Technical Report and Guidelines to Developers

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The scene at the beginning of the project

Mobile devices and communication are ubiquitous in Europe, the penetration of mobile telephones is nearly (or in some cases is above) 100% in all developed countries. Current devices and technology extends the scope of mobile usage and communication far wider than speech and short text messages (SMS). Young people have been grown up with these type of devices and use them as naturally as older people use for example television. Mobile phones -- usually equipped with cutting edge technology -- are inherent parts of practically all spheres of their everyday life.

While in 2000 there were significant differences in mobile penetration and the pattern and speed of expansion between Eastern and Western European countries, today these differences tend to disappear, e. g., the mobile penetration is around or above 100% in all CallDysc Project partner countries (Bulgaria, Hungary, Poland, Sweden and UK -- Romania is the only exception where this number is 80,5%). It can not be stated that mobile markets of these countries would be alike, but today the differences between them can be found rather in the use of third generation mobile technology, in the advancement and scope of mobile delivered content, and in how developed are the devices that typical users can access. On the other hand -- as in this report will be shown -- advanced technologies are accessible in each partner countries, and the rate of 3G users is also constantly growing in each, as well as the amount of available mobile applications and content. As the deployment of new generation technologies is increasing, it can be predicted that traditional use of mobile telephones (speech and SMS) is supplemented by new types of usage methods associated with content consumption and production (i. e., entertainment, business and education).

Current trends of mobile content, applications and devices in the context of m-learning

The category of "mobile content and applications" covers a wide range of services provided either by the wireless network operator companies (like Vodafone Live! and OrangeWorld in several countries), or by other providers, i. e. Mobile Virtual Network Operators (MVNO -- an organization that provides

mobile telephony services to its customers, but does not have allocation of spectrum). Popular mobile content includes services that are connected to mobile device use (downloading ring tones, operator logos, etc.), entertainment related content (games, music, motion pictures, TV), and commercial services (mobile banking, brokerage, shopping, reservation systems, etc).

As third generation services and platforms are entered to the mobile market of European countries, and the acceptance and popularity of such services tends to be increasing, it seems likely that usage patterns of mobile devices will be altered as well. In line with the increase of penetration of devices which support 3G enabled data services, a prediction can be made that handheld devices will be used for not only the "traditional" purposes (i. e. voice and text messaging) but also for information search, consumption, and production by several social groups, especially the "digital native" young people. Current trend shows that the killer applications attracting users to mobile information services are entertainment related products (e. g. downloadable games, music, video, etc.), but once consumers experience the advantages of reaching content on the move, it can be predicted, that they also start experimenting with practical applications (e. g. banking, shopping, or carry out learning related activities).

Besides pedagogical aspects the success of mobile learning applications depends on several technical factors. Devices with appropriate display, memory and mobile internet technology are crucial in being able to access mobile (learning) content in a convenient manner. Deploying technologies that assists collaborative, participative learning (i. e., technologies that support communication, collaboration, creative participation) is of the same importance. How these conditions can be addressed in the context of using mobile phones for learning is summarized below.

Mobile 2.0

Mobile devices are not only applicable for the consumption of information, data and content provided by MNOs, MNVOs or other either profit oriented or

non-profit, but "centralized" content producers. Current web trends, i.e. web 2.0, the second generation of web based communication and communities is social by nature, facilitates collaboration and content sharing between users. In the web 2.0 era users are no longer only consumers of previously edited data, but they also create and share their own (blogs, photo sharing, personal web spaces, etc.), often in collaboration with others (communal blogs, wikis, etc). All this is made possible by easy-to-use CMS-like applications that allow anyone without web programming skills to be a publisher (blog- and wiki engines, social networking applications etc).

In line with these web trends current mobile devices are also used for creating and sharing content (text, or mobile-recorded photos, movies, or speech) with others. Mobile devices are already extensively used among web 2.0 enthusiasts. Most popular social web applications (e. g., blog engines, social networking systems) support content upload via these types of devices. Blogging even has subtypes in "moblogging" and “microblogging” which has been transformed during the life of this project into the enormously successful Twitter. Content creation, sharing and collaboration via mobile devices is often referred as Mobile 2.0. These features are especially important in the context of learning -- regarding m-learning as a subtype of e-learning in which collaboration between learners (consequently applications that support collaborative learning) is taken as the critical factor of success.

Besides advanced data transmission methods, devices equipped with appropriate features are also needed for in order to get delivered mobile content usable, and this is especially important in the case of mobile learning in which attention is a key factor. The features of currently mobile phones not only fit these requirements but some of their features can even enhance the learning process by adding the creativity factor to it: the recording (voice, pictures, movies) function of the devices which open up new opportunities in education.

