digital teacher's perspectives when dealing with ICT introduction, aims, types of ICT tools.

The perspectives of this manual include:

. The presentation of every Module of ICT (in accordance with the curriculum in KSPI);

2. Dealing with humanitarian area in education and ICT implementation;

3. Presenting the technical aspect of ICT usage;

4. Disclosing natural science relation and ICT;

5. Assessment of ICT in education.

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Key

Article 1
(Technology (ICTs) for effective teaching of social studies in secondary educational institutions in Delta State)

Abstract. There is a universal recognition of the need to use information and communication technology (ICTs) in the educational systems of Nigeria in teaching social studies in secondary educational institutions in Delta state as we are in the era of digitalization where the free flow of information via satellite and the internet hold sway in global dissemination of knowledge in diverse subject area. Nigeria is way slow in embracing the integration of ICTs for teaching in secondary educational institution curriculum. A great deal of instructional and administrative work in secondary educational institutions in Delta state is still carried out manually. This is as a result of lack of high cost of computer hardware and software for their application, weak infrastructures, selfish political ambition of individuals, diversion of fund for other purposes in educational institutions, inadequate skilled ICT professionals/teachers, lack of appropriate organizational recognition, unwillingness of teacher to adapt to new trends of teaching, inadequate fund to acquire furniture, textbooks, befitting classroom, cost of subscription to the internet on a regular basis are stumbling block on the adoption of ICTs in secondary educational institutions in Delta state. In this modern society, educational institutions need ICTs to aid their teaching and learning and educational management so as to meet up with the technological development of the 21st century. In the foregoing findings ,the following recommendations were made: that the educational institutions should make sure they have a web page, provide different kinds of computers and Internet access to students, make provision for educational institution to purchase standard software package to manage the creation of course web pages, recruit staff with ICT skills to assist instructors with educational technology, Make provision for classrooms designed for multimedia presentations, special funds of professional recognition for innovative uses of technology in teaching be given to educational institutions in order to have colleagues working on grants that support electronic teaching, the institution should have a plan for on-line course materials, the use of the Internet should be made compulsory to staff and students, and the on-line materials should be made accessible to all staff and students. This paper therefore examines the need for the utilization of ICTs for effective teaching of social studies as a subject in secondary educational institutions in Delta state.

Keywords: Information and Communication Technology (ICTs), effective teaching, social studies, secondary educational institutions, Nigeria.

