Exploring the Effectiveness of Using Integrated Multimedia on the Teaching and Learning Process

Gabriel Lawless

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I certify that this dissertation which I now submit for examination for the award of MSc in Computing (Assistive Technology), 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 cited and acknowledged within the test of my work.

This dissertation was prepared according to the regulations for postgraduate study of the Dublin Institute of Technology and has not been submitted in whole or part for an award in any other Institute or University.

The work reported on in this dissertation conforms to the principles and requirements of the Institute's guidelines for ethics in research.

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ABSTRACT

The methods and trends of providing and delivering education are evolving, the history of technology adoption in education suggests a consistent and challenging model, ideas and innovations are often developed in isolation, often lacking support and encountering resistance from a range of stakeholders

The importance of taking advantage of multimodal processing capabilities through technology based tools offer new hope in the matter of engaging learners in a more productive learning environment. More interactive tools provide great advantages but also challenges, open source resources are increasingly becoming available but some genuine fears remain as to the quality and relevance of some of this content.

Good multimedia instruction is driven by an understanding of how the brain processes information; learning theories have significant impact on instructional design, as there is a logical development from learning to instruction.

Every technology hard and soft, simple and sophisticated have their advantages, limitations and range of application which must be taken in to consideration from an educational perspective, especially where media and technology solutions are integrated into instruction.

There is a need to combine the needs of the educationalist and the skills of the technician. Technology is having a profound impact in the field of education especially in the delivery mechanisms, digital disruption is having a major impact and potentially changing the rules. As learning threatens to leave the school grounds, new approaches are required to meet the new challenges encountered by the relevant stakeholders, there is a need to identify the drivers of change and manage change in a well informed manner.

Key words: *Instructional design, innovation, multimodal, creative destruction, assessment, EPortfolio*

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1. INTRODUCTION

1.1 Project Background

The history of technology adoption in education suggests a consistent and challenging models, ideas and innovations are often developed in isolation, lack of support and resistance to change from a broad range of stakeholders. The emergence of new and improved technologies is consistently challenging the education community. The ability to create active content through the application of multimedia tools has the potential to extend the boundaries of education provision, but many obstacles remain in place before its full potential can be realised.

The importance of taking advantage of multimodal processing capabilities through technology based tools offer new hope in the matter of engaging learners in a more productive learning environment. The elements used in multimedia have all existed before. Multimedia creates the potential to combine these elements into a powerful new tool in the hands of teachers and students alike. Interactive multimedia for example weaves five basic types of media into the learning environment: text, video, sound, graphics and animation. A multimedia Learning environment involves a number of components to aid the teaching and learning process. Hardware and software are only part of the requirements; attention must be paid to the entire environment in which learning is planned to take place.

The pace of technological change in the past twenty years has been phenomenal, new user friendly tools, improved internet connectivity have eliminated many of the barriers previously encountered by a diverse range of learners. While there is clearly much potential in the use of ICT for education, there is, at the same time, a widespread lack of informed opinion of the specific impact of ICT on education goals and targets.

The OECD Report (2001) concluded that there are three main rationales for promoting the use of ICT in schools, namely the economic, the social, and the pedagogical. The pedagogical rationale for promoting ICT in schools is concerned with the use of ICT in improving the teaching and learning process.

According to The Report of ICT in Schools Joint Advisory Group to the Minister for Education and Science, the enabling drivers for a digital learning environment should include the following

- A high standard of reliable technology that is deployed effectively
- A rich source of digital content that supports the curriculum
- Digitally-literate teachers.

Multimedia is being developed worldwide for a number of reasons, change is been driven from a multitude of stakeholders, the emergence what Prensky. M (2001) labels the digital natives, policies and directives emerging from institutions like the EU, new and improved technologies offering increased operability are potentially shifting the boundaries...

- JISC (2004) the widening participation agenda places a responsibility on institutions to assess potential barriers to learning, and to address these through more flexible learning opportunities. Accessibility and inclusion are requirements that have moved beyond the 'special needs' agenda.
  Universal Design and Web Accessible Guidelines are helping to facilitating change.
- Global reach and the emergence of a learning community
- Demand for education in the use of the technology as a core competence in both work and 'life' tool, lifelong learning, learning through technology
- Educational benefits obtained from properly implemented / integrated projects.
- Political and business pressure to improve and extend the education system due to recession, EU initiatives
- Commercial interests for example hardware and software companies, private training, Skills net, Microsoft initiatives

- Companies, and network providers developing strategies to gain a competitive advantage, first to market
- Political and Economic pressures to reduce cost and provide better access
- National competitiveness / Sustainability / Green agenda
- Multimedia technology is seen as clean, reduce travel and improving accessibility and participation
- Formation of a critical mass of networked home / mobile multimedia technology

The potential to extract the benefits of multimedia is often hindered by a lack of skills and in some cases limited architecture.

T**he** Report of ICT in Schools Joint Advisory Group to the Minister for Education and Science generally is positive towards the progress in relation to the development of ICT in Irish schools. But a report ICT in Schools (2008) "*Promoting the Quality of Learning Inspectorate Evaluation Studies Department of Education and Science"* casts some doubt on the progress been made for example, only 30% of primary teachers and 25% of post-primary teachers rated their ability as either "intermediate" or "advanced" with regard to using teaching and learning methods that are facilitated by ICT. At the primary level, the inspectors reported evidence of the use of ICT to facilitate teaching and learning in 59% of the classrooms visited. However, the inspectors observed ICT actually being used in only 22% of the lessons observed.

The evolving natures of learning platforms are creating new visions for the future. The renewed emphasis on collaborative learning and connectivity is pushing the educational community to develop new forms of interaction. Collaborative experiences in virtual worlds are easy to find today compared to even a year ago. A changing environment can have a serious impact in many areas, as learning threatens to leave the school grounds, new approaches are required to meet the new challenges encountered by the many stakeholders. The provision of suitable equipment and properly planned architecture within schools is also important if schools are to benefit from the ongoing training of staff. Access and connectivity are essential.

Delivering on the potential of multimedia

The potential of ICT to provide a new era in education provision has raised much debate. As far back as 1969, Oettinger and Marks (1969) note, that the introduction of computers, systems analysis, and various forms of new media has been heralded as a panacea for all the problems now face our educational institutions. The adoption of new technologies has often been implemented in an unplanned and piecemeal manner. The traditional approach to e-learning tends to be structured around courses, timetables and testing, usually through the implementation of a Virtual Learning Environment. That is an approach that is too often driven by the needs of the institution rather than the individual learner.