To review how mobile devices can be utilized in education the best way is to consider the capabilities that phones in use today possess, and to see what each capability brings us. With half a billion mobile phones sold each year, the

devices are hotbeds of feature innovation—the major features being voice, short messaging service (SMS), graphics, user-controlled operating systems, downloadables, browsers, camera functions (still and video), and more recently geopositioning — with new features such as fingerprint readers, sensors, and voice recognition being added every day. In addition, optional hardware and software accessories are available as both input mechanisms (e.g., thumb keyboards and styli) and optional output systems (e.g., plug-in screens and headphones).

The technology

This project started in 2006, and therefore is written with respect to the technology that was available then and for the duration of the project. This does not affect the outcomes since the project is about the use of the technology and not the technology itself. However, as noted in the Conclusions, mobile technology has moved very quickly since then, with smart phones and high resolutions iPhones becoming standard, along with high speed internet connections. Therefore the following is written with respect to the decisions made within this project, and if the project were to start again now, the technology would allow different decisions to be made.

Traditional features: Voice and SMS

The traditional voice and short text messages of mobile phones can be used for educational purposes. They provide prompt connection to educators and fellow students, and are becoming widely used as a standard part of school administration, such as homework reminders and general school notices. While some adults may have a difficult time with new to digital technology, and even question the value of it, non-face-to-face voice communication for learning and virtual relationships are now second nature to students, and often preferred.

SMS is especially popular among young people in Europe. Short text messages, which can be written quickly (especially with predictive text), offer specific learning opportunities. Currently, SMS messages provide timely "learning" reminders and encouragement for people trying to change their behavior (e.g., for someone who wants to quit smoking). SMS is also used for voting on several television shows and for quizzes with prizes. Marketers use SMS for informational quizzes about subjects of interest to young people, such as movie and television stars. All these features have strong educational potential. In school SMS can be used to conduct quizzes or spelling or math tests, to poll students' opinions, to make learners aware of current events for class discussion, and even to tutor students.

Graphic Displays

Every mobile phone has some kind of graphic display, even if it shows only the signal and battery strength and the name and/or number of a contact. Most new mobile phones come with far more graphic power than that — they typically sport bright colour screens that can crisply display words, pictures, and animation. Many of these screens have resolutions of 320 × 240 pixels—half the screen size of the standard computer of not too long ago—and higher. They present thousands of colours and even three-dimensional images and holograms.

Such high-resolution screens allow for meaningful amounts of text to be displayed, either paragraph by paragraph or one quickly flashed word at a time, known as RSVP—rapid serial visual presentation— with the user setting (and generally greatly increasing) his or her own reading speed.

Better graphic displays also mean that text can be accompanied by pictures and animation (and, of course, sound—it is a phone). Many schools are currently using computers and handheld devices for animations in subjects such as medicine and forensics. Mobile phones can replace these handheld devices, especially given that many of the animations are in Flash, which currently runs on many mobile phones and eventually will run on all of them either directly or through the browser. Adobe through its Flash software

(formerly owned by Macromedia) already offers what it calls "flash lite" applications, including one for learning sign language. These are the forerunners of what is now the highly popular iPhone applications.

It follows that in many cases, mobile phones have the potential to replace textbooks as their processing abilities increase. The limited screen size of the phones may even be a positive constraint as it forces publishers to rethink their design and logic for maximum effectiveness, rather than just add pages using paper-based principles.

Downloadable Programs

Since mobile phones have memories (or memory card slots) that accept downloaded programs and content, new learning solutions can be introduced. Mobile phone users can access versions of the same kinds of tools and teaching programs available on personal computers (at least in theory), and given that the phones are communications devices, use the tools for collaboration in new and interesting ways. All manner of applications combining elements of voice, text, graphics, and even specially designed spreadsheets and word processors can be downloaded to phones, with additional content added as needed. Other tools currently available for download include browsers, fax senders, programming languages, and even applications that gives you access to your desktop computer. This capacity can be utilized many ways for any type of downloadable learning connected material.

Internet Browsers

Internet browsers are now being built into a growing number of mobile phones, especially those that use the faster third-generation protocol (3G). Sites and options designed specifically for Web-enabled mobile phones are becoming more and more numerous. Having a browser in the mobile phone puts a dictionary, thesaurus, and encyclopaedia into the hands of every student. It gives them instant access to search engines, turning their mobile phones into research tools. New mobile internet browsers (e.g. Opera Mini) offer simple access to even those web-pages that are not optimized for mobile phones.

