e-Learning with the GameBoy Advance

Ashley Bennett

www.CreateUK.co.uk/gba

University of Plymouth
School of Computing
BSc (Hons) Multimedia Computing, Final Stage
e-Learning with the GameBoy Advance
Ashley Bennett
May 2004

Contents

Abstract

Portable computing hardware is very popular amongst all of the parties involved in education, which includes the schools, pupils, their parents and the government, but specialised hardware and software development is thin on the ground. Implementations are based mostly on business use models, with laptops and PDA's, but where this new, portable, wireless technology is being used it is shown to be highly effective in motivating children in their learning. The problem arises in the cost of this equipment and who is going to foot the bill. My theory was that many children will already own portable computing hardware in the form of GameBoys and other similar handheld games consoles. These will have been used mainly to trade Pokémon up to this point, but by making greater use of these remarkably powerful machines, not only is a new market opened up to the games hardware and software companies, but a motivating new way to learn is offered to the children, making parent's investment in the 'toy' further justified.

The few organisations trying to push for the use of games technology in education, (such as *Serious Games* and *The Education Arcade*,) have presented their own facts and research to try and convince the gaming development world of the value of the potential products, both in terms of use value to the pupils and schools, and the commercial value in a growing market that they could be gaining from. In general, however, they are looking more at PC games software (such as *America's Army*,) where I was hoping to investigate the feasibility of the use of portable gaming hardware and software developed for it. The aim of this project was to create a new method of teaching and learning content delivery, both in and out of the classroom, using Nintendo's GameBoy Advance (GBA). I was focusing this development towards Key Stage 2, (primary school,) level students whilst outside of the classroom on a field trip to a farm.

In presenting to parents, a school, a farm which hosts field trips, commercial developers and the *Serious Games* and *The Education Arcade* organisations, positive reactions were gained (where responses were received) and work may continue to further develop the content so far provided.

Introduction

That education is important is a given. Next to healthcare it is arguably the most important point in a Government's manifesto. Millions of pounds are promised to schools every year and these schools want to spend it on information and communications technology. Education & Skills Secretary Charles Clarke announced new initiatives for 2004 at BETT that will see ICT transform education saying,

> We have learners enthusiastic in their use of ICT, teachers with increasing levels of skills and confidence and new strategies for learning and teaching. Our challenge is to bring this great resource together with partners, industry and government to deliver an education service fit for the information age.

The Secretary of State has announced that there will be £25 million of additional funding set aside for interactive whiteboards in 2004-2005 alone. So we can see the Government are all for technology in learning. But could we decrease this expenditure by making use of devices that we already own? Most average homes will not contain a laptop or a PDA, especially one that the children in the house are allowed to 'play' with, but many will have a games console, including portable devices such as a GameBoy.

Moore's Law combined with the throw-away society we now live in make this school ICT equipment obsolete in a short period of time. In contrast to this, the video game market moves at a much slower pace, with a new cycle of hardware entering the market in roughly five year intervals. In fact, newer machines are expected to last much longer than this, with the original PlayStation, (in the form of it's miniature re-release, the PSone,) still selling strong today, approaching ten years after initial launch and despite newer, faster consoles being available. This belief of 'not using the most powerful machines is a pointless exercise' within the IT world needs to be reassessed. If it works for the games industry, why can't it work in the classroom and beyond? And if the game console is an exception and not the rule, then why not get the games console into the classroom? The technology should be transparent and the focus should be on the curriculum. The equipment itself is not the focus of ICT use in schools, the learning outcome is and the lack of dedicated software and learning content is the stumbling block.

In taking on this project I was hoping to add a greater use value to devices already found in the average home for their owners. Having already worked on projects utilising WAP mobile Internet sites and mobile phone games, I was specifically looking at portable devices, such as mobile phones, PDA's and handheld games. My aim for this project was to look at ICT use in schools now, and investigate the potential for the use of portable games hardware, or other common household electronics in place of current schemes for providing young children with PDA's or similar devices. Once proven, the objectives I set myself for the project included:

- A working Alpha showing at least one learning type running on the GBA hardware, along with a ROM file for use with emulators (for reviewing on PC hardware) - For this I have created ROMs demonstrating an interactive lesson, an animation explaining a concept, an example of a tool, (a calculator,) and some further ROMs for explaining the project.
- Possibly some promotional material for the software, such as a website, CD-ROM or video - A QuickTime video explaining the project was produced.