Research undertaken by The Society for Learning Analytics Research (www.solaresearch.org) reveals a history of technology adoption in education that suggests a consistent and challenging model: important ideas and innovations developed piecemeal and in isolation, resulting in a fragmentation and confusion for end users who are most in need of efficient solutions.

In contrast, e-learning 2.0 takes a 'small pieces, loosely joined' approach that combines the use of discrete but complementary tools and web services – such as blogs, wikis, and other social software to support the creation of ad-hoc learning communities. Educators and developers need to be continually aware of changes in their environment and also changes to their own role, and in particular the need to adapt to change and evolution by planning for the management of change.

As Lomas *et al.* (2008) point out "*For every effective collaboration tool with well-implemented features, there are tools that do not succeed. The shortcomings of failed projects range from simply having an unintuitive, clunky interface to being too expensive or requiring too much hardware. Lotus Notes is an example of a powerful, multi featured collaboration tool that imposed too large a resource burden on users and administrators and was not able to successfully make the transition from proprietary server/client application to accessible, user-friendly web application.*"

As far back as 1994 Clark acknowledged that media can have positive influences on the cost and speed of learning, arguing that it is only the instructional method that can influence learning. He defines instructional method as "*the provision of cognitive processes or strategies that are necessary for learning but which students cannot or will not provide for themselves*". Emerging technologies have the potential to create a learning environment where students learn through technology rather than with it, tools and resources which are "active" and always accessible can potentially facilitate a more engaging environment. The potential to locate, store and create content can enhance learning and increase motivation.

1.2 Project Description

The question arises whether the advances in ICT in recent years has impacted positively upon the education system, if the education community have not extracted the full potential of multimedia in the teaching and learning process what are the barriers encountered or is it simply a question that multimedia has failed to deliver on its potential because its impact has been over rated or driven by vested interests.

The ability to extract the potential gains from new tools is reflected upon, by a report commissioned by Education Guardian. (2005)
The experience of e-learning for many has been no more than a hand-out published online, coupled with a simple multiple-choice quiz, hardly inspiring, let alone empowering. But by using these new web services, e-learning combined with improved multimedia tools has the potential to become far more personal, social and flexible.

Learners can become comfortable with behavioural objectives to guide their learning and can become apprehensive about determining their own learning needs and adopting self-directed learning.
Emphasis has shifted from the specifications of learning objectives to the specifications of learning activities but,

- Has the ability of learners to adapt to a new and emerging style of education provision been overestimated?

- Is there a need to develop new pedagogies to suit a new era in education provision?
- Are approaches and strategies successful in other countries suited to an Irish context?
- Are the barriers presently identified been addressed in a proper manner?
- Will the economic situation act as a barrier or a catalyst to successful integration?
- Can multimedia content be designed to appeal to a variety of learning styles and cultures?
- Are vested interests acting as a barrier to change?
- Can we identify drivers of change?

An essential area of research is the evaluation of ICT and broadband provision in Ireland under the guidance of the National Centre for Technology in Education (NCTE) which was established to guide the implementation of ICT in Irish schools. Reports commissioned by the OECD and the European Commission will be evaluated and compared with the experiences of the Irish situation.

This research seeks to explore the effectiveness of selected integrated multimedia on the teaching and learning process. Through a suitable methodology gather relevant information, and through detailed investigation make recommendations where applicable. In order to provide a means to undertake the research a Customised Interactive CD to Explore the World of Entrepreneurship has been developed focusing on the creation of a learning path through the integration of:

- Multimedia tools and resources
- Ongoing assessment through e portfolio and multiple choice tests (pre and post)
- Useful websites
- A virtual structure where learners undertake their own learning in a non-linear manner encouraging innovation and creativity.
- A virtual space where learners can communicate and promote idea generation, and locate specific relevant information.

The principles of universal design for instruction will be applied to the design of this CD to the greatest extent possible.

Learning theories have significant impact on instructional design, as there is a logical development from learning to instruction, emerging theories of instruction design will be applied to meet the needs of a changing environment.

Assessment is designed to promote and support learning during the course of the learning process, a formative process that facilitates skills development to be identified, reflected upon and corrected in a continuous manner.

Students will be required to demonstrate knowledge and understanding of course content by recalling, describing, reporting, identifying, recognising, recounting and relating, through the application of the following resources:

- **Online quizzes**
- **Multiple choice** (pre test to determine students knowledge, also a post test to examine students retention and understanding of course content)
- **e-Portfolio** Work co-operatively and independently, be self-directed, manage time, manage tasks and learning through technology
- **Interactive fun tests,** roll over's, drag and drop.

Criteria for Evaluation of E portfolio Content

The quality of information students access and eventually select will be evaluated under the following guidelines

- Authority
- Objectivity
- Authenticity
- Reliability
- Timeliness
- Relevance

1.3 Intellectual Challenge

Interactive multimedia as a subject is still in its early stages creating the potential to extend the boundaries of education provision, motivating educationalists and technologists alike. However, design and development of interactive multimedia content is a complex process usually involving a team of experts, including content providers, multimedia developers, graphic designers, and instructional designers. Embedding multimedia tools into the learning environment is a rewarding but yet a complex and challenging process.

Gagne (1987) identifies five major categories of learning: verbal information, intellectual skills, cognitive strategies, motor skills and attitudes. Ganges theory emphasizes that there are several different styles or levels of learning; there is a need to match instruction to meet individual or group requirements. The theory outlines nine instructional events and corresponding cognitive processes, but also the complex interaction between variables

1. Gaining attention (reception)
2. Informing learners of the objective (expectancy and affordance)
3. Stimulating recall of prior learning (retrieval and reflection)
4. Presenting the stimulus (selective perception)
5. Providing learning guidance (signposting and revision)
6. Eliciting performance (responding)
7. Providing feedback (reinforcement)
8. Assessing performance (retrieval)
9. Enhancing retention and transfer (generalisation, familiarity).

