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The effectiveness of Podcasts when used in a Fifth Year Higher Leaving Certificate Mathematics class and a Junior Certificate Learning Support class.

Dissertation

National College of Ireland

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I hereby certify that this material, which I now submit for assessment of the programme of study leading to the award of Master of Science in Learning Technologies is entirely my own work and has not been taken from the work of others save and to the extent that such work has been citied and acknowledged within the text of my work.

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Abstract

This is an action research study focussing on Second level schools in Ireland. The research is carried out in two separate schools, one a Fifth Year Leaving Certificate higher mathematics class (senior class), and a Junior Certificate learning support class (junior class). The aim of the research is to see if podcasts can improve the learning and motivation of the students.

Podcasts were made available to the senior class and students completed a research diary each time they listened to the podcasts. The diary noted any changes in student behaviour during the study. The areas focussed on were, study patterns, cognitive learning outcomes and the students' motivation and "learning to learn". Learning preferences were studied to see if the use of podcasts were associated with aural learning styles.

The study of the Junior Certificate class focussed on the students themselves creating podcasts. There were various levels of literacy difficulties in the class. The students' motivation was monitored by questionnaire based on Keller's ARCS motivational model. The results of their work both written and a podcast was assessed using rubrics to see if there were any differences in quality and content. Teacher logs were use to get teachers views of the study and its effects.

The results show podcasts had little effect on motivation of the senior class but cognitive outcomes of podcasts as a study resource and as a source for consolidation was considered good. The study helped to highlight problems with the use podcasts in the current Leaving Certificate system.

The junior study found that creating podcasts have significant motivational appeal and the use of podcast substantially helped students with literacy difficulties. The study was very positive in many respects and podcasts will continue to be used by the teachers with this class. Modifications on their use will be made to suite the circumstances on an ongoing basis.

Introduction

The researcher is currently working in St Tiernan's Community School, Ballally, Dublin 16. He has been teaching for three years and prior to that worked in industry developing e-learning products for a large e-learning company. He feels that Information and Communications Technologies (ICT) can offer great opportunities and provide a richer and broader learning experience in the classroom. This research project is aimed at trying to identify possible opportunities, through the use of podcasts to enable greater use of ICT in the classroom.

The researcher feels that educators must look to ICT to enhance teaching and learning. As McFarlane (1997) argues it is when the excitement, wonder and empowerment of children is harnessed and focused by informed practitioners, the intellectual development it facilitates is worth the initial angst. The author agrees and feels that the positive features of the new technologies must be harnessed and systems must take advantage of the social features such as collaboration and communication that ICT can offer to enable greater empowerment of students.

In Ireland and in all developed countries the rise of the Internet, ICT and the communications revolution has focussed interest on using ICT tools to teach and broaden the whole learning experience. As pointed out by Prensky, ICT is ubiquitous in the modern world and children of today are digital natives and teachers are digital immigrants Prensky, M. (2004).

According to Levin, D. & Arafeh. S, (2005), in a recent study in the US many schools and teachers have not yet recognized—much less responded to—the new ways students communicate and access information over the Internet.

The researcher looked at a number of possible solutions to the problem and focused his research specifically on Podcasting.

The word "Podcasting" comes from broadcast and Apple Computers MP3 player the iPod. Podcasting is the process of recording digital audio and posting that audio on a

website or blog in a data structure called an RSS 2.0 feed. RSS is an agreed XML specification and XML tags. This feed can then be subscribed to and downloaded to a subscriber's computer and MP3 player using special feed readers which download the feeds automatically when they are available or uploaded by the producer or author in a similar way to downloading music files.

Podcasting is a relatively new technology but it would be easy for Internet savvy students, "digital natives" who already download music files, to accept and begin using. Because handheld devices are used to communicate and share files the researcher feels podcasting could also be used to bridge the digital disconnect which is emerging between schools and students.

The researcher wanted to see the impact on the cognitive learning outcomes and motivation and learning to learn on the students, if podcasts were made available to a second level class who had access to ICT facilities at home and had access to MP3 devices The researched was influenced by the developments in the third level sector in the United States such as Duke University and Georgia College and also nearer to home, the Sligo Institute of Technology in Ireland who make podcasts containing tuition material available to their students. The research wanted to look at the feasibility of such a system for a teacher with limited ICT resources.

The researcher works with students in learning support classes and feels that podcast could play a role here too. Many of the students lack motivation and this coupled with dyslexia and other literacy difficulties makes life unnecessarily difficult and challenging for them. The researcher feels using podcasts can help students become more motivated and help them overcome their literacy difficulties. The research will focus on getting the students to develop podcasts instead of writing out material in response to questions. The researcher had two goals (1) to improve motivation in the class and (2) see if the students could benefit from answering questions which did not require them to write down the answers but which allowed them to think about the topic and not be heavily focussed or threatened by the prospect of having to write it down.

Literature Review

In this Chapter it is intended to review relevant literature relating to Information and Communications Technology (ICT) resources in schools. The review will focus on the application of ICT and digital technology with particular reference to podcasting. The study while having international relevance regarding the use of podcasting will have particular relevance with respect to the current situation in Ireland

The review will look at the current ICT infrastructure in Irish schools and outline the problems faced with the implementation of ICT from a motivational perspective. An examination of the ICT trends affecting education will be carried out and the evolving technology of podcasting will be discussed in detail. The discussion will describe what podcasting is and how it is being used around the world. It will identify what podcasting offers education and discuss the pedagogical implications of ICT and podcasting.

ICT in Schools

In the world of education today the effect that ICT and the Internet are having on the daily lives of students and teachers and the value of these technologies as an education resource is being more and more appreciated. Pedagogies must change to take account of this. This has been pointed out by experts like Tapscott (1997) and the National Council for Curriculum Assessment (NCCA) in Ireland. (NCCA, 2004).

Given that the need for change has been identified little has happened in its implementation from a pedagogical perspective. This will be a slow process and possibly cannot be effective until the infrastructure is in place to provide a backbone for such change to occur. Infrastructural development is taking place in Ireland with the planned introduction of broadband to all schools by March 2006. This will coincide with the setting up of a national network for schools and the addition of extra resources for schools and teachers. (Department of Communications, Marine and Natural Resources, 2004).

However it must be realised that having the infrastructure in place will not necessarily be the solution to making the best use of ICT. (Goldstein, 1997) points out that after

decades of government initiatives and academic research in the UK, the use of ICT in teaching and learning was only partially understood by educationalists and is inconsistently practised in schools. After huge investment in schools infrastructure there is strong criticism that not enough rigorous research is being done to support this investment in schools (Lynch, 1999) and that practitioners are not drawing on research evidence when it does exist. (Sutherland et al. 1999).

These problems are exacerbated by feedback from teachers in Ireland. According to the OECD research on student readiness for the technology-rich world (OECD, 2006) Irish secondary school principals report that a shortage of computers has hindered instruction and this problem has increased from 2000 to 2003.

ICT and Motivation for learning

There is mounting evidence from institutions including The British Educational Communications and Technology Agency (Becta) that supports the researchers' intuitive feelings that ICT has a positive impact on student motivation (Becta, 2003). In research by Mosley and Higgins (1999) it was shown that ICT increases student motivation and engagement and led to learning gains in literacy and in numeracy. Duckworth (2001) noted that the Notschool.net e-learning company made a significant contribution to re-engaging 92 disaffected young people aged 14-19.

Jerome Morrissey, Director National Centre for Technology in Education in Ireland (NCTE) believes that students will access ICT from home more and that this pattern of access will increase as the trends indicate that computing is getting more ubiquitous and because the intuitive nature of new ICT devices allows young people to instantly adapt them to their personal needs. He goes on to point out that while the OECD report also stated that Irish students were among the least positive in their attitudes towards computers there is a strong consensus that ICT can bring rich and varied learning resources to the classroom and students. ICT is an essential toolkit that allows schools to tailor learning experiences to the individual needs of students and ICT can help provide motivational learning experiences to students. (Morrissey, 2006)

The OECD report (2006) pointed out that while access to computers by students is more universal at school than at home students use computers more at home than they

do at school. This is corroborated by the National Centre for Technology in Education's web site, http://www.Scoilnet.ie, which reports high usage after school and at weekends. They claim this confirms the fact that students are using computers outside school hours for learning materials and general educational purposes.

Other research points to the differences between computer usage at home and at school. These studies have identified significantly higher frequencies of computer use in the home than in the school, and cite different approaches to learning and usage of computers and ICT-related activities in the home compared to school. They indicate that this may be challenging for teachers from a motivational perspective as students with high computer usage at home may have high expectations and may even take on a teacher role for their peers. (Sefton-Green 1998; Downes 1999; Kerawalla & Crook 2002; Somekh et al. 2002; Facer et al. 2003; Holloway & Valentine 2003).

A "digital disconnect" described by Levin & Arafeh (2005) in their research for the Pew Institute in the US shows that schools and their teachers are becoming disconnected from the students and this is preventing students from maximizing the motivational potential and educational value of ICT for classroom work.

Studies have also shown that inequalities are emerging outside the school in respect of students access to and use of ICT. Socio-economic status (Rudd, 2002), social networks (Facer 2002), age (Colley & Comber 2003) and more prominently gender (Harris 1999; Volman & van Eck 2001; Rudd 2002, Colley et al. 1994) have been identified as important areas where young people's access to and use of computers is played out in the home.

From a socio-economic perspective also there is evidence of the effects of the "digital divide" outlined by Kent & Facer (2004) who suggest that students who have access to computers at home use the computers in school for a wider variety of activities than those who do not have a computer at home. Others studies have also evidenced this Somekh et al (2002); Rudd (2002) and Selwyn (2002) all show similar findings.

The problems faced by teachers can be added to by creativity overload where teachers are constantly trying to come up with new ideas. The deployment of ICT can

introduce material that is visually and auditory engaging. However, as with any task, if it is too easy or too difficult, or even overused motivation will decrease (Cox 1997).

As we can see change is happening at an unprecedented rate in ICT and educationalists are finding it difficult to cope on a number of fronts. However, new trends may go some way towards solving some of these problems and these are discussed next.

Trends and Emerging Technologies

Trying to identify what technology will impact on the future of education is difficult to predict. However, when looking at technologies which can support education the task is made slightly easier. There is considerable support in the literature that emphasises the following trends and emerging technologies as outlined by Millea, Green & Putland (2005) and The Horizon Report (2006).

Mobility

There is a growth in 'Always on' devices and they are becoming more compact and portable. This is complemented by the increases in availability and accessibility of wireless high-speed broadband. This trend is growing in the consumer arena and is beginning to be felt in education as well. The ubiquity of these devices has enabled personal broadcasting (podcasting and vblogging) to take off almost overnight, and that is just the first wave of broadband content that will be ported to these devices, especially phones, in the next few years.

Interoperability

More and more devices, systems and programs are being developed to communicate and transfer data seamlessly with each other and over the Internet. As the tools have matured, the practice of online communication and collaboration has increased. This trend is at the heart of social computing and is driving personal broadcasting as well.

Convergence

Devices which originally performed just one function are now performing many functions for example, the convergence of functionality between mobile phones, PDAs and media players.

Divergence

Smaller, more portable devices for example, tablet PCs, PDA's or MP3 players are used more regularly for storing and accessing data while higher functioning devices such as high-end PCs are used for tasks that are less frequently required like printing or running large applications or burning DVDs.

Integration

Increasing availability of interfaces and devices which are customisable to suit the way in which the user organizes their world. Consumers are increasingly expecting individualized services, tools, and experiences, and open access to media, knowledge, information, and learning. The demand for personalized content is growing.

Richness of Content

Richness of content is growing. This is the ability to manage, store, and search large files and to transfer, update and combine and recombine content. It's also being able to analyse and deal with constantly changing, large and different data sets.

Security

Increased digitization creates high requirements for security and protection of sensitive data and personal data. Trusted providers of such security will be come more important.

Creativity, interactivity, and collaboration

Easy to use tools will become available that enable anyone to publish on the web in a range of formats and media, the opportunity to support creativity, interactivity and collaboration will be greater, and the means to participate, either synchronously or asynchronously, will be more varied. A renewed emphasis on collaborative learning is leading to an exploration of the science of gaming, context-aware environments and devices, and their application for teaching and learning.

Open source

Open source programs are alternatives to proprietary software, reducing some of the current software monopolies and placing pressure on proprietary pricing structures.

The effect should help to push down the outright price of software, and to shift the cost emphasis from purchase only to service and implementation packages.

These trends point to technologies which are achieving mass appeal outside of school and could easily be incorporated into the teaching environment.

The Podcasting Trend

One of the technologies to watch, identified by the Horizon Report (2006), is Personal Broadcasting. This technology has its roots in text-based media (personal websites and blogs). The report sees personal broadcasting of audio and video material is a natural outgrowth of a popular trend made possible by increasingly more capable portable tools. From podcasting to video blogging (vblogging), personal broadcasting is already impacting campuses and museum audiences significantly.

"Not since the advent of the World Wide Web has such an easy and exciting communications medium been within reach of the masses. Podcasting offers educators and students remarkable opportunities for their voices to be heard in their local communities or around the world. One could think of podcasting as blogging without writing or as a way for every class to have its own radio station." (Stager, 2005).

What is a Podcast?

The word "podcasting" comes from the amalgamation of the word broadcasting and the name of the popular MP3 player from Apple Computer called the "iPod". This does not mean that an iPod is necessary to listen to a podcast. In fact podcasts can be used with a variety of digital audio formats and play on almost any MP3 player or portable digital audio device - as well as any brand of desktop computer or laptop. Podcasts have been described as an online radio broadcasts which can be produced by an amateur at very little cost. The audience is the online world and anyone who is aware of its availability and has the technology to listen.

Podcasting is the process of capturing an audio event, song, speech, or mix of sounds and then posting that digital sound object to a Web site or "blog". Podcasts are generally associated with a data structure called an RSS envelope (or "feed"). RSS

stands for Real Simple Syndication and is an agreed specification of XML tags used to define objects which can be subscribed to through an "RSS news reader" which is also called an aggregator. Aggregators reduce the time and effort needed to regularly check websites of interest for updates. An aggregator is able to subscribe to a feed, check for new content at user-determined intervals, and retrieve the content. Using aggregators like iPodder or iPodderX, users can subscribe to a Web page containing RSS tagged audio files on designated web pages and automatically download these files directly into an audio management program on their personal computer like iTunes, Windows Media Player or MusicMatch. Then when a user synchronizes their portable audio device or MP3 player with their personal computer the podcasts are automatically transferred to that device to be listened to at the time and location most convenient for the user (Meng, 2005).