This way a mobile device can be used for the reach of almost any web-based educational, scientific material. As mobile 2.0. applications are accessible, effective "mobile" collaboration becomes possible.

Cameras and Video Clips

Millions of camera and video phones (capable of taking and sending photos and short video clips) are sold worldwide, and in many places such phones are already accepted as the norm. Educationally — once students learn that privacy concerns are as important here as anywhere else — they promise enormous advantages. In class, mobile phones with cameras provide possible tools for scientific data collection, documentation, and visual journalism, allowing students to gather evidence, collect and classify images, and follow progressions over time. Creative mobile phone photos can inspire students' creative writing via caption or story contests. Phones can be placed in various places and operated remotely, allowing observations that would be impossible in person. Students can literally see what is going on around the world, including, potentially, learning activities in the classrooms of other countries. Video recording capacity extends the phone's learning possibilities even farther, into television journalism (most TV news clips are less than 30 seconds) as well as creative movie-making. An excellent educational use of short video clips would be modelling effective and ineffective behaviours relating to ethics, negotiation, and other subjects.

Third generation mobile technology (3G), mobile data services

3G is third-generation technology in the context of mobile phone standards. The introduction of 3G services within Europe began in early 2003.

The third generation (3G) mobile technologies can support greater numbers of voice and data for customers — especially in urban centres — as well as higher data rates at lower incremental cost than 2G. The services associated with 3G provide the ability to transfer simultaneously both voice data — a telephone call —, and non-voice data — such as, downloading information (web browsing), exchanging email, instant messaging (IM), and video telephony. The spread of 3G technology allows mobile content (e. g. m-

learning applications) production, transmission, and consumption to become widely used and accepted.

Though data shows that the current 3G penetration in Europe is rather low even in the most developed countries, the tendency (rate of growth) predicts that the number of users will be multiplied (see table 14: Growth of 3G penetration in partner countries (September 2004-December 2006), pp 16). Due to mobile market competition network operators endeavour to transmit attractive content (music, TV, etc.), and make efforts to monetize 3G networks.

Also given the fact, that mobile devices are ubiquitous in Europe -- the penetration of mobile telephones is around 100% in all developed countries, and also the increased use of devices which support 3G enabled data services, a prediction can be made that handheld devices will be used for information search, consumption, and production by several social groups.

Framework to game development for dyslexic language learners

In order to consider the technical details that form the background of the Calldysc Project, it is first necessary to define the common terminology that provides the framework for the development of this project. The three main areas to consider briefly (a fuller description is covered elsewhere) are:

- Dyslexia
- Collaborative Learning
- Mobile learning

Dyslexia is a difficulty in the acquisition of reading and writing skills that is neurological in origin, irrespective of the language of learning. It is caused by underlying cognitive deficits that impact not only upon literacy, but all skill development that is affected by those specific cognitive deficits. This includes additional language learning. (Smythe I, Everatt J and Gyarmathy E, 2004)

Collaborative learning can be defined in many ways, but in the context of e-learning may be considered as a collection of learning objects and development tools that are shared by many in different geographic locations to which everybody can contribute through sharing of the activity and/or sharing of their development. In other words, the individual is not isolated and restricted to a fixed content.

Mobile learning is a term whose usage is developing along with the diversity of technology and opportunities. However, one reasonable definition is (O'Malley et al, 2005)

Any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technology.

The above details provide a basis for determining the technical specifications, which can be covered by two areas that encompass the above.

Pedagogy and psychology

From a psychological perspective the dyslexic individual has usually been struggling for years to overcome literacy difficulties in their first language, and as a consequence will be resistive to learning a second language. This is due to their difficulty with the specific skills, including memory for vocabulary, syntax and grammar, as well as phonological processing deficits that impact upon various aspects of language learning. The purpose of the project was not to develop an entire language learning environment, but to identify how mobile learning could be used to re-engage the dyslexic learner, using methods that were distinct from traditional language learning methods. The intention was to go beyond the "traditional" approaches to mobile learning that have been tried with mainstream learning. These include vocabulary learning through SMS with Japanese students (Thornton & Houser, 2004), using mobile phones to share photos to support vocabulary building (Joseph, Binstead, & Suthers, 2005) and using PDAs as location and communication devices for collaborative mobile subject learning (Ogata H, Saito NA, Paredes JRG, San Martin GA, & Yano Y, 2008).