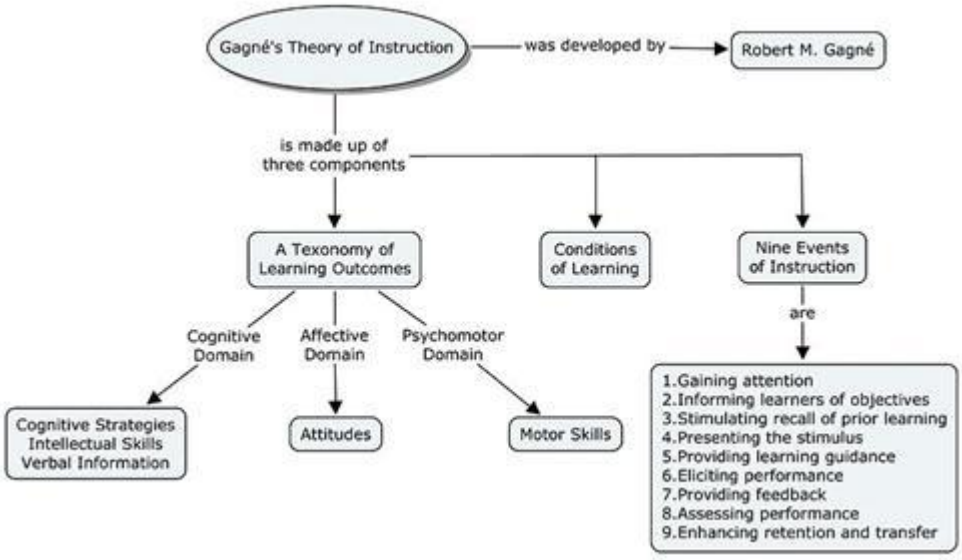

Figure 1a. Teaching and Learning Environment

Figure 1.Demonstronates the potential application of Gagne's Theory of Instruction within the wider environment.

The importance of taking advantage of multimodal processing capabilities through technology based tools offer new hope in the matter of engaging learners in a more productive learning environment. While everyone exhibits a combination of the various intelligences, the goal is to engage as many of these different capacities as possible within the same learning event or program. Good multimedia instruction is driven by an understanding of how the brain processes information understanding the process is a very complex area, creating learning paths which accommodates all learners provides many barriers.

Areas of Interest

- Limitations of technical solutions in the teaching/learning process.
- Out of date pedagogies or undeveloped pedagogies.
- Workload on teachers - technology is a low priority compared to teaching and adapting to changes in curriculum and education expectation.
- Difficulty of incorporating, tacit knowledge into electronic packages / web pages
- Slow progress on agreement and structures for accreditation of course material and certification.

- Contingency of teaching and learning - difficulty of creating common courses
- Technical limitations in relation to accessibility mobile learning, screen size, reliability, usability.
- Cost of selecting installing and maintaining the technology within institutions
- Lack of funding in some sectors,
- Standards issues - portability and compatibility of platforms application, networks etc.
- Uncertainty over the future direction of education and technologies becoming obsolete, the impact of creative destruction
- Lack of skills in production and management of multimedia, particularly in the schools

There is a necessity to marry new technologies within a sound pedagogical model to ensure that the potential is successfully utilised. Poh Meng and Kumar Puttar (2000) the "Old Wine, New Bottle" syndrome must end. Teachers must recognize that technology has successfully removed the constraints of time and space – and has forced us to redefine our basic understanding of where, when and how learning can take place. As with any innovation – be it fire, the wheel or the computer – educators must be brave to re-examine their age – old assumptions about teaching and learning

1.4 Research Objectives

The following objectives (have been) achieved throughout the dissertation and contributed to the overall outcome:
The aim of this project is to evaluate if the selection of multimedia tools and resources can be used to promote a more inclusive and deeper learning environment.
This project will look at models and techniques from the existing body of ICT and educational literature.

1. To investigate if the selection of various integrated multimedia tools and resources can facilitate collaboration and networking?
2. To investigate the attitude of participants to a new form of learning
3. To investigate if we can optimise any positive impacts of multimedia on the learning process?

4. To investigate if we need different pedagogical designs for e-learning?
    - To investigate if a framework can be applied to benefit the process of designing, planning, and sequencing learning tasks within the confines of a CD?
5. To examine if web based technologies can expose learners to a wider range of ideas and resources
6. Highlight the mistakes or failures of the past with a view to recommending solutions in the light of advances in technology
7. Evaluate and compare the relationship between the Irish Governments strategy with regard to ICT integration with similar countries experiences

1.5 Research Methods

This research will incorporate a range of research methods, including Case Studies, Interviews and Questionnaires. The key artefact that will be examined will be the e-Portfolio to determine the level of engagement that the students undertook and the depth of their learning.

Opus Pro is a visual development tool for Windows providing fast-track design of versatile e learning, interactive applications, stylish database front ends, online games and multimedia with or without programming. Publish and distribute to Flash, SCORM and Moodle as well as .EXE, CD-Rom and DVD-video for pleasure promotion or profit. Opus Pro offers a wider range of functionality than any comparable package. No add-ons or extra programs required - everything you need in one program. Design and develop everything from simple interactive presentations and quizzes to complex simulations, commercial programs and database applications with or without programming.

1.6 Scope and Limitations.

This research looks at the impact of multimedia on the teaching and learning process, the content of the CD is not intended as a specific business course but as a general introduction to the subject of entrepreneurship.

1.7 Organisation of Dissertation

Chapter 2

Literature Review.

This chapter traces the impact of multimedia on the teaching and learning process, the changing boundaries in education provision.

It looks at the evolution of instructional design and the impact of Gestalt psychology in relation to perception and attention.

Chapter 3

Methodology

This chapter introduces the methodologies applied in the execution of this research, the design of the Questionnaire, the evaluation criteria applied for this project.

This chapter also covers the methodology applied in the development and design of the software used for the project.

Chapter 4

Experimentation

This chapter defines the Project Objectives the tools and methods applied in the Distribution of the CD and Questionnaires.

An overview of Participants in relation to their present IT skills and prior education attainment is presented in a table format.

Chapter 5

Presentation of Findings

The Presentation of responses to the questionnaires, the set questions and the PMI are presented in a logical manner in order to create a visual platform for future investigation and analysis.

Chapter 6

Experimentation & Evaluation

This chapter describes the experiment. It analyses the Replies to Questionnaire, PMI and Identifies Software Difficulties / Compromises / Problems Encountered.

The difficulties uncovered through the research are discussed in detail

Chapter 7

Conclusions

The feedback from the research is examined in detail and recommendations are put forward based on the findings.

2. LITERATURE REVIEW

2.1 Introduction

This chapter traces the evolution of ICT in the provision of education and its potential impact upon a wide range of stakeholders. Mack and Massillon (1996) note, during a decade of multimedia and networking in education, a community (educational) of users moved from sceptical scrutiny of technology claims. Tracing the history of multimedia in education provides a window of understanding into the technology forces that shape our lives. New and improved technologies offer new hope in the area of education provision, change is been driven and facilitated through a variety of sources.