- A critical look at interface design in handheld games - I have produced a document examining how various game titles for the GBA make effective use of the small display area in getting information across to the user. The limited controls are also taken into account. With this information I could then attempt to create an effective environment in the software that I created, which I compared to the games in terms of layout and presentation.
- Look at current technology and its use in schools – Another paper was written asking questions such as "Are schools interested in using new technologies and how are they implemented, both logistically and financially? Also, what are the views of the government and the tech industry on providing schools with equipment for learning?"
- Try and get some industry and development community opinions on the project - For this I tried to contact many different people and organisations, including professional GBA developers, GBA development websites, educational software organisations, speakers at major computer trade shows and schools.

In a final commercial product, I would expect functionality to include actions such as reading teacher handouts or notes, watching animations and videos, listening to sound clips, having a guide when moving outside of the classroom, taking part in virtual practical experiments and to work as a tool kit (e.g. a calculator, possibly a notepad etc.)

Proving The Potential Of The Hardware

After researching the current use of technology in the primary school classroom and weighing up the pro's and con's of the different types of potential formats I could have developed for, (laptop, tablet, PDA, mobile/ smart phone etc.) the GBA stood out as a good choice, for reasons further explained below.

Findings have indicated that as yet, few schools have implemented the use of palm-sized devices with pupils, however, some schools are using them very effectively. The most recent devices, such as Pocket PC's are still considered too expensive and are often more than over powered for the needs of young children. But by using older/ cheaper/ less powerful portable machines the emphasis is taken away from the ICT and is kept with the main concerns of a lesson.

> Like textbooks, maps, a protractor or a pair of compasses, it is just another resource to draw on (though an immensely powerful and multitalented one). The technology becomes transparent, restoring the emphasis on subject content, curriculum context and skills development. (Perry, 2002)

In March 2003 the first detailed report from a project evaluating the use of PDA's in schools was published. This project, which Becta is managing for the DfES, began in April 2002 with 27 schools using Compaq iPaqs in lessons, and has been expanding from there.

In Becta's research, the characteristics of PDA's that met universal approval by schools included:

- Small size – always with you
- Instant-on (no waiting for an operating system to 'boot up')
- Much longer battery life than laptops
- The price advantage over laptops.

Conversely, the following possible weaknesses were identified:

- Not rugged enough for school use
- Lack of print-out capability
- The time it takes to input data (especially free text)
- The necessity to charge batteries every night
- Costs of software and accessories

While printing is not going to happen and typing out an essay would not be a task to attempt on the GBA, we are not trying to totally replace traditional IT lessons in a computer suite. But by using a device such as the GameBoy Advance for portable learning, I believe that a lot of the problems identified by schools and many concerns raised about funding and safety, (a child carrying a £200-£400 PDA could be a target for thieves,) can be acknowledged. Here are some of the benefits of using the GBA within education:

- Low cost of the device – £80 for the GBA SP compared to double that for an entry level, or £400+ for the latest, PDA.
- Easy to supply – many children already own the console. Families are happy to supply them, taking the burden away from the school and government budget.

- Software is cheap – Around £30, (if the software were developed!)
- Children see the device as a toy – the technology is transparent as well as the learning, making the experience fun for pupils who will gain more from lessons they are involved in.
- A robust device – the GBA was designed to survive the knocks a child inevitably gives it throughout its life.
- Less of a target for thieves – being a common item, potential theft should be kept down.
- Long battery life - for a laptop, about an hour and a half is realistic, where a palmtop or handheld PC is likely to last a school day. Smaller devices such as mobile phones or handheld games consoles have much longer battery life which may last a school week. In research, more complaints were received from schools about the difficulty of keeping batteries charged than any other issue.