Taking pedagogic and practical issues (e.g. costs) into consideration, four approaches were identified, each of which could be used in different ways which both fulfilled the learning needs, as well as provided diversity from traditional learning methods. From a users perspective these could be seen as:

1) Single user games
2) Collaborative – two device
3) Combative – two device
4) Dual use on a single device

However, diversity, motivation and financial considerations were addressed through a blended learning approach, where the blending was not only teaching, but also technologies. Thus a pupil may learn using the mobile phone, but they could also develop some games, as well as play them, through sub-notebooks, laptops and even fixed location computers.

Technology

The project aimed to approach the problem from a diversity of technological considerations which provided the best opportunity to find a good solution. However, due to the diversity of users, the cost variations in different countries, and the diversity (and rapid evolution) of the technology, it was important to accept that there was no single solution, but there would probably be some solutions that would work now, and guidelines that could help develop future related work.

Programming language

Several options were available for programming, but the final decision was chosen for practical reasons. The project is not about providing all the technical solutions, but finding a solution that supports dyslexic individuals. Based on the general available multimedia platform for desktop and mobile environment we found two contenders - Java and Adobe Flash Lite. Both are working well in different devices and different operating environment. After initial trails, where it was obvious that both have some advantages and disadvantages as well as having different version of the platform and diverse support on different devices (Java ME, Flash Lite 1.1, Flash Lite 2.0, Flash Lite 2.1, Flash Lite 3.0 just started this year). Based on the trials we found that Adobe Flash 2.0 is the optimal platform (preinstalled on a lot of devices, compatible with the desktop Flash player, and can be downloaded as a developer edition) so was chosen as the preferred option. Unfortunately, we have realized deviations from the standard implementation of each device and also changes subtly, so we have tested frequently the games on each device and found a commonly usable platform and development strategy to fulfil almost all requirements what we planned. Flash provided diversity through the Adobe providing the players for the machines, making it available on Windows Mobile, Symbian and Linux as well as Windows XP, Vista etc without any modifications So we found a way to developed something once and use it more time in different environment which was our focus as well.

Choice of testing platforms

After much investigation the device of choice was the Nokia N70. This is a robust device that offers all the features necessary, including a Flash player, opportunity to use multimedia content, and the chance to load software through a media card. The phone uses the Symbian operating system common to all Nokia phones. Although this was the device of choice, many other phones were also used, include Nokia N73, N95.

In addition, sub-notebooks such as the Asus EEE (running Linux) were used for testing, as well as standard laptops. netbooks and webbooks.

For touch screen use, the HKC/T-Mobile Ameo (12cm screen), MDA Vario II (PDA type, approximately 8cm screen) as well as Fujitsu 1500 notebook (22cm screen) were used.

We have tested also the games on Sony PSP which had Flash Player 6, using access through a memory card and through wireless networking. networking running well.

The project attempted to use a diversity of interfaces to compare and contrast the potential and preferences. The types of interfaces for mobile phones were

1) Numerical keypads
2) Alpha-numeric systems
3) Location dependent – ie stylus, roller or rocker navigation

Architecture

The architecture was designed to take into account the principles above, and can be summarised in Figure 1.