It is not necessary to use an aggregator to download the audio files in many cases the user may just play the audio from the Web site or blog one on their PC or laptop.

Podcasts are rapidly increasing in popularity because they are simple to produce and very inexpensive to deliver. At its simplest, all that is required to create a podcast is a personal computer with a sound card, an inexpensive or built-in microphone, sound editing free ware, and an internet connection with access to a Web site. Because of the low cost of entry, anyone can be a publisher, or more accurately a broadcaster with their own "radio" show. This can apply to teachers and students as well.

Why has podcasting become popular?

John Udell (March 2005) persuasively identified five major factors behind the explosive growth of podcasting and rich media authoring in general:

- Internet activity is pervasive.
- Broadband has grown very rapidly, which makes it far easier to "consume large media objects."
- The multimedia personal computer can "more or less be taken for granted."
- The distinction between streaming and downloading of media content has begun to blur. People can now have the experience of streaming while enjoying the simplicity of downloading a file.

- Finally, there is the iPod phenomenon and "the rapid adoption of portable MP3 playback devices" up to eleven million devices in the United States alone. Udell calls the portable audio device "the new transistor radio" and points to the beginnings of a "renaissance of creative stuff happening." Because this renaissance coincides with the Creative Commons phenomenon, traditional business models need not constrain the artist's work.

Crofts, et al (2005) see the growth of podcasting as being shaped by a number of social factors:

- Podcasting allows listeners to engage in time–shifting, while providing space independence, *i.e.,* to listen to media at a time and place that is convenient.
- Consumers view traditional radio as having too much advertising.
- Listeners are frustrated with the homogeneous nature of traditional radio programming.
- We are seeing a fragmentation of traditional media from mass broadcasting to media that is tailored to individual needs, i.e., personalized media. This fragmentation is being fueled, in part, by podcasting, a technology that allows individuals to share their expertise and interests with others.

Experiences of Podcasting in Education

The University of Missouri has identified possible uses of podcast (Meng, 2005).

Possible uses of Podcasts	**Prospective users**
Record and distribute news broadcasts	The entire campus community and general public
Students can record and upload their foreign language lessons to their instructor's Web site. The instructor can then listen to the lessons on their MP3 player at their convenience.	Students, instructors
Audio / video recruiting development brochures with personalized Messages.	Prospective students and parents, development and recruiting personnel
Recorded teacher's notes	Student, teachers
Recorded lectures distributed directly to student's MP3 players.	Student, teachers
Recorded meeting and conference notes.,	Students, Departments, Admin
Student projects and project support interviews.	Students
Oral history archiving and on-demand	Students, Departments

distribution.	
Sport event distribution.	Students, alumni, and public

Table 1 Possible uses identified for podcasting.

Educators are looking at podcasting as a tool to connect with students. Odvard (2006) believes that educators and students are essentially writing the book on bringing podcasting technology to teaching and learning. The applications of podcasting range from the placing audio updates from administrators on district Web sites, recording class presentations for later review, uploading interviews of community leaders and producing online school radio broadcasts. Several online directories are also available, such as Podcast.net, to bring significant programs to the attention of teachers and their students. He also warns that content of podcasts is unregulated. It is essential to supervise and establish policies for its use in schools.

Podcasts are making it onto the corporate instructional market too with elearning gurus such as Elliot Masie among others focussing more and more on them.

As part of a university initiative to encourage greater use of technology Duke University distributed iPods to 1,600 students entering first-year.. The evaluation focussed on the feasibility and effectiveness of the iPod as a tool for faculty and student academic use. The purpose of the evaluation was to help decision makers identify what iPod uses were most fruitful and to help shape future academic technology initiatives.

As they expected foreign language and music courses incorporated podcasts and the iPod but it was also incorporated to other courses in the humanities and engineering. The audio intensive courses reported increased and deeper student interaction with audio content due to the portability and flexibility of the iPod. The students used the iPod for recording purposes quiet frequently and this was not anticipated.
The iPods were used in five academic areas.

1. Course content desimination from Dukes iPod server. This included lectures, historical speeches, music and foreign languates content.
2. Recording classroom activity
3. Field recording tool ie interviews and field wrok etc.

4. Study support for repeaded listing to various types of audio such as rehersals, audio books, vocabulary lists etc.
5. File storage and transfer. For transferring large multimedia files.

The iPods were widely used by student and faculty and many projects were supported.

The experiences of Duke were not all positive and some are as follows:

There were significant technical difficulties integrating all the different types of technology and storage devices.

There were licensing difficulties for commercial .MP3 audio content and also difficulties getting access to commercial audio content.

There were problems with the devices because synchronization was the only method of inputting data to them. There was limited technology and some recordings were of too poor quality. There was a lack of awareness or accurate knowledge by students about iPod functionality.

From an institutional point of view the impacts were:
Greater co-operation between the technology support groups which gave impetus to greater planning and better infrastructure.
Greater public awareness in college can lead to new partnerships with other institutions.
Greater discussion among college stakeholders and the continuation of the iPod project incorporating other technologies.

A number of other educational institutions around the world are trialling podcasts and iPods with their staff and students and the results are mixed (although more favourable than not). The Education.au (2005) report in a review said that they believe podcasting is an application that has tremendous potential and one that would seem very appropriate in an educational setting.

Duke will continue with its iPod project and have expanded it to include other technologies. (Menzies, D, 2005)

Georgia College and State University (GCSU) has been using iPods for some time and are quite positive about their use and Drexel University's School of Education is also convinced of the value of podcasting (Reed & Brock, 2005). In Ireland the very innovative Sligo Institute of Technology are offering distance education courses incorporating podcasting which is a very exciting initiative. (Greene, 2006)

Not just higher level educational institutions are podcasting. The use of the technology is also implemented across a wide range of junior and second level schools around the world. Educational journalists across the USA and around the world are reporting success stories of schools at all levels adopting podcasting and finding it a very motivating as a teaching tool for students of all ages. For example Todras-Whitehill E in the New York Times outlines the success of Wells Elementary School in New York (August 3rd 2005). Similarly Borja Rhea, R of "Education Week" a popular US teachers' magazine (December 7th 2005) outlines success stories on K-12 students.

The growth has not been just in the US schools in the Europe are also getting in on the act. Jonny Evans (June 20 2005) reports on a school in Scotland that finds podcasting very effective.

Gardner Campbell who is Assistant Vice President for Teaching and Learning Technologies and Professor of English at the University of Maryland, Washington argues that done well, podcasting can reveal to students, faculty, staff, communities and even the world the essential humanity at the heart of higher education. (Campbell, 2005)

Issues which may affect podcasting growth

While there is a lot of positive reporting on the use of iPods in education it is important to also consider some of the more negative aspects. It appears many teaching professionals and also a reasonable percentage of students require support

and training in their use. Some significant issues are outlined in the http://www.educause.edu (2006) blog by Susan Lister. She feels that there is no shortcut to listening to the entire lecture if given on a Podcast. She also points out that podcasts are more suited to auditory learners and may not be as useful to the other variety of learning styles. There is no chance to ask a question right there and then if the student is not picking up what is being said. She predicts the best podcasted lectures will be the ones that are strict information delivery by someone with a dynamic, interesting voice. She believes that recording someone in a lecture hall can be problematic and perhaps a sound studio may be a better place. Having identified the possible problems that podcasting can have she feels the option of podcasted lectures (it's a great plus for auditory learners!) but she fears that, youth being youth, we will see an increase in, what she calls, coursecast learning ie listening to podcasts and not attending lecturers.

Podcasting faces the same issues encountered by multimedia bloggers, as outlined: (Crofts, S. et al. September, 2005) and (Armstrong Moore, 2005).

- defamation and hatespeech: it is inevitable that someone will take offence at words spoken in a podcast and seek legal redress
- censorship of podcasts for breaches of national or local regimes regarding sexual, political or other content.
- intellectual property: podcasting involves dissemination of an existing recording and thus intersects with the intellectual property rights of lyricists or poets, performers, publishers and the entity responsible for the production of that recording. This has implications for lecturers and instructors also as to how do they protect their work.
- Commercial aspects of Podcasting have not yet been fully developed and this is an area which will undoubtly grow as the medium becomes more popular.

Podcasts for Students with learning difficulties

The emerging technologies such as podcasts can also reduce the digital divide, for example groups with particular learning difficulties can be assisted through access to learning activities which suit them (Millea, Green & Putland, 2005). These groups include a wide variety of students - from the student who may be visually impaired to

dyslexic students for example. For these children audio books and tapes can play a significant role in teaching and are an enormous benefit. Podcasts can also fill this role and perhaps be more targeted to individual student or class needs. Evidence now supports the importance of oral language as a foundation, and an ongoing support, for the development of reading and writing skills. Dorothy S. Strickland and Timothy Shanahan (2004) argue that the development of oral language skills is facilitated when children have many opportunities to use language in interactions with adults and with one another. Oral language skills are strengthened when children:

- interact with others, both one-on-one and in groups;
- engage in frequent, extended conversations with adults;
- listen and respond to stories read and told to them.

These activities enable children to describe events, build background knowledge, and enhance their vocabulary.

What has not yet been fully understood is that computer-based technologies can be powerful pedagogical tools – not just rich sources of information, but extensions of human capabilities and contexts for social interactions that support learning. The process of using technology to improve learning is never solely a technical matter, concerned only with properties of educational hardware and software. Like a textbook or any other cultural object, technology resources for education function in a social environment, for example the tool may help the student organise their thoughts more clearly, mediated by learning conversations with peers and teachers (Bransford, Brown, & Cocking, 1999, p. 218). Learning is achieved by using the tool and the type of learning achieved will depend on the flexibility that tool offers. For example a podcast may help overcome writing and spelling difficulties.

Wireless connectivity will allow students and teachers to move from the computer room to the standard classroom and learning can take place in whatever environment is most appropriate for example learning through an activity which is then recorded to a device for later listening, such as a podcast, or viewing through a blog, vlog or photolog, uploaded to an e-Portfolio or shared in a learning management system. Portable devices such as PDAs, MP3 players, Tablet PCs, gaming devices,

navigational (GPS) handhelds, and mobile phones are emerging technologies for education and training that have clear applications and exciting possibilities.

Many students are entering their school or college with multiple literacies that go beyond text. Educators must acknowledge and recognise this trend. These new literacies will strengthen over the coming years and educators must build upon and extend them. The success of such an approach will require that teachers/tutors have access to professional development opportunities to develop confidence in the use of educational technology, as well as informal support environments of peers (Millea, Green & Putland, 2005).

Why Research in Podcasting is needed

Given the current lack of a top-down approach supporting the change in pedagogy and ICT implementation, the researcher believes a ground-up approach can be used by innovative teachers. In the changing world outlined by Prensky (2004) where he states that the students in today's world accept digital technology as a given and almost intuitively understand it. He believes that to get through to these students in a meaningful way digital technology must be used.

It is clear that experimentation and research is necessary to identify the best blend of ICT and instruction in the classroom. The constantly changing technology and new innovations makes it difficult for busy educators to keep up with the changing times. Teachers need to be innovative on the ground and try out new ideas. Given the issues discussed relating to technology, student motivation, the digital disconnect and the proliferation of home PC and personal digital devices, an opportunity may be presenting itself. "If schools want to reach today's learners, they can't ignore it," said Don Knezek, chief executive of the International Society for Technology in Education in the US (Shen, F, October 2005).

Hypothesis / Research Question

The literature shows that there are a number of issues facing education today. While infrastructure is improving all the time, there is still has some way to go. Perhaps more importantly the pedagogies required to take advantage of ICT do not seem to be

in place or are not acted upon. New social and economic issues are also coming to light as outlined by the digital disconnect. The digital technology is constantly changing and perhaps change is happening too fast for the managers to come to terms with it. New technologies are emerging all the time and are adopted by the wider society long before they are accepted in schools. These technologies appear to offer huge benefits and must be experimented with to take full advantage of them. This may have to come from the ground-up by individual teachers and institutions. Research needs to be done in Ireland to see how these technologies affect the particular Irish situation. This research on new technology must highlight the pedagogical changes that managers need to implement to meet the varied needs of our children and make education relevant to in the digital age. This study asks the question can new technologies like podcasting increase motivation and hence improve learning outcomes not just of privileged students but students with learning difficulties also?

This aim of this study is to examine the effect of the introduction of podcasting on two classes. The study examines podcasting from two of the perspectives outlined by Meng above. One is also influenced by what is happening in third level in both the US and Europe which making podcasts available to the students to supplement their educational material. This will assess the learning outcomes of podcasting. The second study looks at students creating podcasts in a learning support class. This is aimed to motivate the students and enhance learning while helping to overcome literacy difficulties experienced by the class.

Research Methodology

Introduction

This chapter will outline the methodology chosen to carryout the research. It will explain why the action research approach was most appropriate for the study. The discussion will follow the steps of a typical action research study. This will involve identifying a problem and the development of a plan to solve the problem. It is followed by the action which was put on place to tackle the perceived problem. Then the methods of observation will be discussed. This chapter will outline the data collection strategies used and the methods of analysis implemented. The reflections stage of action research which focuses on results, changes implemented and ongoing analysis will be discussed in greater detail in the following chapter. The broader study is intended to examine the use of podcasts as a teaching tool and to specifically examine the effects of using podcasts on the motivation and learning of the students.

There are many ways in which podcasts can be applied in teaching but for the purposes of this study and based on the needs and expectations of the teachers it was decided to focus on just two specific options. One option was working with a Fifth Year Class and it involved adding variety to the teaching by providing podcasts for students to supplement their classroom instruction. The effectiveness of podcasts for this purpose will be examined. The second option was working with a Junior Certificate Learning Support class. Here the students created the podcasts themselves. This study looked at the role of podcasts as a motivational and learning aid.

The research will be discussed in two separate studies and the two studies taken together should provide a broader understanding of the merits and possible uses of podcasting as well as the problems encountered from different approaches. It is hoped it will help the teachers involved and teachers in general may get ideas. It may also be useful in highlighting potential challenges that may arise when considering implementing podcasts.

Why Action Research?

Action Research (AR) represents a growing field of educational research whose chief identifying characteristic is the recognition of the pragmatic requirements of educational practitioners for organized reflective inquiry into classroom instruction. AR is an process designed to empower all participants in the educational process (students, instructors and other parties) with the means to improve the practices conducted within the educational experience (Hopkins, 1993). All participants are knowing, active members of the research process.