Making a 'toy' into a more useful and educational 'tool' is pleasing for the parents, useful for the schools, cheaper for the Government and will hopefully help to better educate the pupils using it. Providing a new focus for the hardware is also beneficial to the games development community. Opening up a potentially huge market to the video games industry, which has been a difficult place to work in recently for the smaller developer, means that expensive development time is made more profitable and more productive. Work on a game that gets cancelled, for example, could be put to use in educational software. Profit from and development for games could fund and enrich educational development and vice versa. The same could be true of hardware. The Nokia n-gage, a handheld games console combined with a mobile phone, has failed to so far capture the imaginations of many gamers, but could it succeed as a wireless device in the classroom? The upcoming Gametrac is another similar device which subsidises software with advertising. It also has a GPS unit in it to track where a user is, (good for concerned parents, and also useful for developers for implementing software which takes your position into account,) a GSM unit for sending and receiving SMS and MMS messages, (which is how advertising comes through) though not phone calls, (which again keeps the thieves at bay,) and it handles media playback. I'm sure Gametrac Europe Ltd. would love to have a great launch pad for getting a large install base by targeting schools to help sell their products, which then brings other developers onboard to support it by making games and other software, further heightening popularity of the hardware. There is money to be made:

> I'd like to (and I think we can) be able to define this area as a $100M market inside of the next five years, and I think we can define it as a $1B market inside 10. It may even prove much bigger.
> *Ben Sawyer, Serious Games*

palmOne, the now separate hardware arm of the Palm handheld device company, have been doing their own trials in education. By helping schools implement the use of their handhelds, both logistically and in terms of how to make use of them in lessons in and out of the classroom. This is obviously an excellent strategy for Palm, who can then publicise these activities and show evidence of exemplar use in test institutions. As far as I am aware, there are no similar efforts from games platform manufacturers or software developers. Hardware companies such as Nintendo and Sony, and software publishers such as EA could be missing a trick, and should try and create a better relationship with the education sector.

Games To Teach?

Games are good to teach with as the problems of user interfaces and handling limited controls for input have been addressed already, and immersive and engaging worlds have been created and lived in by millions. And there should be no doubting the power of the repetition element of games as a learning tool. It is a tactic often used in the classroom already, (such as reciting your 2 times table,) but as Ian Hislop, (*Have I got News for You* team captain,) once put it, "your average ten year old can't name 10 countries and their capital cities but can tell you that Charmander evolves into Charmeleon at level 20." While what I have tried to develop is not restricted to being 'games,' there would be game elements involved, and there are still lessons to be learnt from game development when creating engaging interactive content.

There are four main learning styles, of which each person will be most naturally linked to one. They are:

- **Kinesthetic**: Child works best when able to move and do things with large muscles.
- **Tactual**: Child works best when able to feel using small motor muscles and through personal relationships.
- **Visual**: Child works best when able to see, watch, read and view.
- **Auditory**: Child works best when able to hear, speak, discuss and think out loud.

By creating content for a portable device the user can obviously go wherever they want to and still access the software. So those who respond best to kinesthetic teaching should appreciate the freedom to move around while learning. Children who react best to tactual lessons will hopefully enjoy the use of a GameBoy, especially if link-up titles (where 2 or more GameBoys are linked together, either with a wire or wirelessly, to interact with each other) were a part of the package. Visual learners will be stimulated by the graphics and the auditory children can listen to the voiceovers and sound effects, and may also benefit from link-up content. Obviously these features are not exclusively beneficial to each group, but it is important that each learning type is addressed to create effective learning amongst a large class of pupils.

Speaking To Those Who Know

In order to gauge reception to my research and theories, I attempted to contact parents and their children, a school, a farm which hosts field trips, commercial developers and the *Serious Games* and *The Education Arcade* organisations. Both of these groups held shows as part of the two major computer and video games trade shows this year, with the *Serious Games Summit* at the *Game Developers Conference 2004* and *The Education Arcade* at the *Electronic Entertainment Expo 2004*. In general, however, they are looking more at games software such as *America's Army*, a first-person PC game considered a rudimentary training program, (and more importantly an advertising tool,) for the US Army. Unfortunately I could not attend these events in California, despite an offer from *The Education Arcade* of entry to the conference, however they are clearly willing to listen to anyone who may have an input to the movement. Getting a positive reaction from an industry group such as this was a great boost.