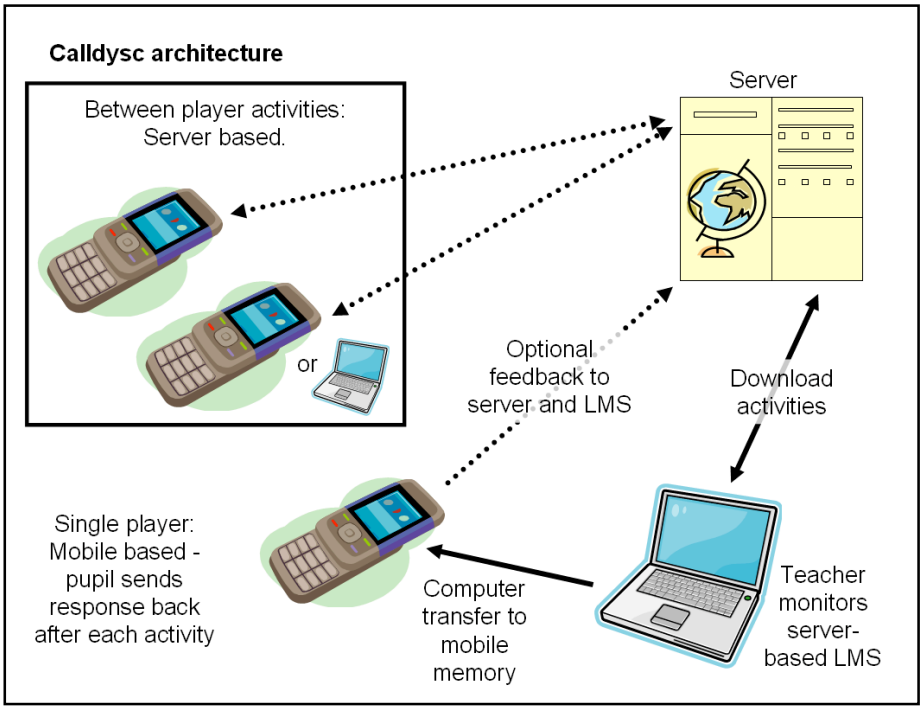


Figure 1: Calldysc main communications architecture

The games are written and stored on the main server. They can be accessed and played directly via a standard computer connect to the internet as well as using a mobile phone that has a web browser that has Flash capability. However, to save download times, especially when there are sound files included or even when the student want to learn when no network environment available (in hills, small villages, etc.), it is recommended that the user downloads the files to a computer, and then installs them on the mobile phone. Hence the need for a phone with a memory card. In this case all of the learning units can be used standalone and a later stage the results can be uploaded to the server for teacher review.

The mobile phone can be used in several ways with the system, which is best illustrated through a series of case studies.

Loading games to mobile phones

For playing games from mobile devices 2 basic steps have to be taken:

- to download the games to the laptop, and transfer them to the mobile phone.
- to ensure the mobile phone can use the programmes, e.g. Flash Lite 2.1 software is installed on it.

Downloading the games

First, download to your computer the full game package (around 7.4 MB) from the project website, or directly from:

http://www.oktatas.magyartelekom.hu/calldysc/

It is a zip file that you have to open up. This you do by creating a new folder and dragging the files from the original (zipped) folder to the new folder.

Transferring the games to the mobile phone

There are two main ways to do this. The simplest is to take the flash memory card from the phone and use a normal data device to transfer the downloaded files from the computer to the memory. Then reinsert the memory into the phone.

The alternative is to connect the phone by cable to the laptop.

In the case of Nokia phone, this can be done using the Nokia PC Suite. If you do not have PC Suite you can download it from:

http://www.nokia.co.uk/link?cid=EDITORIAL_608418

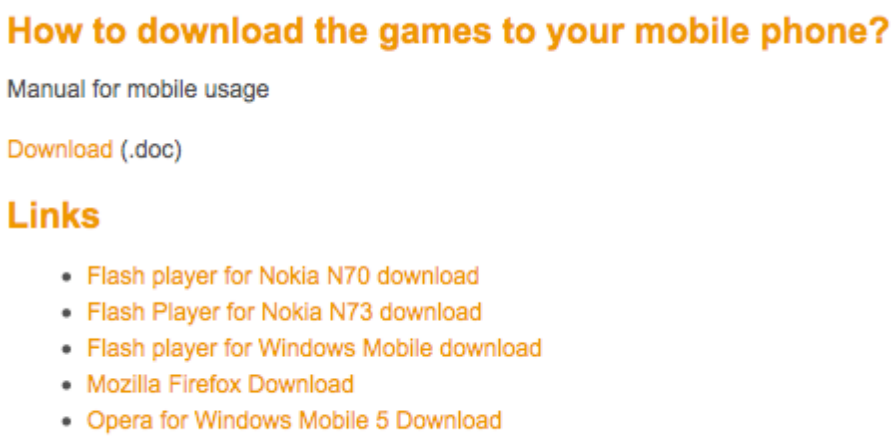
Once you have PC Suite on you computer, it is easy to use the File Manager in PC Suite to transfer the files and place them under "Other" on your phone.

Once you have installed and opened Nokia PC Suite and connect your phone to the computer, the program may "protest" that your phone does not have the right files for PC Suite connection. Let the program get them for you, it will ask

for your permission and then do it by itself and it will take just a couple of seconds.

Downloading FlashLite 2.1 onto the phone:

If a mobile phone doesn't have this version of Flash Lite on it when purchased, it has to be installed by the user. Installation packages for different mobile phones are available from the software producer from their website (www.adobe.com) but to make usage simple, we also collected links to the download files on our project website. A step-by-step manual to install games on mobile phones is also available here.



Learning Management System (LMS) for mobile learning

A learning management system is the technical environment for e-learning activities. It is responsible for how individuals access information, as well as how results are stored. The aim is to provide an environment in which students can access the learning material, teachers (and parents) can monitor the activity of the students and researchers can arrange the participants into different test and control groups and interpret their data based on different user statistics.