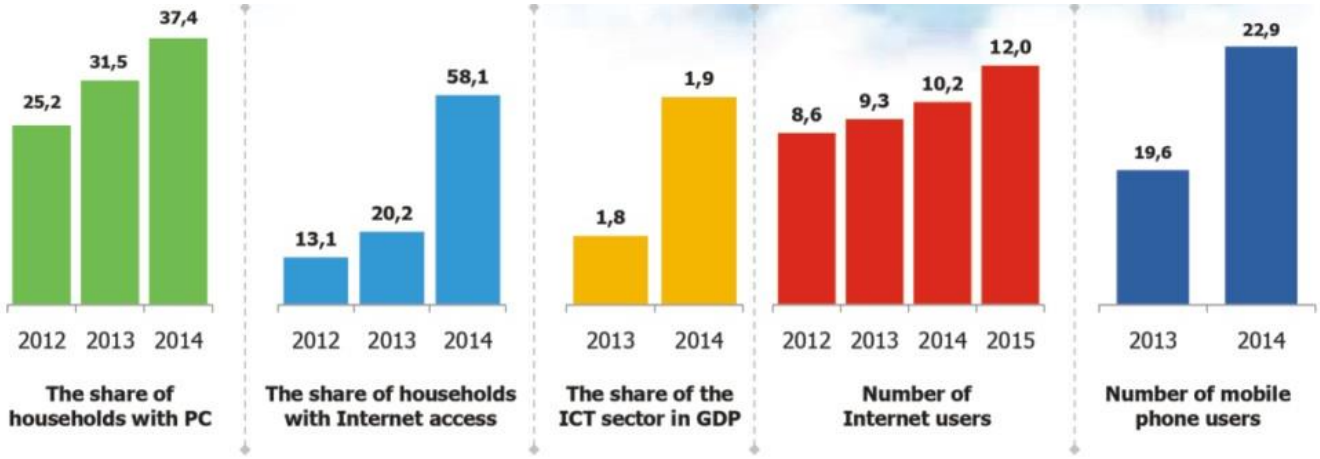
Article 2

Abstract. ICT is a resource that is used by many science teachers worldwide. An evaluation of ICT use in learning science was carried out by Trends in International Mathematics and Science Study (TIMSS) 2011. Resources used by teachers as classroom instruction is one of the major factors that influence students' achievements. The objectives of this paper are to examine the use of ICT in teaching science in Malaysia and the effects on students' achievement based on the TIMSS 2011 results. The results revealed that the average science score of Malaysian Form Two students was 426 which was lower than the international TIMSS scale average and Malaysian Form Two students were ranked number 32 in science among 45 participating countries. This