I have also seen that parents are keen to encourage use of ICT, understanding that it is now vitally important for future use in the workplace. Games are understood to be a good form of entertainment for their children but concerns have be raised at the amount of time exposed to 'mindless shoot-em-ups' and the like. In one such example of this, I received an email whilst researching this project from a parent of a gamer:

> I think you have a very good idea on your hands with the educational GBA. My 7-year old son has one and he plays with it for hours, but with adventures and shoot-em-ups. I am sure he would benefit form some educational content and his mother would be a lot happier with him using it.
> *Mark Baker*

Another student researching e-Learning on the GBA, Anders Lestander from Sweden, also contacted me, highlighting many of the same benefits as myself of the GBA over a PDA. He was toying with the idea of text input, and was looking at developing a system similar to the T9 fast text input found on mobile phones.

Tony Savon and Alex Marshall are two developers that have managed to get separate personal projects based on GBA video codecs turned into commercial products. I managed to speak to them both about their individual efforts and again, they were interested in what I was doing. The fact that big developers do take notice of what the 'homebrew' scene is working on is also very encouraging.

The schools and farms I contacted were willing to talk about the technology they currently used, but were unable to suitably comment on the use of GBA's on a school trip.

Overall, positive reactions were gained where responses were received and work may continue to further develop the content so far provided.

Summary Of Learning

When looking at the project's relationship to the Multimedia Computing degree and the skills I have developed over the past 3 years there is a tight fit. I have been:

- Using knowledge learnt from modules relating to programming, such as Introduction to Java, and Object Oriented Programming in C++.
- Using skills from modules promoting object oriented programming, including Advanced Scripting and Programming for Entertainment Systems.
- Using knowledge gained from the Multimedia Workshop modules in dealing with various media types, including audio and video.
- Using lessons learnt from the Teaching & Learning and Human-Computer Interaction modules in constructing the content and interaction / interface.
- Using my own knowledge of the computer and video games market, as well as any learnt on modules such as Multimedia Entertainment Systems.
- Using my own knowledge of the media business including the movies and music industries, as well as any learnt on modules such as Media Business Systems, Media Industry and New Media Practices.

The project involved a substantial amount of background work from myself, and I have learnt some valuable new skills in the process. Some of the tasks involved:

- Learning to program in C / C++.
- Learning the specifics of GBA development - Including equipping myself with a Flash Cart for using my ROMs on actual GBA hardware.
- Learning about various audio / video codec’s, how they work, and how to port them to the GBA architecture, if possible - The project was initially going to be more of a 'media player' for more generic use.
- Finding out about the target audience, market share and demographics - How many GBA's are out there, and is this a viable market?
- Finding out what is taught to children and how it is currently done at Key Stage 2 - Not just curriculum content, or even lesson plans, but also what technology is available and how it is currently used in schools.

If I were to continue working on this project, or others were looking at producing similar work, I would recommend trying to produce more demos of content to present to developers who may be interested in picking up the product.

Conclusion

I feel that this project critically examines the way in which we approach content delivery in this evolving information age. I have attempted to show through this production that by utilising untapped resources that people will already have in their homes, a unique message can be put across and a new audience and expanded market reached. Through my research I have found that manufacturers or developers of games consoles or other electronics devices see themselves, possibly wrongly, as the owners of these products, not just providing a stage for others. This opinion of ownership of these kinds of devices that can be used for delivery of this sort of content is harming the consumer by restricting what can be released on them. Nintendo in particular is incredibly protective of its hardware.

Despite the advantages in gaming hardware over some more traditional portable computing, the lack of interest from the games industry is staggering. The final hurdle is getting the educational software produced. Games development companies need to be shown evidence, such as that presented at *The Education Arcade* event at *E3 2004*, to understand the vast amounts of money that is potentially there for the taking, which is usually the driving force of business. Perhaps just as important is convincing hardware manufacturers to 'open up' their hardware for easier 'homebrew' development. Huge communities are created around all sorts of devices these days, including games consoles and MP3 players as well as PDA's, all trying to develop software and increase functionality for them. All this despite having to, essentially, reverse engineer these products. Great results have been achieved, but these people are still often seen as a bad thing, as hackers, especially by the games hardware manufacturers. They need to realise that there are some very talented people willing to work for free. Not only that but they are going to do it without the manufacturers help, with great success. Imagine what could happen if they were given just a little support. Be it an API, some tools or just some technical documentation, I'm sure some amazing results could be achieved.