Asthana (2011) notes, the full potential of using multimedia technologies for learning in primary and secondary schools can only be realised after there has been some re-engineering of the way learning experiences are offered in the traditional schools and colleges. Pahl (2000) believes Evolution and change are ubiquitous for computer-based educational systems which can, as we have seen, pose some difficulties for educators and developers.

Both educators and developers can be catalysts and proactively drive innovation, but also need to react to changes in their environment in a holistic manner. Planning for multimedia should be seen in a broad context. It is important because the implementation of multimedia-enabled teaching and learning has to be integrated into an already existing and often rigid system and practice.

E-learning is commonly referred to as the intentional use of networked information and communications technology in teaching and learning. A number of other terms are also used to describe this mode of teaching and learning. They include *online learning*, *virtual learning*, *distributed learning*, *network* and *web based learning*.

The methods and trends of providing and delivering education are evolving. New Media Consortium (2007) note that, rising costs, shrinking budgets, and the increasing

need for distance education, are causing educational institutions to re-examine the way that education is been delivered.

There is new hope of extending the boundaries of education provision by taking advantage of multimodal processing capabilities through the application of technology based tools, engaging learners in a more productive learning environment. Lomas *et al.* (2008) note, Additional channels allow participants to employ the medium that best fits a particular communication and learning style. New collaboration tools and associated best practices are emerging almost daily. Everyone exhibits a combination of the various intelligences. The goal is to engage as many of these different capacities as possible within the same learning event or program. Gardener (1999) work around multiple intelligences has had a profound impact on thinking and practice in the field of education often challenging some the accepted theories of today.

Silver *et al.* (1997) believe that both multiple intelligences and learning styles can work together to form a powerful and integrated model of human intelligence and learning a model that respects and celebrates diversity and provides us with the tools to meet high standards to meet high standards

Good multimedia instruction is driven by an understanding of how the brain processes information, but this is a complex area requiring much understanding and ongoing evaluation of the wider environment. The technological advances of the 1980s and 1990s have enabled designers to move toward a more constructivist approach to design of instruction. One of the most useful tools for the constructivist designer is hypertext and hypermedia because it allows for a branched design rather than a linear format of instruction. Many institutions are adapting the use of technology in developing new and creative courses; the emergence of blended learning has in some cases provided the groundwork to investigate the potential of multimedia in an educational context more fully. Multimedia computers enable educators to build customised and highly interactive learning systems that the learners can explore freely, the potential to offer students resources to construct their own learning environments, through a combination of an e-portfolio and integrated multimedia.

2.2 Extending the Boundaries of Education Provision

The development and application of guidelines like SCORM, Web Accessible Guidelines have the potential to provide a more inclusive and contextual learning environment, more flexible and compliant technologies are creating new possibilities. Multiple single purpose technologies can be cost prohibitive, but a single technology that can be applied for multiple uses, can reduce costs and provide greater flexibility to respond to the growing and evolving needs of a more demanding audience.

Technology in many cases has become ubiquitous impacting on all our lives offering many opportunities and threats. Improved broadband provision and the adoption of new technologies many argue have extended the boundaries of education provision. Multimedia has the potential to facilitate and offer exciting possibilities for meeting the demands of a new generation of learners. Computer based multimedia learning environments for example; employ the use of pictures (video, Skype) and words to create a powerful medium for improving student learning and understanding. Students have the option to select a combination of media to match their learning style.

But caution is urged by researchers such as Cotosman (2006) who notes every technology hard and soft, simple and sophisticated have their advantages, limitations and range of application which must be taken in to consideration from an educational perspective, especially where media and technology solutions are integrated into instruction. The *National Educational Technology Standards for Students* (2008) state that effective integration of technology is achieved when students are able to select technology tools to help them obtain information in a timely manner, analyse and synthesise the information, and present it professionally. The technology should become an integral part of how the classroom functions as accessible as all other classroom tools.

Not all educationalists are convinced with the marriage of present educational goals and objectives and new emerging technologies CIBER (2008) for example, claim that, although young people demonstrate an apparent ease and familiarity with computers,

they rely heavily on search engines, view rather than read and do not possess the critical and analytical skills to assess the information that they find on the web.

In more recent times, the internet has acted as a catalyst for *creative destruction*, a term coined by Schumpeter (1975) Capitalism, then, is by nature a form or method of economic change and not only never is, but never can be stationary. And this evolutionary character of the capitalist process is not merely due to the fact that economic life goes on in a social and natural environment which changes and by its change alters the data of economic action. The increasing impact of open source tools and resources, ever improving connectivity are driving change.

Becta (2009) suggests the development of 'learning paths' that allow students to take their own route through different learning activities based either on the choices they make or their performance in online tests. Feedback they were also extremely positive about the multimedia content and interactivity that we had built into the VLE. Becta (2007) also acknowledge that there is a growing body of evidence that many learners are achieving a kind of self-empowerment and, arguably, engaging in self managed learning through their participation in online social networks and their use of social tools in general.

2.3 Virtual Learning Environments

There are genuine concerns in relation to the quality and relevance of content been accessed, privacy and security issues to name a few. Many institutions have deployed Virtual Learning Environments as a vehicle to respond to, or compete with the threat of potential new and improved technologies, often citing the potential of the VLE to structure course content, the provision of tools for tracking student behaviour and offering full-time access.

Rosenberg (2001) define a VLE as a set of teaching and learning tools designed to boost students' learning practice by including computers and the Internet in the learning process. The main components of a VLE package include curriculum

mapping (breaking curriculum into sections that can be assigned and assessed), student tracking, online support for both teacher and student, electronic communication (e-mail, discussion forum , chat, Web publishing and Internet links to outside curriculum resources.

The emergence of Virtual Learning Environments has to some extent created a platform to diffuse multimedia content in to our education system, a point noted by Walsh (2011) who cites the 2008 *Department of Education and Science* strategy report "*Investing Effectively in Information and Communications Technology in Schools"* revealing that more Irish based resources are available online but collaboration generally takes place through the use of VLEs. Virtual Learning Environments (VLE), such as Moodle has become a powerful tool in education, providing instructors and students alike with multiple tools that support the learning process. These new tools have the potential to provide educators with new and improved opportunities. The selection and application of these new and constantly improving tools is becoming increasingly important.