Action research has been described as an informal, qualitative, formative, subjective, interpretive, reflective and experiential model of inquiry in which all individuals involved in the study are knowing and contributing participants (Hopkins, 1993). This research project uses action research methodology because the primary intent of the researchers is providing a framework for qualitative investigation by teachers and the researcher in a complex analysis of working classroom situations. Both studies are intended to be qualitative analysis and reflections of subjective situations which are fundamental features of the action research methodology described by Hopkins.

Parsons and Brown (2002, p. 158) define action research as "combining research and action to increase understanding and generate change". The two separate studies in this research project focuses on a process where the teachers questioned their practices, decided on a plan of action, recorded the effects of this plan, reflected on it and decided on further action to improve practice. This research project is broadly focussing on changes to practices brought about by the introduction of podcasts which are intended to enhance and bring about change in teaching and learning in two specific scenarios. The effects of the podcasts will be closely examined by both teachers and the researcher in an effort to get a greater understanding of the situation and generate further change where the findings suggest it is necessary for continued improvement.

McNiff et al. suggest this process involves

- A commitment to educational improvement
- A special kind of research question

- Putting the 'I' at the centre of the research
- A special kind of action that is informed, committed and intentional
- Systematic monitoring to generate data
- Authentic descriptions of the data
- Explanations of the action
- New ways of representing research
- Validating claims made as a result of the research
- Making the action research public (McNiff *et al*, 1996, p. 16).

The two studies are aimed at finding how improvement to education can be achieved through the introduction of a specific approach to the application of ICT. The action is informed and intended to bring about change in the teaching practices of both teachers. There is systematic monitoring of the studies using research diaries and questionnaires as well as teacher logs. The data is collected and analysed adhering to the strict guidelines identified by Ebbutt (1983) and Keller (1993). Similar research has not been carried out in Ireland before. The use of different and new technologies in many aspects of the research, SMS messaging, the creation of Web sites and web based research diaries and the new technologies, inspire new ways of representing research. The claims made by the research will be validated by the continued action or change in actions of the use of the technology by the teachers as a result of the studies. Further research will be identified and the findings will be made public. Hopkins (1983) identified the action research framework as the most appropriate for teachers who recognize the existence of shortcomings in their educational activities and who would like to adopt some initial stance in regard to the problem, formulate a plan, carry out an intervention, evaluate the outcomes and develop further strategies in an iterative fashion. This view is also supported by Bell (2001) who says the action research methodology is a workable technique for working classroom teachers. The researcher argues that these points, which broadly adhere to what has been described as an action research process, are supportive of his decision to choose the action research methodology.

The study will aim to feed practical judgment in a concrete situation. The validity of the hypothesis will depend on the usefulness of helping students' motivation and

assisting their learning. It will be a step-by-step process, which will be constantly monitored over a period of time. The study will enable students through their involvement to achieve increased motivation and so learning (Cohen et al, 2003). The feedback will be utilized to modify, change direction or redefine to bring lasting benefit to the ongoing process. As a result the teachers hope to be in a position to make informed decisions on the effectiveness and the appropriate use of podcasts as a teaching tool. They hope to be able to know how to modify their actions as a result of the study or identify areas where further action may be necessary or beneficial to increase motivation and learning.

The Action Research Design

The essentials of the action research design are outlined by Kimmis as the following characteristic cycle:

- Initially an exploratory stance is adopted, where an understanding of a problem is developed and plans are made for some form of intervention strategy. *(The Plan)*
- Then the intervention is carried out. (The *Action*)
- During and around the time of the intervention, pertinent observations are collected in various forms. (*Observation.*)
- The new interventional strategies are carried out, and the cyclic process repeats, continuing until a sufficient understanding of (or implementable solution for) the problem is achieved *(Reflection and Revision).*

The protocol is iterative or cyclical in nature and is intended to foster deeper understanding of the situation, starting with conceptualizing and particularizing the problem and moving through several interventions and evaluations. A representation of an AR protocol by Kemmis is provided in Figure 1.

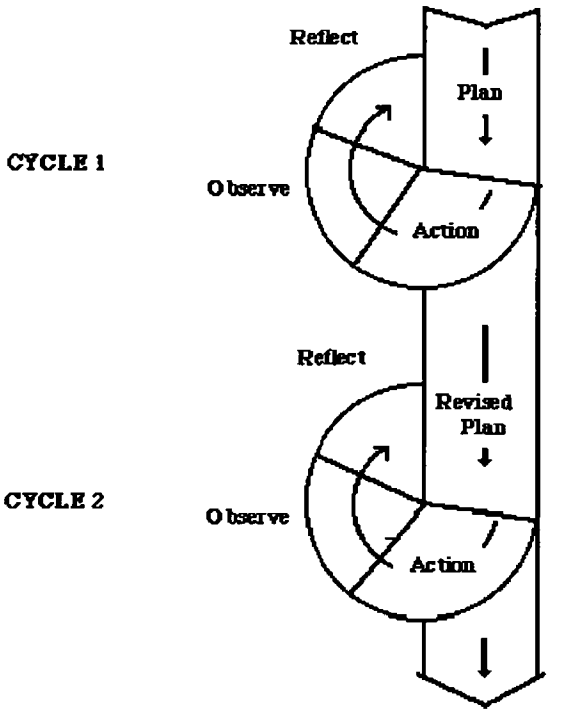

Figure 1: Action Research Protocol outlined by Kemmis

Figure 1 clearly displays the iterative nature of AR along with the major steps of planning, action, observation and reflection before revising the plan. The idea is to close in upon a final goal or outcome by repeated iterations.

Communications and Reflection in Action Research

Kemmis & McTaggart (1990) consider the need for communication between all participants to be of paramount importance. Involvement in the research is of a knowing nature, with no hidden controls or pre-emption of direction by the researcher. In this study all participants including the researcher, the teachers and the students negotiated meaning from the data and contributed to the selection of intervention strategies.

Perhaps the key component involved in action research is the notion of praxis. Action research is intended to be the reflective counterpart of practical diagnosis (Elliott, 1978). Schon (1983) describes the use of reflection to generate models from a body of previous knowledge. These models are used in the research to re-frame the problem;

then experiments are performed to bring about outcomes which are subjected to further analysis. This model (called reflection-in-action) frames means and ends interdependently and recognizes that there is little or no separation of research from practice, little or no separation of knowing and doing. Schon's model of reflection-in-action compliments the iterative and investigative nature of action research carried out.

As mentioned the broader research project consists of two studies both using different approaches to the implementation of podcasts to facilitate change and examine the results from a positive and constructive perspective for each study.

The Research Studies

This section will describe the motivation behind the studies and how the studies were carried out. Each study will be described separately to explain how it adheres to the action research methodology described above. One of the studies involves Leaving Certificate students and is called the "Study One" simply because it was the first study to begin. It focuses on the provision of podcasts for students and examines the effects. The second study "Study Two" refers to the Junior Certificate class. It focuses on the students creating podcasts themselves and examines the effects.

Study One

The aim of the study is to examine the students attitudes to the use of podcasts which were intended to offer variety in the teaching process and so alter levels of motivation and learning achieved in the class as well as assessing podcasts as a revision tool. This study involved a group of thirty two Fifth Year students. The subject they were being taught was Leaving Certificate mathematics higher level. It involved providing pre-prepared podcasts for the students to supplement the material covered in class. The study involved the researcher creating and publishing a website specifically for the research. The researcher also recorded the podcasts and published them on the research site.

The Planning Stage

In this study the teacher concerned identified a need to enrich the learning experience for one of his classes. He wanted to try a new approach with his Fifth Year students which involved the use of information technology. He felt that podcasts could offer greater variety of material and an opportunity to reach his students outside of school hours when they were doing homework or studying. He intended the podcasts to be a source of revision offering student's choice on how they access study material using computers and the Internet at home. The teacher knew his students used computers a lot at home and he wanted to explore this avenue as a further method of providing information for them. He also felt that his students had more variety and exposure to ICT from home than from school and he wanted to take advantage of this. The action research approach was decided on after consultation between the researcher and the teacher concerned. It suited their situation and goals best, because the teacher involved could assess the process as it went along and make adjustments when he felt it necessary.

The study would examine the student's responses and make adjustments to suit student and teacher needs and goals. It focussed on examining the student's attitudes on the use podcasts from a number of perspectives.

It was planned that each Podcasts was roughly of five minutes duration. This allowed for easy matching with what the teacher covered in a class each day (Reed. Brock. 2005). When the Podcasts were created they were uploaded to the companion web site where they could be downloaded as Podcasts by the students. The plan involved making the Podcasts available according as the class dealt with the subject. The teacher felt the students would not get more value from the podcasts after covering the content in the class. The reasoning behind this was that mathematical topics such as complex numbers with the Argand diagram and other symbols would be difficult to interpret in audio alone. Discussion with the teacher also led to the view that the best use of Podcasts was as a revision and study tool (Blaxter, H, C. & Tight, M (1996).

Data Collection

When deciding on the data collection methods on line student diaries were selected. They would be used to collect data on the effects of the podcasts. This approach is in

line with the principles of action research and is the systematic study of attempts to improve educational practise by groups of participants by means of their own practical actions and by means of their own reflection upon the effects of those actions (Ebbutt, 1983). Diary's permitted the examination of reported events and experiences in their natural, spontaneous context, providing information complementary to that obtainable by more traditional designs (Reis 1994). Another advantage of choosing diaries is the dramatic reduction in the likelihood of retrospection, by minimizing the amount of time elapsed between an experience and the account of this experience. This involved the setting up of a website where students logged on daily for the duration of the research.

Shiffman et al. (1997) demonstrated that subjective aggregates have a poorer fit to actual (diary reported) experiences, than do empirical aggregates based on these responses. Thus, one advantage of diary-based data, even for such simple questions, is the reduction in systematic and random sources of measurement error, and with it the increase in validity and reliability. Diary data can be used to generate summary accounts without the biases introduced by retrospection over relatively long periods. In addition to yielding estimates of within-person central tendency, the diary approach can show how much people vary over time in variables of interest.

The burden of repeated queries and responses places substantial demands on the participant. To address this, the design of the diary instruments require that they are short and take several minutes to complete.
(Mohr et al, 2001).

Three broad types of research goals can be achieved using diary designs: (*a*) obtaining reliable person-level information; (*b*) obtaining estimates of within-person change over time, as well as individual differences in such change; and (*c*) conducting a causal analysis of within-person changes and individual differences in these changes. (Searles et al. 2000)

The diary would be a self-observation schedule (called a research diary) and had to be relatively easy to use in terms of clarity, time and effort, and which would be used repeatedly by each participant. It needed to be highly structured and capable of being

completed in a few minutes, possibly after each podcast. (McEuwin, A. McGuinness, C. & Knipe, D. 2001)

The diaries design was planned to fit a HTML form page on a companion web site which the students would access the podcasts from. The web site can be accessed at http://www.schoolspodcasts.com. The web site would facilitate the entries being sent to the researcher when the form was filled in by the student. The researcher created this web site and tested with students in his own school prior to publication.

The Diary questions covered the three areas of interest shown below:

Section one

- Student ID
- Study patterns
- Method used to listen to Podcasts

The aim here was to get personal information about the student and his methods of study as well as how and where he listened to the podcasts.

Section two: Cognitive Outcomes rating 0 to 5

- *Study resource*
- *Vocabulary/terminology*
- *Memorizing*
- *Understanding and analysis*
- *New learning*
- *Consolidation*
- *Own explanation*
- *Mastering skills*
- *Application of skills*

The aim here was to do a cognitive learning assessment which was aimed at the perceived cognitive benefits of podcasting and getting feedback from the students on a scale of 0 to 5 how they felt these benefits were attained.

Section three: Learning to learn rating 0 to 5

- New sources of information
- Planning study
- Independent learning
- Confidence in learning
- Communications

The aim here was to assess if the students took more control of their own ability of Learning to learn and being motivated to learn more. (McEuwin, A. McGuinness, C. & Knipe, D. 2001)

Motivation and learning

The study wanted to access the motivational aspects of podcasts for the class. In doing this a focus on the learning to learn aspects of the diary was considered the best measure. Many studies have illustrated that motivational issues are influenced on instructional outcomes, because they are fundamental to driving the students' performance (Ames, 1992. Alderman & Maher, 1994. Bandura, 1997).

The ARCS motivational model (Keller, 1983, 1987) is widely applied when evaluating motivational strategies because of its applicability and practicability with instructional design processes (Huang & Johnson, 2002). Keller said that learning motivation is affected by four perceptual components: attention, relevance, confidence and satisfaction. Each component plays a critical role in motivating students through the learning process. A brief description of the four components is as follows: (Small, 2000),

Attention refers to the learner's response to instructional stimuli. This could include perception arousal, inquiry arousal, and variability. The researcher argues that the introduction of podcasts as part of the instructional design meets this requirement.

Relevance helps learners associate their prior learning experience with the given instructional material. The podcasts provide this relevance to the students because they contain information which the students covered previously in class.

Confidence stresses to the value of building learners' positive expectations towards the learning task. This question was dealt with specifically in the section 3 of the diary, the learning to learn section.

Satisfaction is intrinsic reinforcement and extrinsic rewards and equity. The ratings given by the students to the various questions and the comments made by the students throughout the study can be interpreted as measuring the students' level of satisfaction with the podcasts.

The researcher felt that Keller's ARCS model can help judge if the motivation of the students was influenced by the introduction of podcasts based on the diary responses.

It was decided that a number of other comparisons be carried out while doing the research. These included a comparison of the students results achievement in a test after podcasts were used with previous tests to see if the study had improved student performance. A comparison of student learning preferences was compared with the feedback from the diaries.

Learning preferences

An analysis of podcasts from a student learning styles perspective was also planned to see if using podcasts suited some students more than others. The researcher looked at a number of learning styles theories and given the resources and time constraints it was decided to use the VARK analysis. The students learning preferences could be assessed by giving a learning styles questionnaire based on the visual, aural, read/write and kinesthetic learning styles. This analysis was based on the VARK analysis web site on the Internet. The results of the VARK test would be compared with the diary data to see if there was any correlations evident (VARK Analysis, 2006).

On completion of the study there would be a period of reflection where the teacher would evaluate how the study went and decide on further action.

Procedure

The teacher wanted to work specifically with that class because he had identified the class beforehand as all having access to the Internet at home. The students needed to have access to audio devices which could download and play MP3 audio files from the Internet. The class were surveyed and found to have the facilities to download and listen to MP3 files from the Internet. Typically the students had and used iPods or MP3 players which are capable of playing downloading MP3 files from their home computers. These facts contributed to the teacher's perception that podcasts could be easily used with the class.