References

Bibliography

Designing and Evaluating the User Interface: Make your Design User Seductive
Charm, Orrin March 1996, Home Automation & Building Control

intouch! January 2004
Department for Education in Schools

RM plc Interim Results - Six months ended 31st March 2003
Greig, Mike 2003

Effective Affective User Interface Design in Games
Johnson, Daniel and Wiles, Janet

User Interface Design for Games
Kieras, David, University of Michigan

Use of Computer and Video Games in the Classroom
Kirriemuir, John 2003, University of Bristol

Físchlár on a PDA: Handheld User Interface Design to a Video Indexing, Browsing and Playback System
Lee, Hyowon, Smeaton, Alan F., Murphy, Noel, O'Connor, Noel and Marlow, Seán, Dublin University

The Digital Disconnect: The Widening Gap Between Internet Savvy Students and their Schools
Levin, Douglas and Arafeh, Sousan 2002, Pew Internet & American Life Project

Wireless Networking in Schools: A Decision Making Guide for School Leaders
Perry, David 2002, Becta ICT Research

Handheld Computers (PDAs) in Schools
Perry, David 2003, Becta ICT Research

ADL/SCORM – What Does it Mean for Developers of ICT Projects?
Rehak, Daniel R. 2002, Carnigie Mellon University, Pittsburg PA.

Applying Video Game Interaction Design to Business Performance - Round 2
Shirinian, Ara and Dickelman, Erik NOV/DEC 2002, Performance Improvement, Volume 41 Number 10

Exemplar Primary School Design: Suburban Site
Walters & Cohen Architects 2003

Netography

http://www.createuk.co.uk/gba/bookmarks.htm

Companies and Government
http://www.dfes.gov.uk
http://www.becta.org.uk
http://www.gametrac.com
http://www.nintendo.com
http://www.playstation.com
http://www.palm.com

Studies, Papers and Statistics
http://www.gamestudies.org
http://www.gamedev.net/reference/articles/article1942.asp
http://www.gamesindustry.biz
http://www.mcvuk.com
http://www.chart-track.com
http://www.elspa.com
http://www.becta.org.uk/research/research.cfm?section=1&id=541
http://www.teachernet.gov.uk/management/resourcesfinanceandbuilding/funding/bsf/

Development Community
http://devrs.com/gba/
http://www.gbadev.org/
http://forum.gbadev.org/
http://www.rllmukforum.com/index.php?showtopic=39065
http://www.seriousgames.org/wiki/index.php?page=SeriousGameResources
http://www.gbajunkie.co.uk/
http://jharbour.com/gameboy/
http://www.thepernproject.com/index2.htm

Education Resources
http://www.elspa.com/about/education/gamesineducation.asp
http://www.dfes.gov.uk/ictinschools
http://www.sln.org.uk/green/nav28.htm
http://www.atschool.co.uk/keystage2/default.asp
http://www.bbc.co.uk/learning/
http://www.bbc.co.uk/schools/
http://www.blueyonder.co.uk/blueyonder/getContent.jspx?page=edu_revision
http://www.nc.uk.net
http://www.teachernet.gov.uk

Conferences, Shows and Contacts

Discourse Power and Resistance ……... http://www2.plymouth.ac.uk/conf/dpr/
Game Developers Conference 2004 ……. http://www.gdconf.com
Game Developers Conference 2004 - Serious Games Summit
……...… http://www.gdconf.com/conference/seriousgames.htm
Serious Games ……..……... http://www.seriousgames.org
E3 2004 ……. http://www.e3expo.com
The Education Arcade - The Future of Videogames in Education
…….…. http://www.educationarcade.org
South Penquite Farm …….. http://www.southpenquite.co.uk/schools.html
Upminster Junior School ……. http://www.upminster-jun.havering.sch.uk