The Calldysc LMS was designed with due respect to technology limitations, local (national) limitations in partner countries and financial limitations. Therefore the specified system can be used via mobile devices, wireless devices and wired devices as well. Mobile devices can connect to the LMS interface either via mobile networks (gprs, 3G) or they can access the educational material as downloadable programmes running locally. In this case user data (learning results) stored locally and can be uploaded to the LMS later. All activity and progress of the individuals are recorded electronically, which also allow students to rejoin at any time at the appropriate level. This practical and fundamental approach to the LMS should greatly improve the chances of the main activities of the project being sustained after initial project funding.

The learning management system in this project was used to arrange activities for students and report the results to their teachers, as well as implementing the testing into it. Before gaining access to the learning games, teachers and students had to fill in an online electronic test on their attitude and motivation about mobile learning, and at the end of the learning course, a post test was also taken.

On the next few pages will be found a basic guide to the LMS. Figure 1 shows the teacher login page, using login and password details provided by the project partners

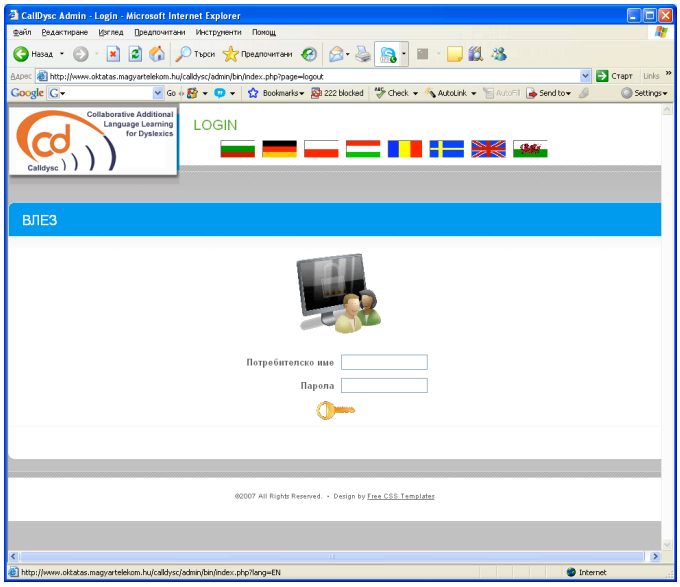


Figure 1: Calldysc Login Screen

The student is expected to fill in (with the help of the teacher where necessary) their personal details, including their language learning background. The questions are in their first language.

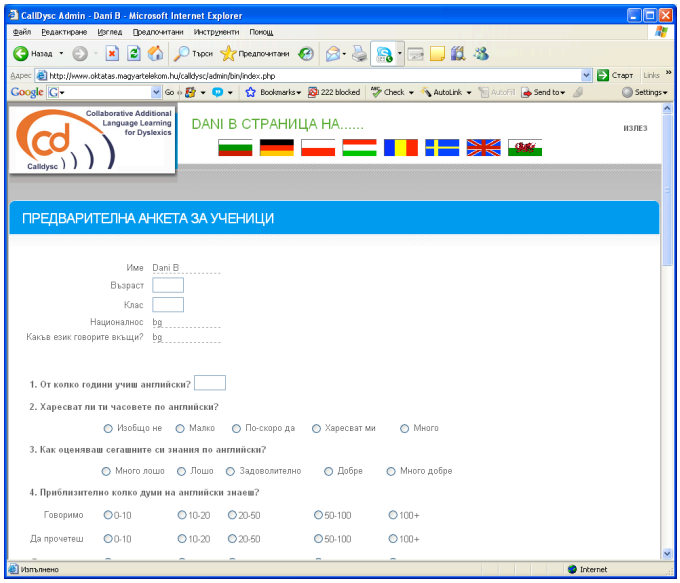


Figure 2: Student Pre-test form

Figure 3 shows the Reward System, whereby the student can see how many Cups they have collected for completing the activities. It also provides a rapid visual indication to the teacher.