The Diaries

A web site was developed and set up by the researcher, to host the podcasts at http://www.schoolspodcasts.com This site had a number of functions as well as being a point of contact for the students and the researcher. It also hosted the structured diary form which the students would fill out each evening after listening to the podcasts. The information was emailed to the researcher each evening from the site. The site also provided information on podcasting for the teachers and students as well as other online resources relating to mathematics.

The web site also helped validate when the students logged on and who logged on. Having the online resource offered access to respondents who would not or could not participate in person and it offers potential for more candid responses. However it excludes respondents without Internet access.

The study required the researcher and the class teacher to be in daily communications with each other. As the teacher covered class material, podcasts were made available by the researcher on a daily basis to match what was covered in class. The teacher would inform the class of the podcasts and texts were also sent to the students to remind them of the availability of the podcasts. Daily contact with the teacher also helped solve any technical difficulties the students were experiencing from time to time. This regular contact also helped get the teacher's views on how each student performs and whether the student is likely to utilise the material in the podcasts. The teacher also made suggestions on extra material that should be included in the podcasts.

The VARK Study

The VARK analysis aspect of the research involved the students being given a learning styles questionnaire based on the visual, aural, read/write and kinesthetic learning styles. The analysis of the learning styles was carried out by printing the questionnaire from the VARK web site and getting each student to fill out his answers. The researcher using guidelines outlined on the VARK web site assessed the results.

The Examination

A third aspect of analysis involved the students being given an examination. The reasons for this were: (1) Implementing a motivational factor into the research for the students and the see if the students would use Podcasts for study purposes when studying for examinations and examine their views (Keller, 1987). (2) The results of the examination would be compared with the most recent examination results which the students obtained in the same subject to see if there were any significant differences between the two results.

Observing of the action

An iatrical part of the research was the use of a research diary. The Diary is designed to capture the "little experiences" of everyday and change and variability within-students and between students over time. It was felt that diaries would help provide the best information to the teacher and researcher regarding the attitudes of the students over a period of time. The researcher was not working in the school and did not have day-to-day contact with the class. However the researcher used SMS text messages to communicate with the students each day and accessing the students diaries each evening also helped provide qualitative data on the thinking of the students as they used the podcasts over time.

The analysis focuses on cognitive outcomes (e.g. learning vocabulary, terms and methods, understanding, memorizing, consolidating) and learning habits and techniques.

The questions were aimed at trying to identify both cognitive learning outcomes and learning to learning techniques that that student may achieve after using Podcasts. The

students could fill in the diary as often as they liked but this usually happened after listening to Podcasts. After each Podcast the student registered his views and the information was automatically sent to the researcher for data collection and analysis.

The students were also prompted to respond and access the podcasts from SMS text messages which were sent to the students each evening around study time. The study patterns of students became apparent shortly after the study began because they would send in their diary reports and it became apparent the time each individual would finish their mathematics study.

An observation of learning styles was completed in the class and the results compared with the Podcasts ratings.

Observations of the diary results required multilevel analysis as outlined by Raudenbush & Bryk (2002). Multilevel relates to analysis of within person variance and between person variance. Thompson & Bolger (1999).

The observation involved looking at the following:

> Aggregating Over Time: What is the Typical Person Like, and How Much Do People Differ from Each Other?
>
> Modeling the Time Course: How Does a Typical Person Change Over Time, and How Do People Differ in Change Over Time?
>
> Modeling Within-Person Processes: What is the Within-Person Process for the Typical Person, and How Do People Differ in These Processes?

(Bolger & Eckenrode 1991)

The total class size was 32 but a number of students did not respond for reasons which will be outlined later when dealing with reflections. That left under 30 students who responded regularly. Because of the size of the group and because the study ran for just four weeks it was felt that the analysis could be successfully managed using Microsoft Excel. A worksheet was created for each student and their responses were placed there each time they responded. This made it easy to track any change in the response to any question. Another worksheet was created which contained the average

response for each question for all students and this facilitated a picture of the whole class at once.

Similar worksheets were created to observe the VARK analysis results and at the end the examination results were observed in worksheets which contained other relevant student information gathered from the other aspects of the research.

Study two

The second study refers to a class of 12 Junior Certificate students who were in learning support class. The class had poor writing skills and this was thought to be one of the problems affecting the students' confidence. The aim of the study was to examine the effects on student motivation and learning of creating podcasts in class. The study also wanted to see if podcasts could help find ways for the students to overcome their literacy difficulties. The researcher worked as a co-teacher with this class and was involved in the provision of ICT support in the teaching. The students were brought together to study subjects where extra assistance was needed. The focus was mainly on English and History but the teacher also wanted to build up confidence and a positive attitude towards learning among the students.

Planning the study

The second study arose out of a desire by the teachers to see if podcasts could bring about increased motivation. The reading and writing skills of the students was seen as a hindrance to them expressing their learning and a source of frustration making it more difficult to teach for the teacher and for the students to learn. It was planned to use podcasts to see if the problems perceived could be alleviated in any way. The goal was to add variety to the teaching and evaluate the effect on motivation and learning experienced by the students. It is intended to be an ongoing process with the first and major objectives of increasing motivation of the students and the second allowing them to use an alternative to writing to express themselves and their learning, presentation and knowledge.

The teachers of the Junior Cert class see motivation as the essential component that stimulates and sustains learning. This view has been supported by many researchers such as Berliner and & Gage (1998). They also feel that motivation is inferred from

learning and learning usually is an indicator of motivation (Weiner, 1985). So the teachers focussed on increasing motivation in an effort to improve learning. This approach is supported by others such as Sankaran and & Bui (2001) and Sachs (2001).

The teachers are aware as Snow & Swanson (1992) point out that motivation is a function of internal and external multifaceted factors. So changes in the school context as well as changes in students' levels of development lead to changes in their motivational reactions also. However the parameters of this study do not allow a complete analysis of all factors affecting motivation and for the purposes of this study we will focus entirely on the work done in the classroom situation.

The Questionnaire

The questionnaire was conceptualized and designed using Keller's ARCS model of motivation. This model states that attention, relevance, confidence and satisfaction are the four conditions of motivation in an instructional situation. (Keller, 1983, 1987). Keller's first condition for motivating students is maintaining their attention. This can be achieved through instructional strategies that increase student curiosity or arousal. His second motivational factor is relevance of the instructional environment. This factor can be addressed through instruction that matches learners' goals. The third motivational factor is confidence. Confidence is related to students' expectancy for success or failure. Clearly stating criteria for success and providing a low risk environment can increase students' confidence. Finally, Keller says learner satisfaction is essential for maintaining motivation. Providing appropriate learner recognition for success as well as giving appropriate feedback can foster students' satisfaction. According to Keller an examination of motivation should focus on three elements in each of the four conditions of motivation mentioned. These are outlined as follows:

The Attention elements are:

- Perceptual arousal - capturing the students interest
- Inquiry arousal - gaining the students' curiosity or interest
- Variability - changing activities to maintain the students' interest

The Relevance elements are:

- Goal orientation - meeting the students' expectations or educational goals.
- Motive matching - matching the students' interest and learning styles.
- Familiarity - creating links or hooks to students previous learning.

The Confidence elements are:

- Learning requirements - clearly stating the expectations for learning
- Success opportunities - supporting the students' beliefs about their ability
- Personal control – establishing the concept of effort as the basis for success.

The Satisfaction elements are:

- Intrinsic reinforcement – encouraging the joy of learning
- Extrinsic rewards – establishing rewards for learning
- Equity - fair and equal treatment of all students.

(Keller, 1983).

The Rubrics

It was decided to use a rubric to assess the quality of the students' work ie the artefact. As Pickett, N. & Dodge, B. (2006) point out a rubric is an authentic assessment tool which is particularly useful in assessing criteria which are complex and subjective. This is case when we were assessing two different media for the same thing.

The advantages of using rubrics in this assessment are that they:

- allow assessment to be more objective and consistent
- focus the teacher to clarify his/her criteria in specific terms
- clearly show the student how their work will be evaluated and what is expected
- provide useful feedback regarding the effectiveness of the instruction
- provide benchmarks against which to measure and document progress

Common features of rubrics include;

- focus on measuring a stated objective (performance, behaviour, or quality)
- use a range to rate performance
- contain specific performance characteristics arranged in levels indicating the degree to which a standard has been met.

Procedure

The students had considerable access to ICT resources such as the Internet and there were Laptops available between two or three students during class. This helped familiarize the students with ICT and they were competent users of computer applications such as MS Word and mind mapping tools. This was previously introduced by the researcher as part of a project complementing this course. The instruction involved introducing a topic and allowing the students to work in groups to gather information on the topic. Then a mind map was created with the information the students had gathered with the teachers acting as facilitators. This would serve as the summation of the topic covered. At the end of the topic the students would be asked a comprehensive question on the topic. The class were divided in to two groups. One group would answer the question using the standard written answers while the other group would create a podcast with their answers. The groups then rotated in the second phase of the study and after the second topic was covered those who created podcasts would write out the answers and visa versa. A rubric was used to assess the content and detail of information given in the written documents and the podcasts. It was felt that this approach focussed on content and knowledge shown in the answers and presentation of information were compared on both the podcast and the written work. This process was repeated when a new topic was introduced and this time the group who wrote about the topic would produce a podcast while the students who produced a podcast for the first topic would write abut the second topic. On completion they again filled out the motivational questionnaire and the results were analysed. The artefacts produced after the second topic were also examined based on a rubric to compare the content of the material. The study ran for over a month due to school holidays etc and on completion the teachers reviewed what was done and made adjustments where it was felt necessary.

Observing the action

A questionnaire was used to gather the student's feelings and attitudes between the conventional approach of writing out the material and the use of podcasting to demonstrate their learning and knowledge.

Holly and Whitehead (1986) point out that action research can be used in evaluative procedures such as improving a teacher's methods of continuous assessment. The two stages in this study and the use of a rubric was used to assess the quality of the student's responses fulfilled this continuous assessment method.

Data was also gathered from the teachers. The teachers kept journals on how the process was evolving and this information would feed the research process as it went along.

The questionnaires were designed to assess the student's views on attention, relevance, confidence and satisfaction. This it is hoped should give the teachers an indication of how effective the creation of podcasts was in motivating the students. The students work was also assessed to see if the quality and detail given in the answer varied as a result of creating the podcast. This analysis was done using a rubric to assess the work. The artifacts produced by each of the students included a written document or a podcast.

The responses to the questionnaires were fed into an MS Excel spreadsheet for observation and analysis. The scores achieved in the written material and podcast were also analyzed in MS Excel.

Discussions between the teacher and the researcher concluded with a review of the teacher's log of how the action research proceeded and included some discussion for future implementations which will be carried acted upon next year.

Discussion

Introduction

This chapter follows on from the methodology discussion in the previous chapter and will follow specifically the reflections of the action research model. Zuber-Skerrit, (1996) argues that reflections in action research is of vital importance as it will feed into the ongoing process to help the researchers identify what changes or adaptations may be necessary to maintain successes. It will also identify failures or successes and areas where enhancements are possible, She goes on to say that in the cyclical action research model, described earlier as the reflection stage, encompasses the critical and self-critical reflection of the results of the plan, action and observation stages and helps in making decisions for the next cycle of research. This stage will monitor the whole revitalization process as well as reflecting on the results and drawing conclusions before entering the next cycle.

Study One

Reflections on the action

The research was carried out over a four week period. There was a high level of continuous cooperation between the researcher and the teacher which was vital to the success of the project. This allowed for changes to be made quickly when necessary. The teacher's views were always taken on board as the research was aimed at improving the teaching as well as learning. The researcher had daily contact with the students also. Each evening the students would receive an SMS text message saying which Podcasts were available and where to access them. They were also reminded to fill out the diary. A number of issues arose as the research progressed and the following is a description of the action taken and the results achieved.

Issues when accessing the podcasts

Almost immediately it became apparent that some of the students were unable to access the podcasts. There were a number of reasons for this. (1) A few of students home PCs were not able to play MP3 files. (2) Some students did not have broadband internet access which is considered necessary for efficient downloading of the files.

(3) Some students were not able to use or did not have the skills necessary to download the material and play it. This was a surprise as initially they all claimed to have knowledge of it. To cope with this problem a number of options were offered to the students. They were given the option of downloading at school which sometimes proved difficult because the students were, not always able to access the school computers.

Solution

This problem had to be solved at an early stage and was overcome by putting podcasts on CD which the teacher handed out. The CDs were copied in different formats which included audio files and MP3 format to allow the CDs to be listened to on standard CD players or "Discman" as well as on PC. It was considered necessary to put all the podcasts for the topic being covered on one CD.

This result meant that the students could now listen to podcasts before they were covered in class. However this did not occur. The students used the CDs or downloaded the material according as they were instructed to and only one student reported listening to podcasts before they were covered. That particular student excelled in mathematics and was doing so out of genuine interest in the subject.

Issues with the devices used

Twelve students actually listened to the podcasts on their MP3 devices. The remainder used their home PC There were a number of reasons for this. (1) The students found it easier to listen to the material on their home PC when they were doing homework or studying. (2) They did not know how to copy the material on to their devices without using the iTunes software. (3) They did not see the value of having the material on their devices because they felt mathematics study required looking at visual material as well.

Solution

The original plan was to get the students to use their MP3 devices but as the research progressed it became apparent that some students did not want to do this for the reasons outlined above. As the students expressed satisfaction with the way they were listening to the podcasts it was decided to continue making the podcasts available on the web site and letting the students choose what ever method they desired to listen in.

Issues with podcast content

The topic being covered in mathematics was Complex Numbers. This was is a large topic and needed careful planning to allow the podcast material match what was covered in class each day by the teacher.

Solution

The complex numbers topic was divided into thirteen subtopics and a podcast was created for each subtopic. The content covered in class would comprise of one, two or three subtopics at a time so keeping pace with what was covered was easily managed. This was brought about by planning and coordination between teacher and the researcher before the study began.

Issues with trying to make the podcasts more appealing

Initially the podcasts contained some popular music clips in an effort to make them more appealing to the students. This however was not appreciated by the students early on and they expressed comments about the music choice.

Solution

It was decided to drop the music and when it was not added in it did not have any appreciable effect on the students' attitudes.