study revealed that 33% of students were taught by teachers who used ICT for science instruction. This was about doubled the international average (16%). However, the percentage of students who had computers available for science lessons was 17% and the use of computers in a month was very low (14-17%). Students seldom use ICT to look up ideas and information, to perform scientific procedures or experiments, to study natural phenomena through simulations, to process and analyze data and to practice skills and procedures. Based on these findings, implications towards science teacher education will be discussed.

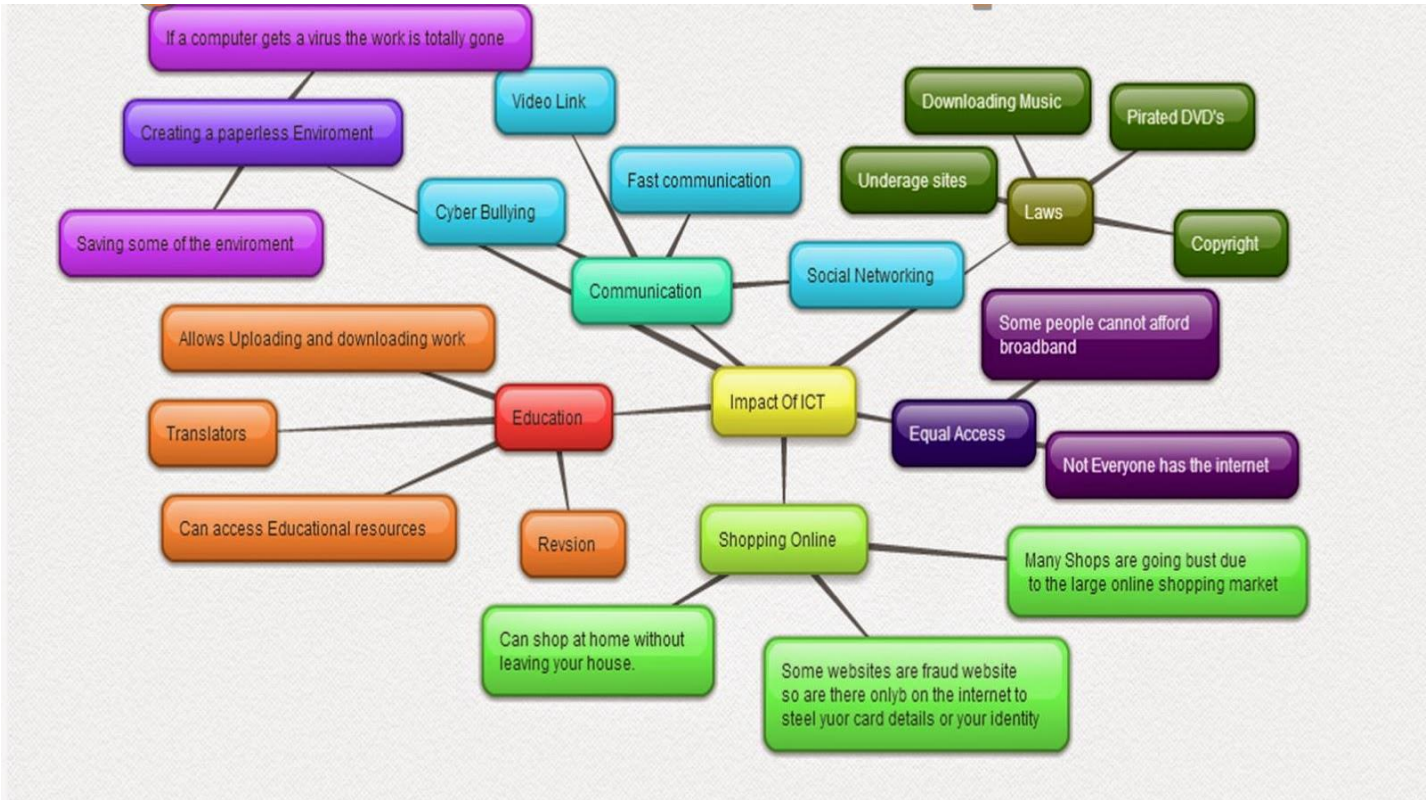
Keywords: Student centered; Information and Communication Technology (ICT); Science Education; Malaysian Students' Achievement.