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VLEs represent a shift away from the model in which students consume information through independent channels such as the library, a textbook, moving instead to a model where students draw connections from a growing network of resources that they select and organise. Gardner *et al.* (2005) observed however, the vetting of materials on a common platform for use by pupils across all three schools proved to be an early problem, owing to teachers' concerns about inappropriate aspects of the content. This was resolved by controlling access using locked folders for each school. Questions arise as to the quality of the content provided, the skills needed to produce quality content, the ability of a diverse range of learners to assimilate the content, or the ability of the VLE to compete with the emergence of Personal Learning Environments?

Stiles (2007) while acknowledging the evolving nature of the VLE suggests that whilst VLEs may remain for some time to come, their role will change. Instead of being monolithic systems full of bolted on technologies at the core of an institutions e-learning activities, they will serve simply to articulate intended learning outcomes. However Wilson (2006), considers VLEs to be a barrier to innovation, as they have become what he describes as a "dominant design" a term introduced by Abernathy and

Utterback (1978) After a technological innovation and a subsequent era of ferment in an industry, a basic architecture of product or process that becomes the accepted market standard. He goes on to suggest that other more innovative technologies, such as Web 2.0 tools, have been at best marginalised and at worst banned in educational institutions.

Becta (2007) acknowledge that there is a growing body of evidence that many learners are achieving a kind of self-empowerment and, arguably, engaging in self managed learning through their participation in online social networks and their use of social tools in general. The removal of learning from within the school walls provide many challenges but Chaffert and Hilzensauer (2008) note, there has been a renewed focus on open models that have the potential to improve the teaching and learning processes in education, exploring the possibilities of different technological configurations that can facilitate student-centred teaching methodologies by incorporating LMS, PLEs, e-portfolios, etc. Becta (2007) detect a move from passive consumption to active participation this requires stakeholders to adapt to a new environment there is a need for all stakeholders to become what they term "second wave adopters"

The Horizon Report (2008) focuses on the need to look at the changing environment in regard to the way information is accessed retrieved and stored, Two new forms of information stores are being created in real time by thousands of people in the course of their daily activities, some explicitly collaborating to create collective knowledge stores like the Wikipedia and Freebase, some contributing implicitly through the patterns of their choices and actions. The data in these new information stores has come to be called **"**collective intelligence" and both forms have already proven to be compelling applications of the network. Explicit knowledge stores refine knowledge through the contributions of thousands of authors; implicit stores allow the discovery of entirely new knowledge by capturing trillions of key clicks and decisions as people use the network in the course of their everyday lives. The rate of technological development is so great, Stiles (2007) one must consider the future of learning environments, especially with the onset of Web 3.0 and Web x.0.

2.4 The Emergence of Mobile Technologies and Digital Natives

Internet technology is a tool that can be applied in different ways and for different purposes and is part of an evolving process that may involve change, modification and reinvention by individual adopters, a changing environment where networking technologies, memory, displays and sensors is enabling a move towards pervasive computing, ubiquitous connectivity and more adaptable interfaces that are sensitive and responsive. The emergence of integrated multimedia marks a fundamental change in the role resources both people and media play in teaching and learning. But research conducted by the University of Edinburgh FAME 2010+ casts some doubt on the marriage of technology to a sound pedagogical base.

As regards content for education proper, much of the widely available material to date is sadly lacking in sophisticated pedagogic provision. Most is Skinnerian, response reinforcement, with limited (though for certain purposes very useful) educational validity. Much boils down to "electronic page turning" and amounts to no more than a dynamic text book.

Bavelier *et al.* (2100) suggest that it is clear that the vast majority of studies that address the impact of technology on academic achievement do so using standardised tests developed in the 20th century; it is questionable if these tests are valid tools to evaluate how well our educational system prepares learners for the demands of the21st century.

Assessment for example is often applied through multiple choice quizzes which can be often difficult to construct effective questions to measure higher order thinking. There is a requirement to create effective content through the application of multimedia. Active content with instant feedback can be facilitated by the application of selected multimedia tools, there is also a variety of toolkits which can be accessed to evaluate the quality of the content, and the learning community is evolving and adapting to change.

Chaffert and Hilzensauer (2008) note there is a responsibility to, explore the possibilities of different technological configurations that can facilitate student-centred teaching and self directed learning, e-Portfolio and the ability to learn through technology. As individuals and institutions complete the process of adopting new technologies to support learning, many factors can impact upon them, especially in their design and delivery. New technology presents risk for many stakeholders. They react differently toward this risk based on their innate characteristics, their wants and needs. The pace of change poses many challenges for education provision; many new technologies have rewritten the rules. We now must question the ability of traditional methods to create a rich multimedia teaching and learning environment which will incorporate all aspects of a potentially new pedagogic practice.

Bavelier *et al.* (2100) note, the pace or lack of change poses many challenges for education provision; many new technologies have rewritten the rules. We now must question the ability of traditional methods to create a rich multimedia teaching and learning environment which will incorporate all aspects of a potentially new pedagogic practice. As there is a logical development from learning to instruction, is there a need for emerging theories of instruction design to be applied to meet the needs of a changing environment.

Watson (2001) detects many barriers to ICT integration and importantly adoption of new technologies. The history of innovation in education should teach us to be cautious about predictions and assumptions associated with new and emerging technologies. Curriculum change theories believe that once a small cohort of innovators emerge, their adoption of the innovation will filter through their peer group of teachers. But it is clear this is not happening with respect to ICT in schools; the innovators have remained a minority of teachers for well over a decade. Interactive multimedia as a subject topic is still in its early stages, but the design and development of an interactive multimedia program is a complex process involving a team of experts, including content providers multimedia developers, graphic designers and instructional designers.