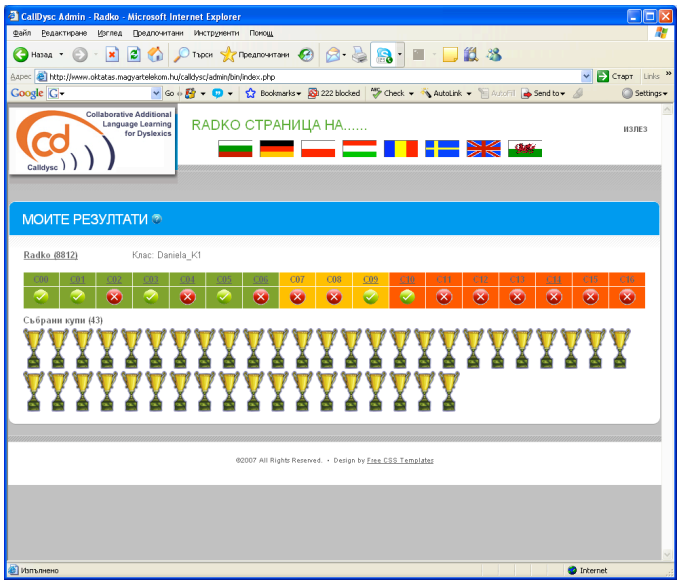


Figure 3: Student Rewards for completion

The teacher has access to all the pupils they have registered, with the details being shown for every activity undertake – see Figure 4.

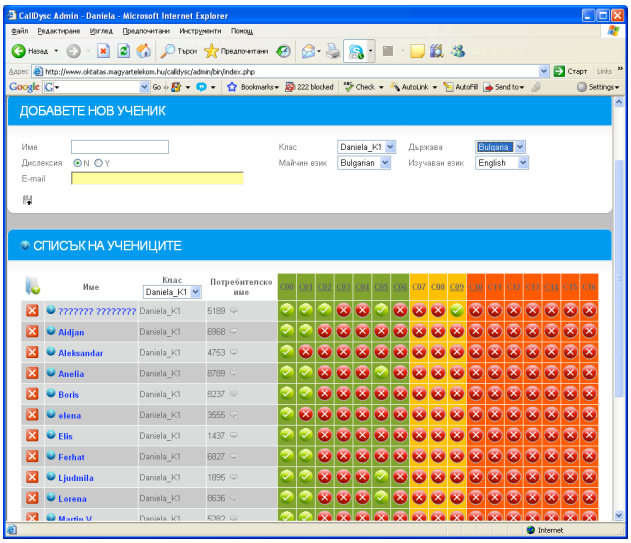


Figure 4

More specific details of those activities are provided by clicking on an individual and their specific activities. Figure 5 shows the overall times and date of the activities, as well as overall score.

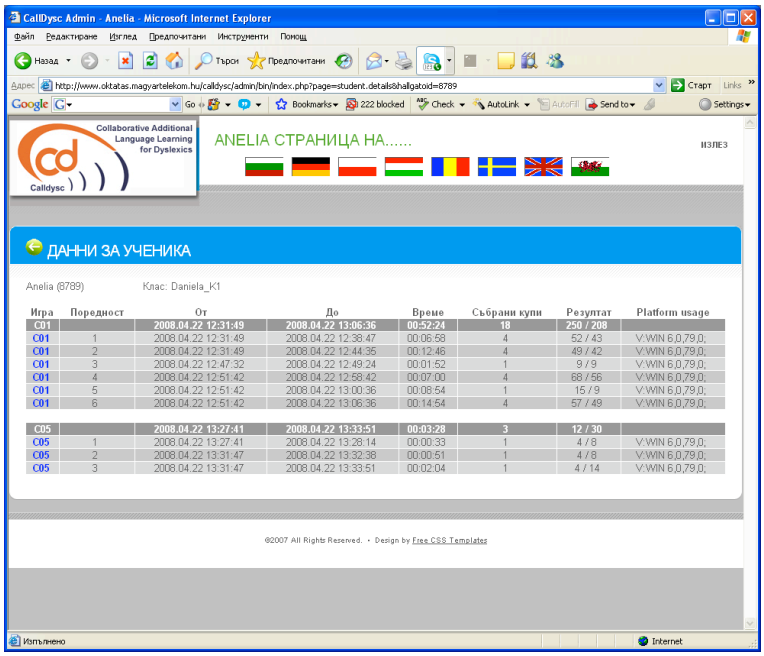


Figure 5: Calldysc LMS Student results overview

In the advanced data level, the student is able to see each and every response made by the pupil. In Figure 6, responses and errors of the student are shown.