The research diary design

The diary proved very effective in gathering the student opinions. Apart from the two students who did not get involved, all students were able to access it and managed to fill it out. There were no negative comments, misunderstandings or complaints about the diary. Before the study began the diary was explained to the students in class and any difficulties were ironed out with them at the time. Another reason for its success was the fact that it had a number of trial runs before publication to get student opinions of it and changes were made to eliminate potential problems.

Issues filling out the diary

At first the uptake on listening to the podcasts and filling out the diary appeared slow and after encouragement from teacher and researcher this improved. Of the thirty two

students two did not interact with the podcasts at all. A further six students responded in an intermittent way, one of whom did not fill out the diary entries properly. At the end of the topic these students had less than five diary entries and were not considered for detailed analysis. However two of this group responded at the end and communicated that they found the podcasts more useful near the end of the study when the mathematics topic got more complex.

Solution

At the outset each student supplied his mobile phone number to the teacher and researcher and this allowed SMS messaging encouraging the students to respond. This proved very effective and after the text message students invariably logged on and filled the diary. It was also time consuming for the researcher and would not be practical outside of a research situation.

The VARK analysis

A smaller study was undertaken during the study to assess learning preferences and an examination was given to the students to see if the podcast were of benefit and if the students would use the podcasts for study purposes after the topic was completed. There is a general assumption that learning preferences particularly aural learning preferences would be suited to the use of podcasts (Crosson, S. V. 2006). To further explore this, the students completed an analysis of learning styles in an effort to see if there was a correlation between learning styles particularly aural learners and those who felt the podcasts were beneficial. The analysis was based on the VARK learning website (VARK Analysis, 2006). VARK is a questionnaire that provides users with a profile of their learning preferences. These preferences are about the ways that students want to take-in and give-out information.The appropriate questionnaires were printed off and given to each student by the teacher. The researcher then analyzed the responses and based on the guidelines on the web site assessed the learning style of each student. This information was given to the students and was analyzed later when the study was completed and all the diary responses were collected. There was a very high response rate to this study and the students who were not responding to the podcast study also took part. This generated a lot of interest in the class and helped focus the students' attention on the research.

Topic Examination

The research study also involved giving the students an examination when the topic was completed. The questions were a similar standard to what the students would get in any other topic covered and were based on the Leaving Certificate examination paper. The researcher also corrected the examination papers. The results of the examination were also compared to the results the students achieved in their most recent mathematics examination. The examination was given in an effort to see if the students were motivated to use the podcasts as a study resource and to see did the use of podcasts aid students while studying for this examination. Another reason was to note if there were any students who excelled in this topic compared to previous work using podcasts as a study source. After the examination the students filled the diary for the last time and their responses were examined. There was a 100% attendance at the examination by the students.

The Analysis processes for study one

Analysis was carried out on the diary results and the VARK learning preferences/styles of the students. The learning styles scores were compared with the ratings given in the diaries. The test results were analyzed and compared to previous results.

The Diary Analysis

The contents of the diaries were emailed to the researcher each time they were completed by the student. The replies were aggregated over time as they were imported to Microsoft Excel for analysis. Section one, contained personal information on each student. Section two and three used a rating system from 0 to 5 to assess the student preferences.

The goals of the diary analysis as identified by Searles et al (2000) earlier were;

- (a) obtaining reliable person-level information;
- (b) obtaining estimates of within-person change over time, as well as individual differences in such change; and
- (c) conducting a causal analysis of within-person changes and individual differences in these changes. (Searles et al. 2000)

This multilevel analysis relates to within person variance and between person variance. Thompson & Bolger (1999).

Analysis involved looking at the following:

- Aggregating Over Time: What is the Typical Person Like, and How Much Do People Differ from Each Other?
- Modeling the Time Course: How Does a Typical Person Change Over Time, and How Do People Differ in Change Over Time?
- Modeling Within-Person Processes: What is the Within-Person Process for the Typical Person, and How Do People Differ in These Processes?

(Bolger & Eckenrode 1991)

This involved:

1. Looking at the responses of each individual separately and examining the answers given to the study patters and methods they used when studying.
2. Examining the ratings the students gave to each of the cognitive outcomes and the learning to learn ratings to see what the student was like.
3. Comparing each student's responses to see how and where they differed from each other over time. This involved comparing the answers given to each question by each student for the duration of the research.
4. Building up a record of the student's thoughts and actions taken throughout the period of the study to see what the student was like.
5. Building up a record of the responses of the students so they could then be compared within and between students over time
6. Getting an average value for the students' responses for each question at the end. This gave an average response value for each question over the course of the study. This average provided a single value for each of the questions answered by each student. This allowed for each question to be compared across the student population to give a broader perception of the data and identify which categories were rated highest and so are the most popular in the cognitive outcomes and learning to learn sections.

The analysis required creating worksheets for each student and inputting the data as the information was received.. Worksheets were also created for all questions for comparative purposes.

The VARK Analysis

The analysis of the learning styles was carried out by printing the questionnaire from the VARK web site and getting each student to fill out his answers. The analysis was then done by the researcher based on guidelines outlined on the VARK web site. These results were then compared with the averaged response to each question for each student. A correlation was carried out to see if there was any significance in the spread of values between the students' ratings for the different questions i.e. values between 0 and 5 the scores achieved in the preferences. For example was there high ratings for podcasts and high scores for the aural learning preference among the class and individual students.

The Test analysis

Correlations were also carried out between the past examination results and the results of the test the students were given. These were also compared to the responses given by the students ratings of what they thought were effective outcomes of the use of podcasts. There was no significant change noticed between what the students achieved in the test and their past performance based on previous exams and on teacher expectations. No further analysis was done in this case.

Comments on the reflections of Study One

Study one research project went well. The high level of communications and among all involved helped solve problems and any issues were sorted out early. The online web site and SMS messages worked extremely well.

Study two

Reflections on the Action

In the second study the researcher was co-teaching the class. This meant that there were two teachers in the class and both teachers would share the teaching duties. The main role of the researcher in the co-teaching environment was providing ICT

support. Both teachers kept logs as the research began and there was constant involvement in the action research process by both teachers and the students. As mentioned previously the aim of the action research was to improve the motivation of the class and the learning achieved by the students. Podcasts were examined to see if they could be effectively implemented in the teaching.

The Junior Certificate class of 12 was randomly split in two for study. The class were taught two topics. At the end of the first topic one half of the class created a podcast in response to a given question. The other half wrote their answers to the question. They then filled out the ARCS questionnaire. The results of this questionnaire was analyzed.

At the end of the second topic the roles were reversed and those who created the podcast now wrote their answers and those who wrote before now created a podcast. All students again filled out the ARCS questionnaire and the results were analyzed. This allowed the researcher to compare the results between the two groups and to interpret the data.

The students' answers to the topic question were assessed for learning content using a rubric. Throughout the research the teachers kept a log on how the research was going and adjustments which they felt would be necessary and going forward.

Assessing the students motivation

As mentioned in the previous chapter the ARCS motivational model (Keller, 1983, 1987) is widely applied when evaluating motivational strategies because of its applicability and practicability with instructional design processes. Keller said that learning motivation is affected by four perceptual components: attention, relevance, confidence and satisfaction. Each component plays a critical role in motivating students through the learning process. The questionnaire attempted to gather data on the student motivation. The questions were multiple-choice and consisted of statements on each of the four motivational factors. The students were asked to select either "written document", "podcast" or "the same" as appropriate for how they felt about the statements. The questions were closely aligned to guidelines outlined by Keller above. See Appendix 2.

Assessing the students work

At the end of each topic the students were required to answer a question on the topic just covered. This was assessed by both teachers using a rubric. The rubric focused on the content, structure and understanding the students showed in the creation of the artifact. A rubric was chosen because it allowed for the assessment both written material and the podcast on similar aspects of content. The researcher created a rubric for each section covered and designed it so as it best assessed the learning outcomes that the teachers aimed for. The students were graded on their results and there performance compared with those in the same study and with there performances in the two studies.

Issues creating the podcasts

When each topic was covered half the students were given a question and the other students set about creating the podcast. However it was noted in both teachers logs that the students who wrote the question had there artifact finished before the podcast group. This was because they were all able to sit in the same room and answer a conventional question at the same time. The students who created the podcast had to take turns to do their recording because there were not enough lap top computers for each student. The students also needed assistance with the setting up of the recording equipment and some assistance with how the podcast was to be recorded and editing the sound files. This created a considerable delay.

Solution

It was decided that the researcher would do the recording and assist the students with any sound editing issues. This cut down the time taken to create each student's podcast significantly. This time delay became apparent at the end of the first topic. It was felt that the research should still focus on the goal of each student producing a podcast and to continue with the motivation analysis because the findings after the first topic was completed were very encouraging. Because half of the class had not yet created podcast it was felt necessary that all students should be given the chance to create their own podcast. This was a view also felt by the students and was noted in the teachers' logs. The second phase continued as planned with both groups completing the tasks and the material assessed and analyzed.

The Teachers' Log

After each class the teachers would make notes on how they felt the process was going. This proved valuable in the end as it helped to jog memories of events and situations which arose during the study. The logs were useful too in collecting each teachers view and ideas of what was successful and what was not. This helped in the planning which is intended in the next iteration of the project.

The Analysis processes for study two

The questionnaires responses were analyzed using MS Excel and the number of responses for podcasts and written documents were collated for each of the four motivational factors. If podcasts were selected it was taken to say that the students felt more motivated about podcasts in that particular situation. Comparisons of feedback between the two groups were compared after each topic. The overall group's feedback was also examined.

The marks that each student achieved in the podcasts and the written document were compared and a comparison of the marks for documents and podcasts for the whole class was also carried out. Each students work was checked by each teacher independently. The results were discussed if there were any variation in the teacher views. This issue did not cause any concern as both teachers findings agreed in all cases. The use of rubrics helped to facilitate this as it focused the assessment in specific areas.

Results and Findings

In this chapter the results of the action research will be discussed and conclusions drawn where appropriate. The results of the two studies will be discussed separately.

Study One

The discussion will examine the findings of the research diary and then focus on the learning preferences study and the examination results. The research diary was divided into three broad sections: personal information which included study patterns, cognitive outcomes and learning to learn.

Of the 32 students, two did not respond at all and another 6 were not able to access the site on a regular basis or were not interested or motivated by the availability of Podcasts. They made a few token responses but the diary was not properly filled in one case and the others only filled out the diary between two and four times and it was felt the responses would not be significant and would not represent the students deep thinking on the Podcasts availability and access. Excluding the six mentioned that left the average number of diary responses per student at ten each. Sometimes there were two Podcasts uploaded at the time so the students by and larger would have listened to and communicated their feelings on all the Podcasts.

Diary results: Section one

Study sources question

All students reported using the text book for study material and some also used study notes, examination papers and grinds notes. The grinds notes referred to are notes the students have or get from courses where they receive extra tuition outside of school. Three quarters of the respondents claimed to use the podcasts as part of their study. However those who did not mention using the podcasts also listened to them and may not have seen them as an effective study option.

Listening to podcasts question

All but one of the students who did respond listened to the podcasts after class as directed by the teacher and SMS messages. The student who did not was a particularly high achiever in mathematics and listened to all the podcasts.

Other resources used question

The other resource which some students used when studying was past exam papers and grind notes. The researcher also made additional Web resources available on the support site for the students. However, these were not accessed at all. This would suggest that the students do not see or are not fully aware of the power of the Internet as a source of information for mathematics.

Listening to the Podcasts

Research prior to the commencement of the study found that all but one of the students possessed an .MP3 player of some description. In the course of the study eleven students used their devices to listen to the Podcasts, All the students used their home PCs to listen to the podcasts at one stage or another. The response rate from the students was sluggish on the first week and after that increased after some technical difficulties were overcome.

The technical difficulties were:

- Some students expressed difficulties in accessing the podcasts and did not know how to get the podcasts onto their devices.
- Some of the students did not have broadband access and this was also contributed to some of the students not being able to download the podcasts.

The resolution to the problem involved making the podcasts available on CD both in MP3 format and audio format for all students who needed them. This enabled all students to access all the Podcasts. It also meant that the students could now listen to all Podcasts when they wanted to and before the class if they wished. The solving of the technical difficulties experienced at the start by some of the students accounts for the low response during the first week. The response rate increased as students become more familiar with the technology. Having the podcasts available on CD meant that some students did not download the podcasts. It was also noted from the data that as soon as the CDs became available some students stopped downloading.

During the study, the researcher did not attempt to increase the number of students who were using MP3 devices. This may also have contributed to fewer numbers of students using their MP3 devices. The teacher and researcher were concentrating on getting the students to listen to the podcasts and felt if they did it on their home pc it would suffice as focus was on cognitive outcomes and learning to learn attitudes. It is felt that greater use of MP3 players could be achieved if necessary as the responding students were supportive and cooperative with the aims of the researcher and teacher.

Clearly podcasts work better when students all have access to broadband and have multimedia PCs. Regrettably broadband availability is not yet the norm in Ireland in 2006.

Diary results: Section two

Cognitive Learning Outcomes.

In the cognitive outcomes section the students identified learning outcome of consolidation as being the highest of all learning outcomes achieved among the class as a whole, This represents a strong feeling among the class in general that the Podcasts are most useful for consolidation. The second highest rating was study reference. It was one of the main aims of the researchers to use the podcasts as a study resource and getting the consolidation and study reference rating so highly on the cognitive outcomes points to the success of the action research from that perspective. The table below lists of learning outcome in order of importance according to the students in the cognitive outcomes section.

Cognitive Outcome	Order of Importance
Consolidation	70
Study Reference	67
Terminology/Vocab	59
Memory	55
Understanding	54
Skills	48
Alternative View	46
Explain	46
Core Skill	46

Table 1. Cognitive outcomes rated highly in order of importance for podcasting.

The next two cognitive aspects were helping with terms, memory and understanding. These ratings varied a lot from individual to individual and were consistently below the cognitive outcomes already mentioned. The remaining outcomes of new skills, alternative views, ability to explain and core skills did not get a significant ratings. It could possibly be drawn from these findings that the Podcasts are more beneficial as a source of consolidation and as an alternative learning resource. The effect of podcasting as a tool for understanding was perhaps understandable given the lack of visuals in mathematics. This point was commented by a number of students who felt it would be more suitable for languages. Again linking the podcasts more with the written material and graphics from the text book should be considered. Teacher's however may have problem with this in terms of intellectual property, time etc and have difficulties in this area. The application of podcasts in subjects which do not require such high visual content is a study which deserves further examination.