According to Mitchell (1998) a cross-disciplinary approach to interactive multimedia design in education is required stakeholders with the interest and ability to produce

works that not only stimulate our senses, but also challenge us intellectually. Multimedia computers potentially enable educators to build customised and highly interactive learning systems that the learners can explore freely, the potential to offer students resources to construct their own learning environments, through a combination of an e-Portfolio and integrated multimedia. The process of designing planning and sequencing learning tasks are essential to a successful outcome not only should care be taken to ensure the use of sound pedagogical models but also to the wider environment should be continually monitored for potential change. With higher expectations also comes the responsibility to deliver. Appropriate research methods and sound frameworks need to be applied to deliver on the potential of multimedia in education development. Gardner *et al.* (2005) summarise some of the difficulties involved: the large volume of resources available created a number of structural design difficulties the expertise of technical experts is crucial to ensure a navigable design. The identification, quality assurance and structural design processes requires considerable time and effort

Krumsvik (2008) notes, that we are also seeing a move away from cognitive psychology to more socio cultural perspectives on what constitutes learning in the new, virtual learning arenas. The most common example of this is young people's "online existence" and the digital world they inhabit with its chat forums and online communities. Now the aim is to make all learning resources, tools and environments adaptive to individual needs but also taking in to consideration what Prensky (2001) identifies as three distinct groups of people in the area of education, digital natives (those who have grown up immersed in technology; digital immigrants (those who have developed aspects of new technology) and analogues (those who will not, or cannot, adopt any aspect of new technology). Mitchell and McKeon (2004) this demands an understanding of how individual learners make sense of their own learning process, and how learner differences should be represented and addressed. Newhouse (1999) states that some of the barriers preventing teachers from integrating technology were poor computer literacy, lack of time, lack of confidence, and hardware malfunction, a lack of standardised concepts and procedures for design and management contributes to this dilemma. The only solution is to embrace evolution and change from the outset through the design of flexible systems.

Current policies guiding our education system have generally followed a consistent design pattern. The traditional approach to e-learning in many cases has tended to be structured around the courses, timetables and examinations. An approach that is many instances is dominated by the needs of the institution rather than the needs of a diverse range of learners.

Leadbeater (2006) summarises the new challenge, Schools are factories for learning in an age when we need agility and self-motivation. Learning beyond the school, using new technologies and tools, will become as important as learning at school. Imagine an education system for the generation that grew up with eBay and Google, MySpace and Wikipedia: participative, personalised, collaborative, and always available. This increased availability of new technologies and tools combined with an increased awareness in the area of information processing, offers the opportunity to extent the boundaries of education instruction and delivery. The potential to expose students to new forms of content delivery is well documented and there are concerns that as a medium multi media has failed to deliver on its potential. A point well made by Parker (2009) who notes, *"Learning technologies can promote powerful connections to content, context, and community. Unfortunately, they can also offer broad access to poorly designed and executed courseware".*

There is a need to take a more long term view as a study by CIBER (2008) notes that a new study overturns the common assumption that the 'Google Generation' - youngsters born or brought up in the Internet age - is the most web-literate. The first ever virtual longitudinal study carried out by the CIBER research team at University College London claims that, although young people demonstrate an apparent ease and familiarity with computers, they rely heavily on search engines, view rather than read and do not possess the critical and analytical skills to assess the information that they find on the web.

It has been widely recognised that extracting the potential of modern technologies for teaching and learning purposes requires that appropriate teaching / learning strategies be developed and applied JISC (2004). The emergence of integrated multimedia marks a fundamental change in the role resources both people and media play in teaching and learning. In a rapidly changing environment where information is ubiquitous and needs

only to be located is creating a lot of debate in the field of education creation and delivery.

Siemens (2006), concept of learning ecologies views an environment that supports and encourages learning, characterised as being adaptable, dynamic, self organised/individually managed, informally structured, varied, and evolving. Van Patten (1989) detects a change in the role of instructional designers, Instructional designers no longer depend on any one theory; they draw upon and incorporate from different learning theories, mix those with other information and apply the results to meet human needs.

Recent research by Rowland *et al.* (2008) indicates that the technological skills of society are becoming more balanced; now the aim is to make all learning resources, tools and environments adaptive to individual needs. Greater access to new tools and improved IT skills has the potential to create a new paradigm in education; Boyle (2002) delivery but technology integration can be complex and there is a need to align all the necessary elements into a cohesive methodology

Campbell *et al.* (2007) clearly identify some of the barriers yet to be overcome in the evaluation and comparison in performance. In spite of the attention given to analytics as a concept and the development of methods educators do not have access to integrated toolsets that allow for varied and complex evaluations of learner performance and comparisons between different sets of learners. There is a requirement to understand all the variables and how they interact. Nesbit *et al.* (2006) for example believe evaluation instruments designed specifically for smaller digital resources are required there is a need to look at this area at both a macro and micro level.

2.5 Instructional Design

Instructional design is a method for systematically promoting design development, and is used as a way of improving quality in the design of educational courses and systems. In principle it enables the development of effective educational programs by going

through the stages of analysis, design, development, implementation and evaluation. Traditional ISD Models are often viewed as representing a linear process -- a plan of separate steps that proceed in a linear sequence. Bagdonis and Salisbury (1994) indicated the typical ISD model is divided into five stages: analysis, design, production/development implementation, and maintenance/revision. The five stages consist of an integrated set of components that are sequenced so that each component within the process must be completed before continuing to the next.

Over the years many instructional design models have been proposed by Bagdonis and Salisbury (1994). However, the many of these models currently employed are based on social science theories from the behavioural family, largely defined to include information processing and cognitive science theories that break down content to be taught into smaller units and are then taught with direct instruction strategies. Crotty (1994) for example Suggests a constructivist will try to create, where learners "*are required to examine thinking and learning processes; collect, record, and analyze data; formulate and test hypotheses; reflect on previous understandings; and construct their own meaning"* .

Dick and Carey Design Model

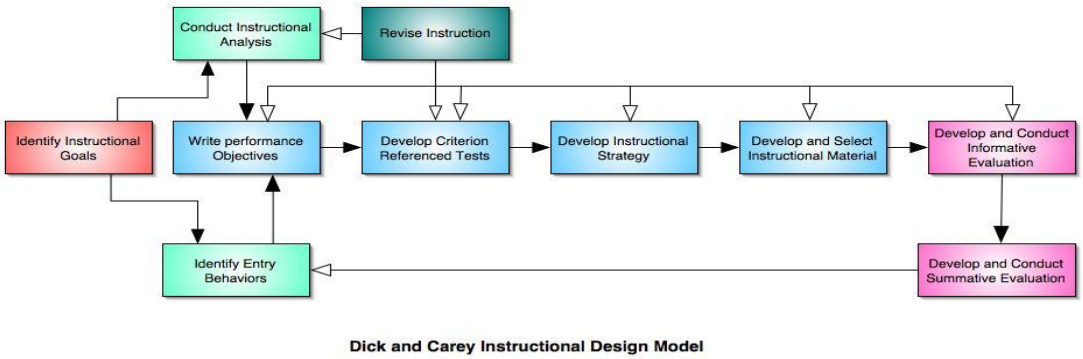

Figure 2a The Dick and Carey (1996) design model

The Dick and Carey (1996) design model uses a systems approach for designing instruction. The systems approach is sometimes criticised, as it is seen to be too focused on specific objectives to be successfully applied to the development of instruction which supports higher level thinking and the active construction of knowledge by the learner.