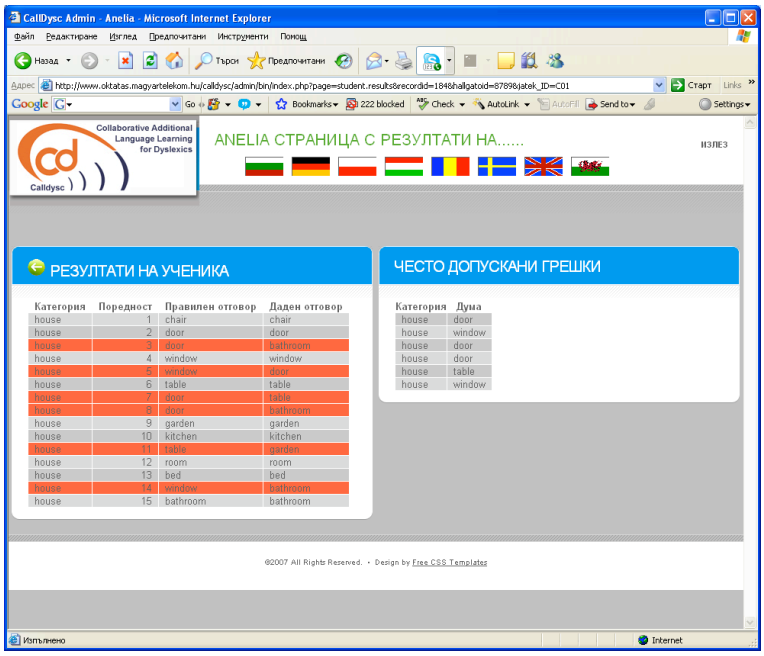


Figure 6: Calldysc Individual games result

Summary

When the development strategy was formulated in 2006, it was difficult to choose a unified platform to the applications. End devices (smart phones) to support different modern platforms were relatively expensive. At the end of the project, in 2009 we can see that our choice to the Flash Lite technology was a good solution, as it is supported by many new mobile phones and even a newer version came out. Not only Flash Lite 2.0 is widespread now, new mobile phones are offered with Flash Lite 3.x version that makes the creation of multimedia application even easier, both on mobile devices and desktop computers. Prices of these new end devices are also more affordable now than it was in 2006.

Although Java solutions are theoretically supported on more mobile phones, recommendations on network and multimedia operations are carried out in vary different forms in different mobile phone types. Java platforms available in 2006 e.g. did not support vector graphic forms of pictures and handling mp3 files were also problematic. Using Java for development would offer the advantage of unified object-oriented programming, still development of desktop and mobile phone applications demand a completely different approach that would not allow simultaneous development of web based mobile phone gaming applications.

Flash technology on the other hand, if development standards are followed strictly, can be used for a variety of different multimedia platforms without having to make adjustments. This enables us to concentrate on pedagogical considerations instead of technological ones when designing mobile game based learning.

Soon end devices with Android operating system will be available that could greatly enhance development of multimedia applications to mobile devices, as features offered by these devices will be more and more easy to exploited, such as 3G browsing or video podcasting.

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Appendix 1 – Phone usage

During the project we developed for the following end devices and platforms: N70, N95, PSP, HTC-MDA, Symbian S60, S60v2, Linux, Mac, Windows and various Flash players. The survey of technology currently used by participants, collected as part of the pre-test questionnaire, revealed the following usage:

- LG 2.6%
- Motorola 6.7%
- Nokia 39.4%
- Philipps 0.5%
- Sagum 1.0%
- Samsung 14.5%
- Siemens 3.1%
- Sony Erikson 32.1%

As we were experimenting with implementing all possible technical features on the mobile devices into teaching activities, we sometimes had to face difficulties due to different levels of sophistication to the end devices, e.g. taking photos with mobile phone cameras and uploading them to a community portal using mobile internet. We could solve this, but did not succeed with creating a simple and truly user friendly interface to this feature.

Appendix 2 – Attitudes

As attitude tests taken with students and teachers clearly shows, both parties are very open and motivated to use this form of learning and explore new possibilities offered by technology.

Students

Over 280 students answered on their attitude towards mobile learning with the following results:

Would you like to use computer games to learn English?

Yes	88%
No	7.5%
Not sure	4.5%

Do you have a phone?

Yes	77%
No	23%

Would you like to use a mobile phone outside the classroom to learn English?

Yes	55%
No	23%
Not sure	22%

Would you like to show your friends the games?

Yes	89%
No	11%

Teachers

More than 90 teachers answered on attitude towards teaching with mobile phone games with the following results:

Do you feel that using computer and mobile games will help these students to learn English?

Yes	92%
No	0%
Not sure	8%

Would you like to use computer games to teach English?

Yes	96%
No	2%
Not sure	2%

Would you like to use your mobile phone to teach English?

Yes	70%
No	12%
Not sure	18%