Diary results: Section three

Learning to Learn and Motivation

The analysis of the learning to learn section should provide an insight in to the students' motivation and any changes to the learning to learn attitudes of the students. The ratings in the learning to learn section of the diaries were consistently lower than the cognitive learning outcomes in section two. Items mentioned such as planning, new source of information or independent learning scored as highest in this section. The overall impression was the class in general did not rate these items highly. The researcher's interpretation was that satisfaction was generally low in this area. Confidence in their learning techniques and independent learning ratings were not significant and rated low.

Learning to Learn	Order of importance
New source of info	54
Independent learning	51
Planning learning	50
Confidence	37
Communications	32

Table 2. The learning to learn features of podcasting in order of importance

Findings from the Diary

Motivation

It is clear that the cognitive learning outcomes benefit more from this use of podcasting. The other aspect of the research motivation and learning to learn was not considered hugely important or effective by the students. This could imply that the motivational aspects of the podcasts were not effective as identified in ARCS model.

The students commented that they found the podcasts relevant and the ratings of the outcomes stands testament to this. However the low level of confidence reported by the students and the overall low ratings of section three, the learning to learn, suggests that motivation was not greatly enhanced in the class as a whole after the introduction of podcasts.

Student Attitudes

Some students also commented that mathematics needs visuals and the lack of visuals was a factor in their poor ratings of the podcasts. The podcasts did not use examples from the text book because it was felt that different examples would provide a richer experience for the student. The text book is the main source of study material and so it is felt that having podcasts more closely aligned to the book and especially taking advantage of the visuals in the text book it could possibly help the students more. This corresponds with some issues mentioned in the literature review regarding access to content and rights to use the material of others.

The examination which the students completed as part of the study was intended to motivate the students to use the podcasts more. It was hoped that this would help to be a motivational factor for the students and the diary entries would show this. However the student responses in the diary during the study period for the examination did not change from the perceptions which they expressed earlier. According to Keller satisfaction comes when learners are allowed to practice using newly acquired knowledge or skills and to receive feedback on a manner that leads to positive attitudes towards the learning behaviours (Keller, 1978). The use of podcasts in the study did not provide this experience and student motivation is something which must be addressed in the next cycle of the action research.

Learning Preferences Results

A study of the VARK learning preferences of the class was carried out and compared with the results for consolidation and study resource findings from the diaries. This was because these two cognitive outcomes rated highest by the students. Surprising there was no strong correlation noticed between the aural learners and the students who rated the podcasts highest as a study resource and consolidation. This was significant as many theorists believe that podcasts may suit aural learners most. The researcher was surprised and more detailed analysis may be needed here to examine this finding more. Possible reasons why the VARK analysis proved so inconclusive may be found in comments by the students who claimed that podcasts have a place when used for language subjects or history but in mathematics visuals are also needed and perhaps a study of subjects other than mathematics may prove more conclusive.

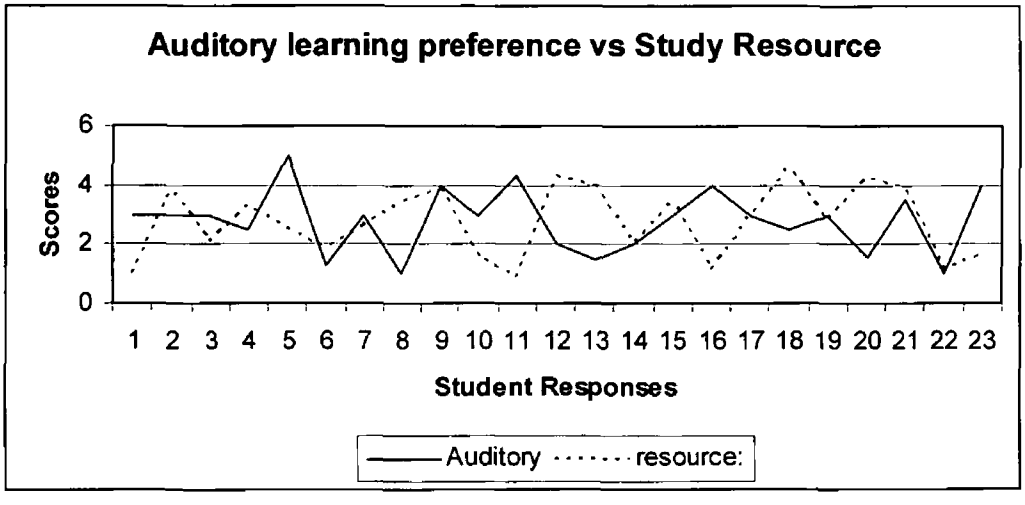

Figure 2: A comparison of the aural learning preferences and rating of podcasts as a study resource identified by the 23 of the students.

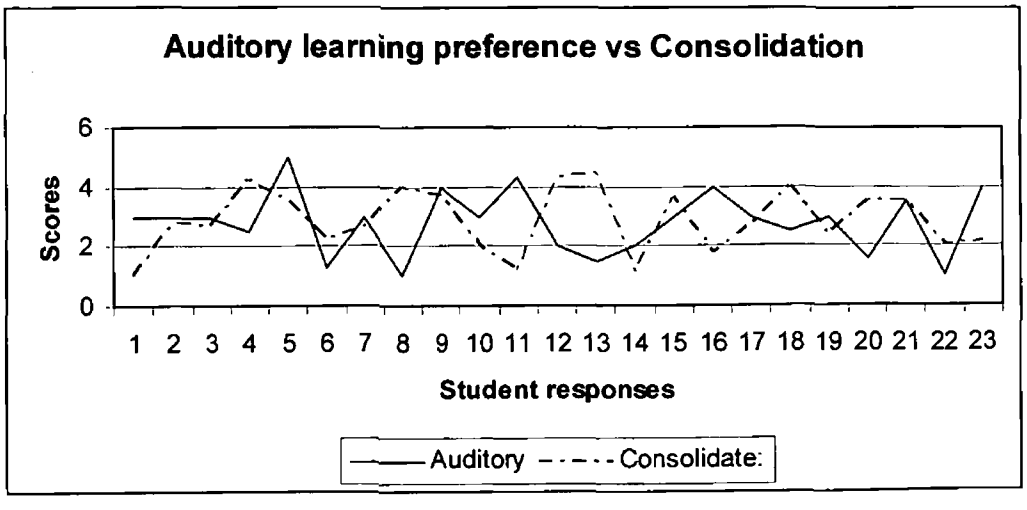

Figure 3: A comparison of the aural learning preferences and the ratings of podcasts as an aid to consolidation.

Experiences of Individual students

An interesting aspect of the examination of the individual diaries was the consistency of feelings which remained throughout the study. At the beginning, the ratings expressed by students on the different learning outcomes remained almost unchanged throughout the study. This seems to show that the students' first impressions lasted. Students who valued Podcasts as a useful resource and gave it ratings of 3, 4 or 5 out of 5 consistently rated them so and there were only marginal changes in ratings throughout the study. Similarly students who rated the Podcasts from 0, 1 and 2 were consistent in their views throughout changing marginally and generally staying low.

Another interesting finding was that students' who's rating for podcasts use as a study resource also had similar ratings for outcomes such as consolidation. This consistency is shown in Figure 3 below. Here there is consistency in student attitudes in relation to different learning outcomes are closely related.

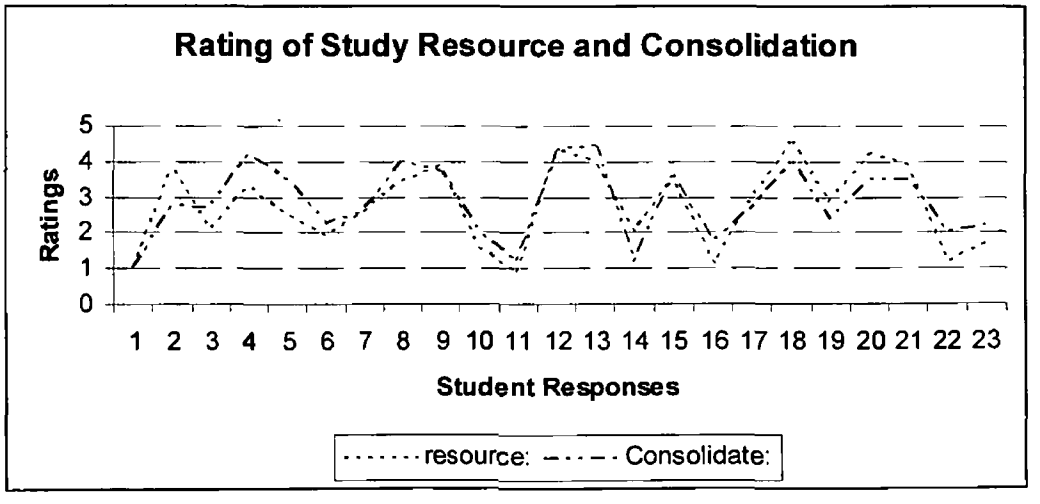

Figure 4. There is consistency in the ratings of cognitive outcomes for example the ratings of study resource and consolidation follows a similar path.

As the study progressed, the difficulty of the material being taught in class increased. Cleary, diagrams and visual examples are very useful in the teaching of mathematics and this is a weakness of podcast-based information. The students also commented on this on a number of occasions.

Podcasting was noted by some students as being very useful for catching up with work missed while absent from class. Another mentioned that it helped him get a better overall picture of the topic. This may have been because the Podcasts were created on a topic by topic basis and while two topics may be covered in one class they may blur into one topic in the course of the instruction while the Podcasts clearly identified the different topics on separate Podcasts.

The students did not see the Internet as a study resource for mathematics. This was highlighted by the fact that the students used text books and notes in practically all cases and they did not see the Internet as a study resource in the cognitive aspects section. This was also evidenced as the students did not access the study resource websites which were made available to the students during the study. This is interesting as the students were selected in the first place because of their high level of home usage. This may mean that students use computers more for other subjects other than mathematics. The students do not realise or are not interested that there are many and varied study resources out there and perhaps are not motivated to look for it. If they feel satisfied that the text book, past examination papers and possibly a grind session are sufficient to get the grade they want in the examinations then there is little chance of them doing extra research on the web. This is a discussion which wider implications about the way mathematics is thought and examined in Ireland and it needs further discussion and further research.

The learning Styles analysis

Each student also completed a learning styles questionnaire and this was compared to their preference level for podcasting as a study resource and as a consolidation resource. There was not a significant correlation between the students as a whole who expressed an aural learning style and a high preference for the Podcasts as well. This surprised the researcher already and further work is needed to assess the value of podcasting for aural learners. However on analysis of the individual diaries some individuals who rated significantly aural also came over as strong proponents of Podcasts. The reason for the discrepancies here perhaps is that more detailed analysis of the learning preferences assessment. As mentioned it may have something to do with the lack of visuals and the subject which the students were studying.

The Topic Test

The topic test was based on a question similar to what the students could expect to see the Leaving Certificate examination. The students do these regularly as topics are completed. In this occasion there were no significant changes noticed in the student performances in this test and on previous performances. The teacher's expectations of how each student would perform also matched these findings. The podcasts did not appear to have any bearing on how each student performed in the test. There was no significant change in the results obtained by the class and what each student achieved in their last mathematics examination. Apart from some minor changes which could not be explained by the use of podcasts no change could be attributed to the use of podcasts alone. The final responses of the students again were consistent with what they had been saying already and so the test did not shine any more light on the effects of this application of podcasts.

Study two

The analysis of the second study looked at the findings of two sets of questionnaires which were completed at the end of each topic. It reviewed the assessments of the artefacts based on the rubrics and examined the teachers' log.

Results: The ARCS questionnaire

The questionnaire used Keller ARCS model to see if motivational levels were enhanced by the use of podcasts compared to written documents. Three questions relating to each one of the motivational aspects of attention, relevance, confidence and satisfaction were asked. For each question the majority of students selected podcasts as their preferred option to answer questions. This suggests that the majority of students feel that creating podcasts is more motivating than writing down answers. This is shown in the table below.

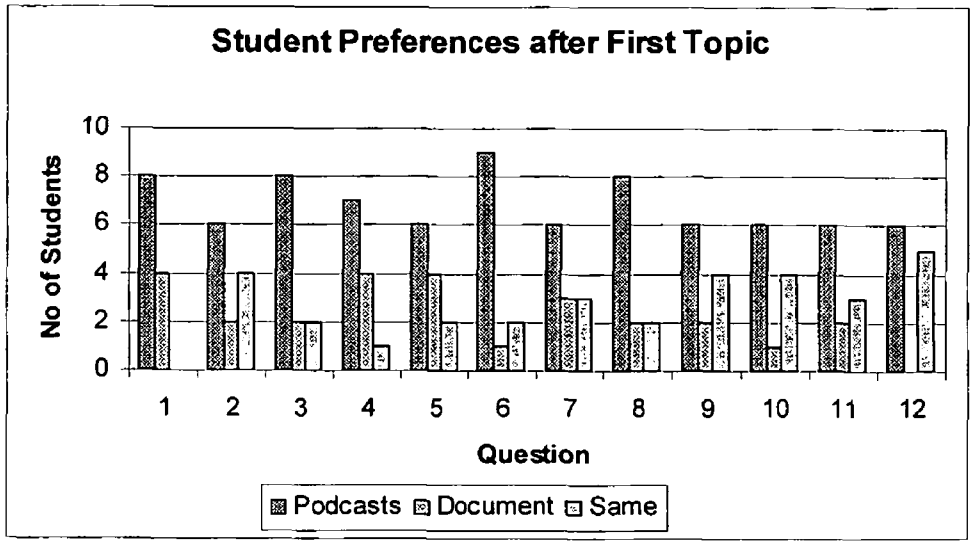

Figure 5. The students preferences when filing out the questionnaire after the first topic was covered. . The options they chose from were "a podcast", "a document" or if they considered no difference between either of these options then they selected "the same"

At this stage only half of the students had created a podcast for the study. Some of the students who had not yet created podcasts, also selected podcasting and a reason for this may be that they had created podcasts already in an earlier project.

After the second topic was completed a questionnaire was again completed and the results were remarkably similar. Again the podcast option came out ahead of the document. This can be seen in Figure 6 below.