Supporters believe the systems approach can be effectively employed to set appropriate goals and construct learning environments that facilitate the reaching of those goals Merrill (1988). But it should be noted that the 1996 edition of the model the original model was introduced in 1968 included some important changes. Dick and Carey consider the impact of performance technology on the derivation of instructional goals, as well as increased focus on the context of learning.

Dick (1995) has slightly revised his traditional ISD approach. Some of his suggestions now seem to reflect some of the positions advanced by Willis (1995). Dick's new revision of his model included: Extensive formative evaluation "*if 'creative instruction' is an important characteristic.... then an array of questions can be asked during the formative evaluation to determine how creative the instruction is perceived to be by the learners*".

The Kemp Model defines different elements – not "step, stage, level, or sequential item" Morrison *et al.* (2004) of an instructional design, and emphasises the adoption of continuous updating and evaluation during the entire instructional design process. According to Morrison *et al.*, there are nine key elements to successful instructional design.

- Identify instructional problems, and specify attainable goals for designing an instructional programme.
- Identify learner characteristics that should receive attention during planning.
- Identify subject content, and analyse task components related to stated goals and purposes.
- State instructional objectives for the learner.
- Sequence and pace content within each instructional unit for logical learning.
- Design instructional strategies so that each learner can master the objectives.
- Plan the instructional message and delivery.
- Develop evaluation instruments to assess objectives.
- Select resources to support instruction and learning activities.

These elements are independent of each other, in that they do not need to be considered in a linear fashion and there is no particular start- and end point. The oval

shape of this model is constructed to convey the idea that the design and development process is an iterative cycle that needs constant planning, design, development and assessment to ensure effective instruction.

Dick (1995) suggests that a compromise is required, what are required are a balanced perspective, and a balanced set of criteria, the bedrock assumptions and conceptual framework within which we operate, that are most important.

Mayer and Moreno (2002) note, multimedia instructional messages can be influenced by the instructional designer's conception of multimedia learning. When the instructional designer takes an information delivery view, the goal of the multimedia message is to deliver information. When the instructional designer takes a cognitive view, the goal of the multimedia message is to promote knowledge construction in the learner. This is accomplished not only by presenting relevant material in words and pictures, but also by helping the learner to process the presented material in meaningful ways. Consideration must always be given to the application of audio, animation and text in the design of such a learning event, content needs to be displayed in a clear and logical manner.

Engagement of the learner is essential but providing an optimum mix of resources can be a very complex matter and has implications for instruction. The developmental framework below proposed by Hede and Hede in 2002 identifies many of the variables necessary for delivering sound e-learning instructional materials grounded in engaging multimedia effects is guided by the integrated model of multimedia effects on learning.

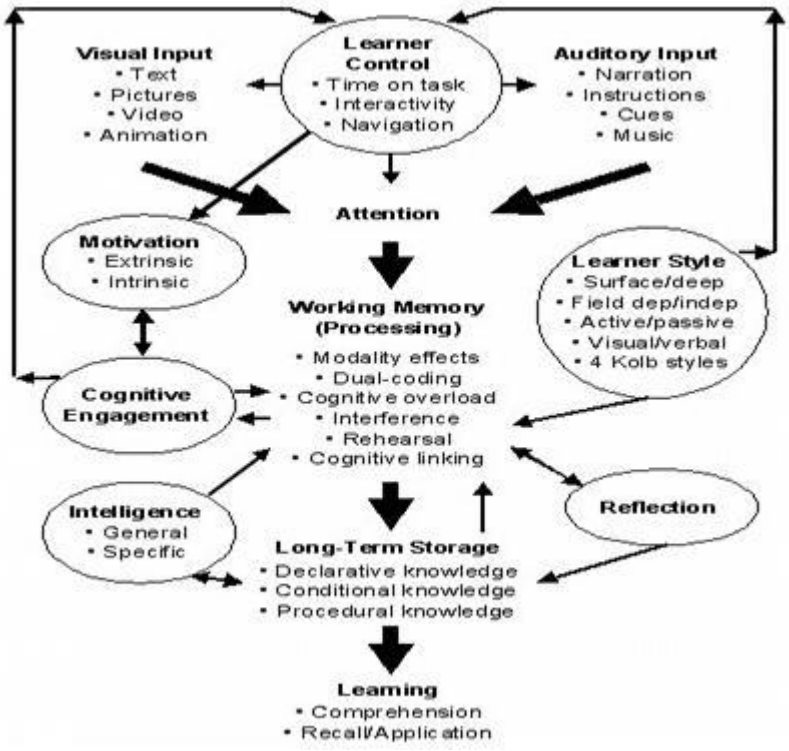

Figure 2b The Hede and Hede (2002)

The Hede and Hede (2002) model shows in the range of up to 12 multiple factors and their complex interactions that multimedia and e-learning designers need to be aware of to account for multimedia effects on learning.

Creating a more engaging environment

In the matter of engaging learners in a more productive learning environment, Marton and Saljo (2005) have identified different approaches to learning by individual students resulting in different levels of understanding; these have been described as surface and deep approaches to learning. Learners tend to focus their attention either on the text itself or on what the text is actually about. Multimedia can stimulate more than one sense at a time, in the process may be more attention getting and importantly attention holding. Multimedia affords the potential to accelerate or decelerate processes for purposes of understanding, time and space can be extended to meet the particular needs.

Sweller (2003) notes Our ability to process information is a multi step process that involves perception, attention, selection, organisation and integration of information the Cognitive Load Theory developed by Chandler and Seller (1991), states that

working memory is limited in its capacity to selectively attend to and process incoming sensory data so it is essential that contents delivered in a balanced and perceivable format. Miller (1956) for example presented the idea that short-term memory can only hold 5-9 chunks of information (seven plus or minus two) where a chunk is any meaningful unit. A chunk could refer to digits, words, chess positions, or people's faces. The concept of chunking and the limited capacity of short term memory became a basic element of all subsequent theories of memory, however

Good multimedia instruction is driven by an understanding of how the brain processes information. It looks at issues such as levels of processing; the idea that the way information is encoded affects how well it is remembered. The deeper the level of processing, the easier the information is to recall. There is a requirement to provide content in a manner that students can process in a meaningful way which will provide a platform for further learning.