Appendix

Appendix A
The main indicators of ICT

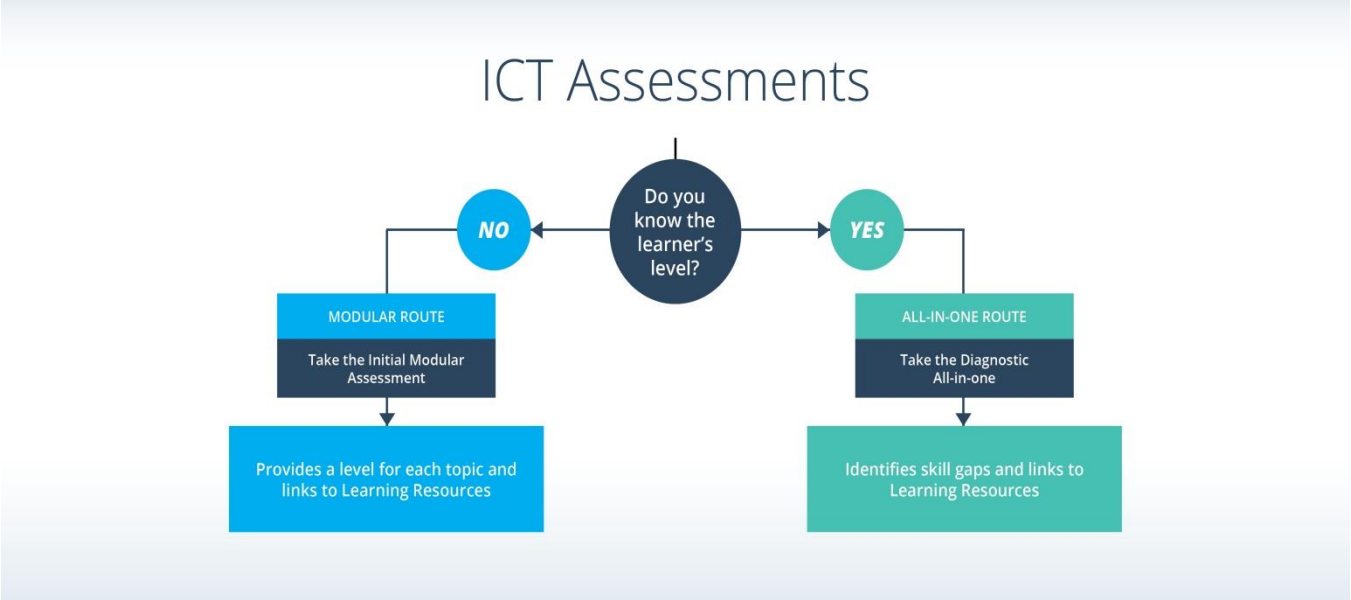


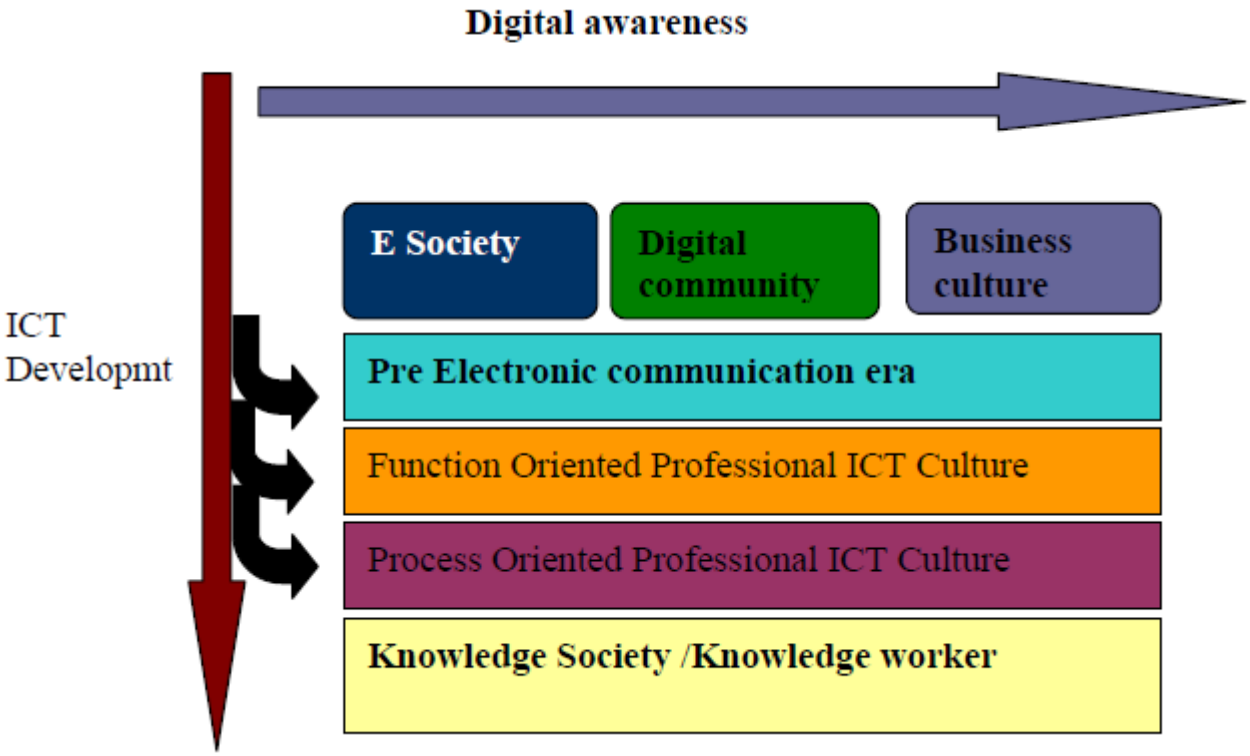
people	million USD	million USD	billion sum
The number of employees in the ICT sector 2014 – **35 305** 2013 – **34 163**	Export volume of products and services of the ICT sector 2014 – **213,8** 2013 – **223,2**	Import volume of products and services of the ICT sector 2014 – **382,0** 2013 – **363,9**	Production volume in the ICT sector 2014 – **4 189** 2013 – **3 567**



Appendix B

Digital assessment and awareness





Appendix C

Introductory Information and Communication Technology Learning Experiences