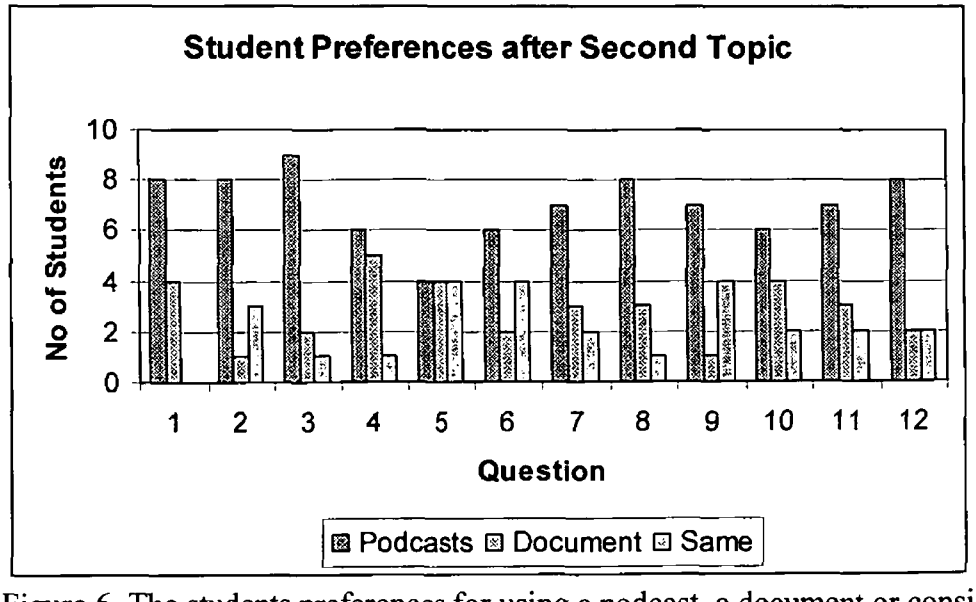

Figure 6. The students preferences for using a podcast, a document or considered both the same when filing out the questionnaire after the second topic was covered.

An interesting point about these two charts is that the option which scored next highest to the podcast in most cases was the "The Same" option. This is the option chosen when the student gave the same motivation factor to both documents and podcasts. This indicates that podcasts are preferred by most of the class and only a tiny minority see writing documents as more motivating. One can conclude that podcasts are more motivating for the class as a whole and so the learning of the class as a whole is greater when podcasts are used.

The students who completed the written exercise after the first topic showed a slight decrease in motivation for podcasts after they created a podcast. The students who created a podcast in the first topic showed a slight increase in motivation for podcasts after doing the written exercise for the second study. This would suggest that the students who had not created podcasts felt that they would be more motivating than doing a written exercise. However when they got their chance they realised that there was an element of work involved and the motivation slightly decreased. This however was not significant and the podcasts were still considered motivating. Interestingly the students who created the podcasts had a slight increase in motivation for podcasting after the written exercise. This suggests that the students see podcasting as better than writing an exercise.

Analysis of the four motivation factors

When examining the breakdown of the results according to the four motivation factors of attention, relevance, confidence and satisfaction of the students' impressions become clearer. As can been seen from the attention questions there was an overall increase from topic one to topic two.

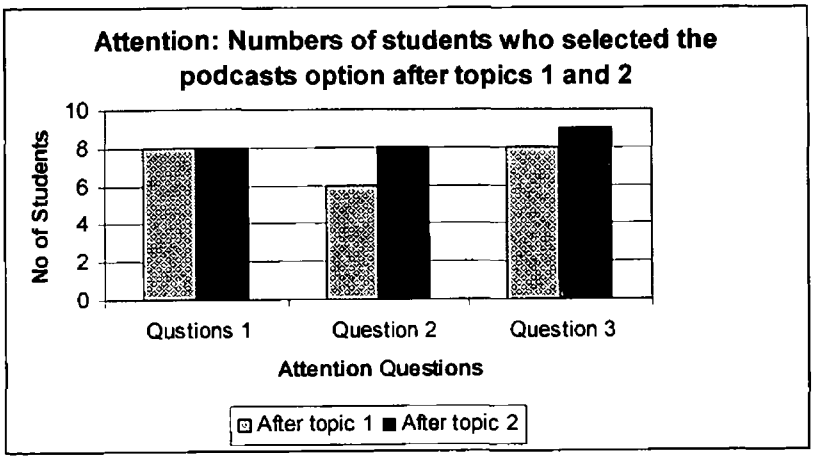

Figure 7. The number of students who chose the podcasts option from questions 1, 2 and 3 in the attention section of the ARCS questionnaire. See Appendix 2.

There is a slight change in the relevance questions of the questionnaire. This was the only section where there was a drop in the selection of the podcasts option by the students between topic 1 and 2. .

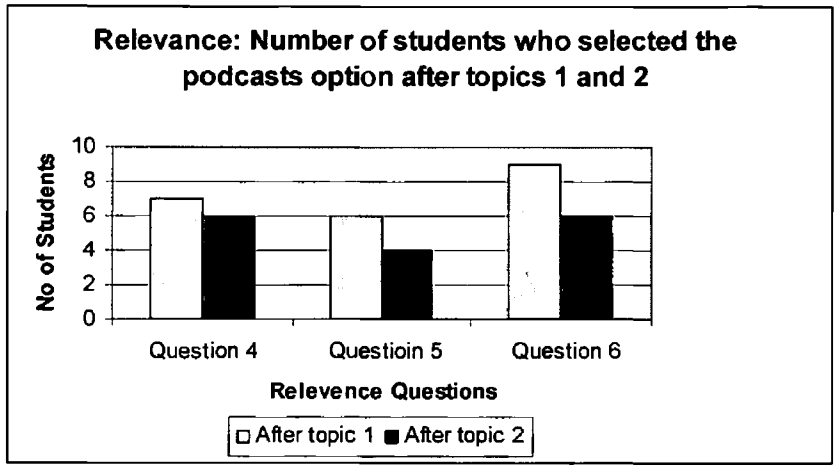

Figure 8. The number of students who chose podcasts options from questions 4, 5 and 6 in the Relevance section of the ARCS questionnaire.

It is very interesting to see a decline in this section because it is this section where the student asks himself about the importance of the exercise. If the learner can see the value of studying the material being relevant to the learners needs. Keller says relevance can come from the results of learning too ie improved ability and it can come from enjoying the process of learning, Students can see the relevance in the process if it matches the students learning styles and creates hooks with previous learning. Question 5 in particular focussed on the student's learning style and two of the students felt this. This changed is compensated for when "The Same" option is looked at where there is an increase of 2 from topic 1 to topic 2. Table 8 helps to identify what these students chose. They selected "The Same" option which implies that the students feel the same about this question for both podcasts and written documents from a relevance point of view.

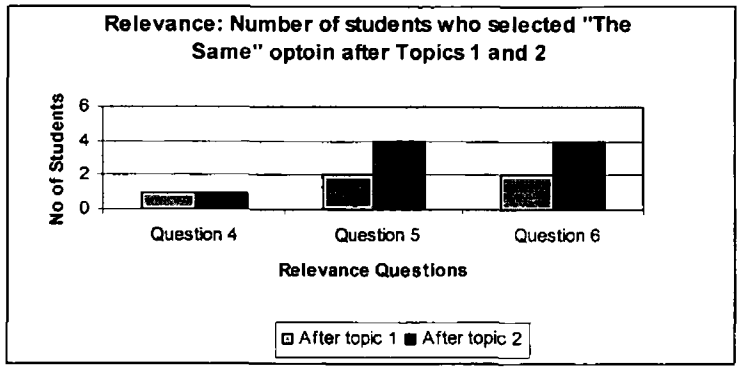

Figure 9. The number of students who chose "The Same" option from questions 4, 5 and 6 in the Relevance section of the ARCS questionnaire.

The other motivational factors such as Confidence and Satisfaction also increased after both topics were completed.

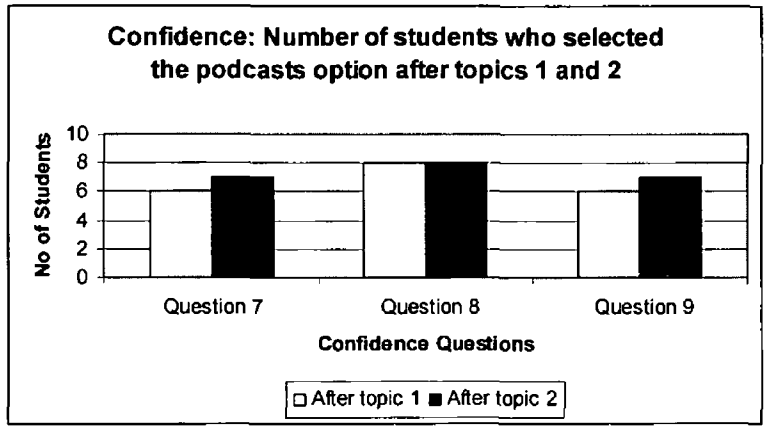

Figure 10. The number of students who chose the podcasts option from questions 7, 8 and 9 in the Relevance section of the ARCS questionnaire.

Again it is clear that this motivational factor increased after the topics were completed.

The final motivational factor was satisfaction. Here again the students' motivation levels increased.

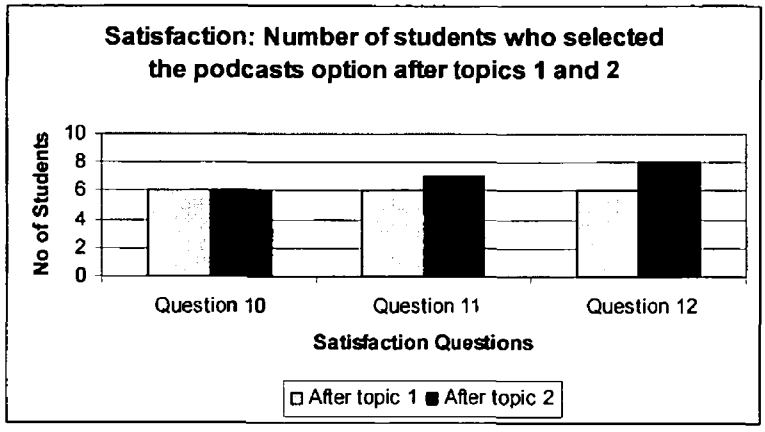

Figure 11. The number of students who chose the podcasts option from questions 10, 11 and 12 in the Relevance section of the ARCS questionnaire.

This chart continues the upward trend on motivation identified by the students.

Results: The Artefact

The second study also required the students to create artefacts which were assessed using rubrics. The results of this aspect of the study are very impressive.

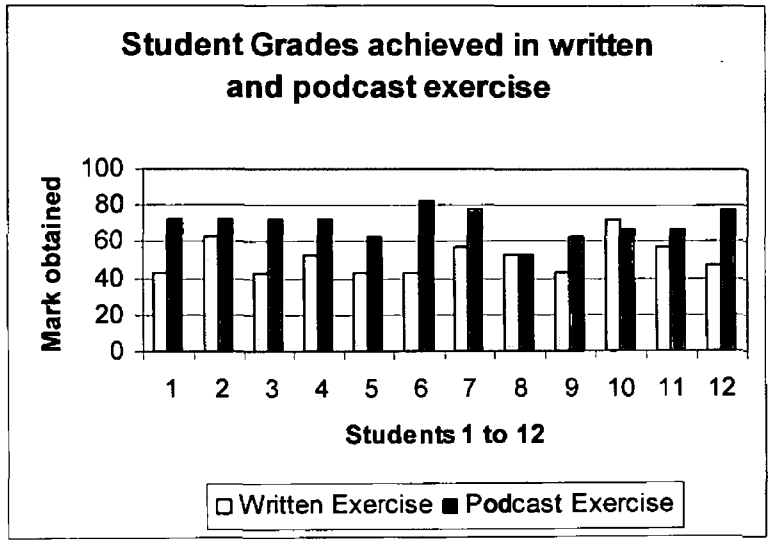

Figure 12. The grades obtained by the 12 students in both the podcast and written exercises. The grades are rounded to middle of the interval for charting purposes.

The grades are rounded to the middle of the interval but it is clear that the effect of the podcasts has liberated the students and allowed them to contribute and give more detail on the topics questioned. The results show the same for both groups in the class. The podcasts came out on top all the time.

The Teacher's log

The teacher's logs were invaluable in keeping account of the developments of the study. There was a problem creating the podcasts because of the length of time it took. The teachers had access to the class for a double period once a week which amounted to 80 minutes and this double period included a 15 minute morning break in the middle.

The teachers noted the following negatives:

- *Time consuming*: The podcasts took more time to create than anticipated
- *Learning curve*: There is a learning curve involved for teachers and students when creating podcasts and a number of classes would be given over to this exercise before podcast creation can begin.
- *Planning*: involving all students in the podcast at the same time would require detailed planning and building the podcast creation into the year lesson plan.
- *High tech vs. Low tech*: the technology was excellent but felt that the students could get so used to it they might find it difficult to concentrate and stay focused when dealing with more mundane tasks which did not require ICT usage.
- *Technology dependant*: the dependence on technology functioning perfectly at all times. On one occasion there was a problem when the students could not get on Internet due to technical difficulties and this forced the teachers to revert to the old methods which the teacher had not prepared for that day. This problem could arise just as easily using podcasts.
- *Recording facilities*: It is difficult to create more than one podcast at a time in the class. For this study the teachers were able to take the students aside one by one to an empty class room to do their podcasts.
- *Uploading the material*: Uploading the material onto the Internet can have its problems for teachers and students who may not be familiar with the technology. It also raises the question about who is allowed to access the podcasts from outside the school and should the web site be password protected. The issue of student confidentiality must also be grappled with.
- *Content monitoring*: The teacher would have to monitor the content of the podcasts created by the students to be sure there was no negative or offensive material included.

- *Assessment time*: There was a significant amount of time taken to listen to podcasts for assessment. This took much longer than it did to assess the written material.

The positive aspects of the experience are:

- *Motivation*: There was a noticeable increase in motivation and participation by all the students.
- *Literacy difficulties over come*: Students who had literacy difficulties were freed and given the opportunity to express themselves possibly for the first time. This was an invaluable achievement.
- *Enlightening experience*: It proved to be a very enlightening experience for the teachers and they learned a lot from it. It opened the doors to new ideas and new ways of teaching and will make planning classes much more interesting.
- *World wide audience*: The students work can now be listened to by family and friends which is also motivating for both parents and students alike.
- *Project planning*: The students are forced to develop planning and organizational skills when creating podcasts which they did not have to do before. For example setting up recording times and planning and sequencing the content as well as coordinating their material with what other students might be doing.
- *Public speaking*: The students had to focus on their speaking skills to be sure they were loud and clear and to the point.
- *New technology*: The students got to access new technology and life long learning ICT skills such as researching a topic and assembling the information for public delivery.
- *Ownership*: The students had a sense of ownership of their work as opposed to the material which they cover in class each day which sometimes they may feel is being delivered to them without any involvement by the student.
- *Assess and participation*: A key aim of the Education Act is that Special Needs Education students be enabled to not only access but to participate in the curriculum. The use of ICT and particularly podcasts gave the students a real experience of participating.

- *Positive social interaction*: In using podcasts effectively there is a need for greater collaboration and sharing of information. This promotes self esteem and greater cooperation between students and groups of students.
- *Understanding diversity*: Next application of podcasting in class will include students sharing their information via podcasts with students of same age from two special needs schools which St Tiernan's CS is currently working in collaboration with. This is aimed at breaking down barriers to understanding disabilities. It should also promote maturity in the students.

Conclusions

Two adaptations of the uses of podcasts outlined by Meng (2005) were implemented in this study with various levels of success. The first study included making podcasts available to students by teachers and the second study involved allowing the students to create podcasts as part of their project work.

Consolidation and study resources

Second level students say that podcasts are good for consolidating information and as a study resource. This corroborates the findings mentioned earlier in Duke University. Podcasts can be used with second level students in Ireland and in a single teacher classroom. The view that podcasting can be created and accessed easily with very limited technical resources by any teacher of any subject is supported.

Access to resources and content

Students feel subjects such as mathematics certainly need visuals to support the podcasts. The issue of finding resources and providing access to them was raised in the literature review relating to the findings of Duke University when they also had problems with access to content. Focussing on a text book and using the visuals from that book could be of assistance. However, this raises the problems of ownership and plagiarism when the material is broadcast on the Internet. There also can be problems simply accessing appropriate material for to put in podcasts. For example it was difficult to access visuals to accompany the podcasts. These points were also highlighted by (Crofts, S. et al. September, 2005) and (Armstrong Moore, 2005). Making visuals available would increase the work load and time required. This could require the use of vodcasts i.e. podcasts with visuals. Vodcasts require more resources than podcasts to produce and store. There is also the issue that students may not have the technology to access the vodcasts. Given the difficulty the students had accessing podcasts it could be argued that the time is not right for vodcasts yet.

Technical issues

Other factors which arose in the study and again were experienced by Duke University were the problems which students experienced accessing the podcasts with limited technical knowledge. Despite Prensky's view of the digital age and digital natives not all students have an aptitude for digital media. Training and support must be provided to support students when podcasting is undertaken.

Motivational limitations of podcasting in the current examination system

Simply providing podcasts to students and without any student involvement in the preparation of them does not enhance student motivation. The approach limits the podcast to a purely study resource and students can see it in a similar light to any other source of study material including textbooks. This concurs with the view expressed by Susan Lister earlier that podcasts are not a panacea to all problems.

In the Irish context students use text books and examination papers as the main stay of study material and grinds are accessed around examination time. This corroborates the study findings which show that mathematics students do not do research or find extra resources themselves. This has implications for the curriculum planners as there is no incentive on students to do research themselves or try something new as they have all they need to do this highly structured and predictable examination.

New technology trends, Communications and the Digital Disconnect

The infrastructure is not fully in place yet to tackle some of the issues highlighted in the digital disconnect mentioned earlier. Schools and society at large will have to access to broadband technology and material and training aimed at bridging the digital disconnect will have to take account of the technology available to all students.

Interestingly SMS messaging was found to be extremely effective when contacting students and encouraging them to respond to diaries etc. This coupled with the web site which all students could access offered a new dimension to communication with students. This has huge potential that can be taken advantage of and is limited only by the teacher's and students' imagination.

It is clear that trends in new technology offer much to education. However over usage or ineffective usage of these technologies could have a negative effect. There is also the issue of protecting students and student identities which needs to be included when planning a podcast project. Because this technology is new researchers and teachers need to be aware of what is not working and change or adapt quickly before the effect of the tools become a hindrance rather than a help.

Motivation and Special Education Needs learning

Podcasting has been shown to have enormous benefits for students with special education needs. The creation of podcasts by students has proved to be a highly motivating experience for all the students concerned. The learning and ability to deliver their learning displayed by the students is also extremely exciting. This has borne out the literature review by Millea, Green & Putland as well as work done by Strickland and Shanahan. This finding is very significant and perhaps was one of the most important and encouraging aspects of the whole study.

Pedagogical change

As outlined by Bransford, Brown & Cocking (1999) The study proved that motivation and learning can be achieved using tools and the level of motivation and learning achieved is dependant on the flexability that podcasts can offer. It is clear that new technology has huge potential. However the methods of teaching and application of this technology needs careful and ongoing review. The process which involved getting the students to create podcasts in response to questions may not be the most effective approach. More experimentation is needed here to find other efficient ways to assist the pedagogy as it is proven that podcasting does improve motivation and so the willingness to learn as outlined by Keller. Teachers have indicated the podcasting experience has been very enlightening and it will be incorporated into their planning in the future.

Life long learning skills ICT skills can be easily thought when students got to access new technology and researching a topic and assembling the information for public delivery can be easily facilitated.

Issues with the devices used

Many of the students did not listen to the podcasts using their digital media players and this did not seem to influence overall affect of the podcasts. This raises the issue of when and where should digital media players be used. It seems certain that mathematics students do not find them beneficial. Further research is needed in this area,

Future research

As mentioned in the literature review there are many aspects of podcasting which have not been evaluated in this study and they require further research. However the evidence from this short study is that podcasting has a place in education. The success of its implementation is dependant on the system that exists and on the flexibility that the teacher has to try new ideas. Change is planned for the Irish education system and when this change comes about then the role of podcasting and other new technologies should increase. Now is the time to experiment with new technologies so when the infrastructure and curriculum changes have been put in place the advantages they will bring can be availed of quickly.

Issues which need further research include:

- Research should to be carried out to see if the provision of podcasts in languages and subjects like history and geography could be more beneficial to students than was the case for mathematics in Study One of this research.
- More research in the special needs education area is needed to test the effectiveness and find the optimum method to allow a whole class to create podcasts quickly. Perhaps using the students own MP3 devices to record their material outside of class and then uploading it in school instead of written homework.
- Research is needed to see if Podcasts can breakdown barriers and create a greater awareness both nationally and internationally by allowing inter-school collaboration projects to develop podcasts. This would allow students from different backgrounds and cultures and languages communicate with each other.

- Research needs to be carried out to see if SMS messaging can be used to increase student participation and motivation as it was found very useful for contacting students outside of school hours in this study.

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Appendices

Appendix 1

Research Diaries

Your Diary Page

Please tell us what you think about the podcast you have used last. Filling out the Diary Page is your vital part of your contribution to the research project. All information gathered is strictly for research purposes and will be treated in the strictest confidence. No personal information will be divulged to anybody or group and will be destroyed when the research is completed.

Top of Form

Section 1.

Student Information:

Name

Cell Phone

E-mail

Study patterns

These questions are aimed at assessing how much time you spend studying mathematics and what you use to help you with your study.

Select one or more of the following that you use when studying mathematics?

☐ Class notes	☐ Text Books	☐ Podcasts	☐ The Web
Other Please specify			

How much time do you spend studying mathematics each week?
Less than .5 hours per Week

Podcasts

What was the last podcast you listened to about?

What device do you used to listen to the Podcasts?

☐ IPod/MP3 Player	☐ Cell Phone	☐ Computer in school	☐ Computer at home

When did you listen to podcast?

☐ Before the topic is introduced in class.	☐ After the topic is introduced in class.	☐ For reference at any time.	☐ Not at all.

Section 2.

Cognitive Learning assessment

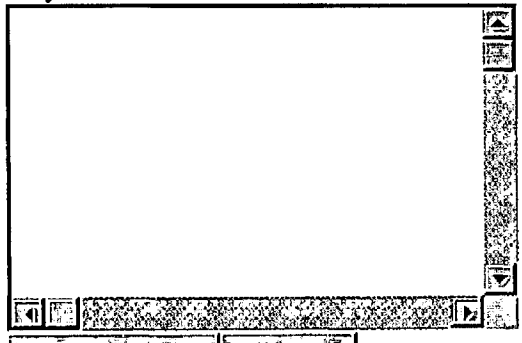
Assessment of learning using Podcasts On a scale of 0 - 5 to what extent did the following figure in the podcast.	0 = not at all 5 = to a large extent
New resource for helping with your study?	○ ○ ○ ○ ○ ○ 0 1 2 3 4 5
Becoming familiar with a new terminology/vocabulary.	○ ○ ○ ○ ○ ○ 0 1 2 3 4 5
Learning to structure, memorize and order information.	○ ○ ○ ○ ○ ○ 0 1 2 3 4 5
Understanding of concepts, interpreting facts, analyzing ideas and arguments.	○ ○ ○ ○ ○ ○ 0 1 2 3 4 5
Learning about alternative theories or points of view on the same topic.	○ ○ ○ ○ ○ ○ 0 1 2 3 4 5
Consolidating previous learning.	○ ○ ○ ○ ○ ○ 0 1 2 3 4 5
Learning to construct your own explanations.	○ ○ ○ ○ ○ ○ 0 1 2 3 4 5
Mastering specific skills or tasks.	○ ○ ○ ○ ○ ○ 0 1 2 3 4 5
Application of number skills or. information retrieval.	○ ○ ○ ○ ○ ○ 0 1 2 3 4 5
Enter any other learning you have gained not mentioned above.	Knowledge learned [ ] ○ ○ ○ ○ ○ ○ 0 1 2 3 4 5

Learning to Learn

Learning to learn refers to the knowledge you acquire about your own learning habits and strategies and how you organize your own learning. This section tries to see if using Podcasts has helped you do more or improve your own learning management.

Learning to Learn: To what extent do you feel using podcasts helped you with the following:	0 = not at all 5 = to a large extent
Sources of Information: Made you aware of other sources of information eg books, libraries, people, Podcasts, Internet, search-engines.	○ ○ ○ ○ ○ ○ 0 1 2 3 4 5
Planning & Self Monitoring: Helped in planning and monitoring your own learning progress, time management.	○ ○ ○ ○ ○ ○ 0 1 2 3 4 5
Independent learning: Learning to take the initiative, to make judgments and direct your own learning.	○ ○ ○ ○ ○ ◉ 0 1 2 3 4 5
Confidence: Gaining confidence in yourself as a learner.	○ ○ ○ ○ ○ ○ 0 1 2 3 4 5
Communications: Developing communications skills in speaking and writing.	○ ○ ○ ○ ○ ○ 0 1 2 3 4 5

Any further comments:



Thank you for completing the Diary. Please update it regularly.
Bottom of Form

Appendix 2

ARCS Questionnaire

Questionnaire for Motivational analysis

Answer all questions by circling the answer you think is most correct.

Attention:

Q1. Which method do you think is best for answering the question given?

- A Podcast
- A written document
- The Same

Q2. Which do you think gives you more choices for answering the question?

- A Podcast
- A written document
- The Same

Q3. Which do you think makes answering a questions at the end of a topic more interesting?

- A Podcast
- A written document
- The Same.

Relevance:

Q4. Which do you think can help a student remember more when answering the question?

- A Podcast
- A written document
- The Same.

Q5. Which do you think best suits your learning preferences/style?

- A Podcast
- A written document
- The Same.

Q6 Which makes a more interesting presentation ?

- A Podcast
- A written document
- The Same.

Confidence

Q7. Which do you find easier to do?

- A Podcast
- A written document
- The Same.

Q8. Which gives you more control over your work?

- A Podcast
- A written document
- The Same.

Q9. Which do you think you need to know more for?

- A Podcast
- A written document
- The Same.

Satisfaction

Q10. Which do you get more satisfaction from creating?

- A Podcast
- A written document
- The Same.

Q11. Which gets you more recognition when you do work?

- A Podcast
- A written document
- The Same.

Q12. Which helps you achieve more?

- A Podcast
- A written document
- The Same.

Appendix 3

Rubrics used

First Rubric

Question
Christopher Columbus Discovered the New World. What motivated them to come to this hemisphere? What challenges did they encounter here? What changes did they bring back to Europe? What is their legacy?

Your answer should include the following topics:
Who (Background information, nationality, timeline information about the explorer)
What were the reasons for the trip?
Where did he sail to?
What did he discover?
What did he find?
What difficulties did he encounter? (as a result of the exploration)
What was the result of his trip

Evaluation

Task	1	2	3	4
Content and interpretation of mind map.	Provides the name of an explorer, but few details. Answers 4 or fewer questions.	Identifies and provides 5-8 facts about an explorer. Some important information is missing..	Identifies and provides all important information about the explorer.	Identifies and provides all important information and additional information that is relevant about the explorer.
Structure of presentation	Attempts to make a presentation, but does not include much of the essential information.	Includes most of the essential elements, but information is not presented in a clear and concise manner.	Includes all of the essential elements, and is presented in a clear and concise manner.	Keynote includes all of the essential elements, as well as additional relevant information. The is presented in a clear and concise manner

Understanding of overall events Overall presentation.	Presentation is made with little or no enthusiasm. No further details are provided.	Presentation is made with some enthusiasm. Some details are provided in the some extra work done.	Presentation is made with enthusiasm. Details are provided in the presentation show that further understanding of the events.	Presentation is made with enthusiasm. Many additional details are provided in the show student's further the understanding of the subject. Well delivered.

Second Rubric
Question
Outline and explain each of DeBono's six hats.

Identify two of your favourite hats. Say why you prefer these hats to the others.

Select any 3 hats. Make a statement about Christopher Columbus and the Exploration that corresponds (matches) each of the hats you select.

Evaluation

Task	1	2	3	4
Content and interpretation.	Provides the colour of each but few details. Answers 4 or fewer questions.	Identifies and provides 2-4 facts about hats. Some important information is missing..	Identifies and provides all important information about the explorer.	Identifies and provides all important information and additional information that is relevant about the six hats.
Structure of presentation	Attempts to make a presentation, but does not include much of the essential information.	Includes most of the essential elements, but information is not presented in a clear and concise manner.	Includes all of the essential elements, and is presented in a clear and concise manner.	Keynote includes all of the essential elements, as well as additional relevant information. The is presented in a

				clear and concise manner
Understanding of overall process Overall presentation.	Presentation is made with little or no enthusiasm. No further details are provided.	Presentation is made with some enthusiasm. Some details are provided in the some extra work done.	Presentation is made with enthusiasm. Details are provided in the presentation show that further understanding of the events.	Presentation is made with enthusiasm. Many additional details are provided in the show student's further the understanding of the subject. Well delivered.