Boyle and Jackson (2009) note, Incorporating digital media content in a presentation can greatly enhance the ability to reach a wider audience by way of appealing to a variety of learning styles; the potential to search and locate information can aid the student greatly as context can play a vital role in understanding and knowing.

The ability to deliver / communicate content to a diverse range of individuals requires a lot of understanding of the cognitive processes to be successfully executed, technology integration is not a “one size fits all”

Researchers in education and learning leverage epistemological and psychological concepts in order to study how people really learn, and to develop improved methods of teaching and assessment for use in various situations and circumstances.

Shavinina and Loarer (1999) notes, contend that the design of multimedia learning materials are frequently not informed by relevant research in psychology and education

Creating a balance

There is a need to combine the needs of the educationalist and the skills of the technician. *Intrinsic cognitive load* can occur when the interaction between the level /nature of the material being provided and the ability of the user to assimilate the message. De Jong (2009) in his paper Cognitive load theory, educational research, and instructional design: some food for thought notes, Cognitive load is a theoretical notion with an increasingly central role in the educational research literature. The basic idea of cognitive load theory is that cognitive capacity in working memory is limited, so that if a learning task requires too much capacity, learning will be hampered. The recommended remedy is to design instructional systems that optimize the use of working memory capacity and avoid cognitive overload.

Brown *et al.* (2006) found that the ability to engage the individual is essential there is a need to be flexible and adaptive, affordance and the potential to motivate learners are required, easy navigation, and tolerance for error and natural language are essential components to a successful outcome. Many hypermedia systems are employed for educational purposes. One of the main tenets of education is that students are different from one other, and these differences may have an impact on how they learn. This strongly suggests that any material used for pedagogical purposes should be changeable or adaptive, in order to cater for these differences. The instructional design of these systems should be based on a careful examination and analysis of the many variables, both human and technical,

A Multimedia Learning environment involves a variety of components in order to effectively facilitate learning. Hardware and software are only part of the equation. Text, sound, video, animation, and graphics are the cornerstone of effective communication but attention must be applied to areas like Human Computer Interface design, Accessibility issues, Delivery modes / combinations, Scheduling and Recording, nature of interactivity.

There has been a considerable move away from static content to a more interactive world; data can be easily viewed in different formats and in real time. The placement and application of animations on text and pictures can prove a delicate balancing act; there is a need not to overburden the information processing process.

Gestalt Psychology

Gestalt psychology has shown the importance in human thinking and problem solving of the behaviour that it labels “intuition,” “insight,” and “understanding.” Gestalt psychologist emphasise the importance of organisational processes of perception, learning, and problem solving. They believed that individuals are predisposed to organise information in certain ways. This can be very useful to the understanding of the interaction between man and machine Gestalt laws can be applied as a guideline in relation to context, navigation, Recognition and the grouping of information

Paivio (1986) presents a dual coding theory which believes that visual and verbal materials are processed in different processing systems the visual channel takes input initially from the eyes and ultimately produces pictorial representations, the verbal channel takes input initially from the ears and ultimately produces verbal representations. Presenting too many elements to be processed in visual or verbal working can lead to overload in which some of the elements are not processed. Mayer (2005) has identified the following guidelines:

- The multiple representation principle states that it is better to present an explanation in words and pictures than solely in words.
- The contiguity principle is that it is better to present corresponding words and pictures simultaneously rather than separately when giving a multimedia explanation.
- The coherence principle is that multimedia explanations are better understood when they include few rather than many extraneous words and sounds.
- The modality principle is that it is better to present words as auditory narration than as visual on-screen text
- The redundancy principle is that it is better to present animation and narration than to present animation, narration, and on-screen text.

Learning styles

Curry (1990). An increasing number of educational psychologists now believe that there is little evidence for the efficacy of most learning style models, that the models are often based on unproven theoretical grounds, a point reinforced by Reiner and Willingham (2010) who note learning-styles theory has succeeded in becoming

"common knowledge." Its widespread acceptance, underpinned by a well-known cognitive phenomenon called the confirmation bias. Encouraging us to seek out information that confirms our beliefs and ignore contrary information, even when we encounter it repeatedly.

Well-designed studies by Pashler *et al.* (2008) contradict the widespread "meshing hypothesis", that a student will learn best if taught in a method deemed suitable for the individual student's learning style. Technology needs 'to adjust to the needs of all learners an integrative approach is put forward by Seale (2004) continually anticipating and planning for student diversity

2.6 Constructive Alignment

Biggs (2006) introduces the concept of *constructive alignment* represents a marriage of the two thrusts, constructivism being used as a framework to guide decision-making at all stages in instructional design: in deriving curriculum objectives in terms of performances that represent a suitably high cognitive level, in deciding teaching/learning activities judged to elicit those performances, and to assess and summatively report student performance. Multimedia provides the potential to extent time and space, the combination of software tools and resources allow learners time and space for experimentation potentially allowing the teacher to scaffold learning in a meaningful way. Vygotsky (1978) provides a very influential theory which emphasizes a meaningful social context in the development of learning.

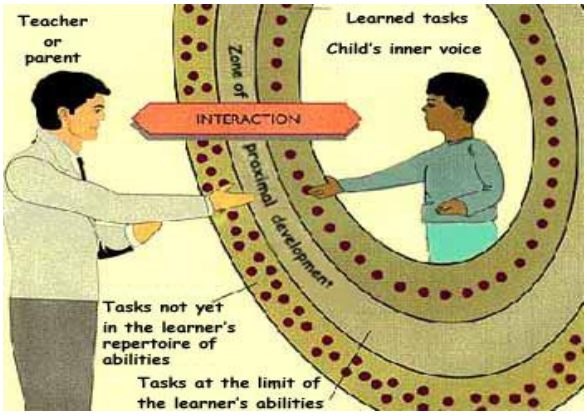

Figure2c Vygotsky ZPD

The Zone of Proximal Development, often understood to refer to the way in which the acquisition of new knowledge is dependent on previous learning, as well as the availability of instruction. There are two levels of attainment for the ZPD:

- Level 1 – the present level of development
- Level 2 – the potential level of development

The gap between level 1 and 2 is what Vygotsky described as this zone of proximal development. Scaffolding provides an effective way to reach potential levels of development, but only when different levels of assistance are given when required, culture, background and social interaction are important factors. Data mining techniques have the potential to track and monitor learner behaviour creating a more informed environment. Educational Data Mining is an emerging discipline, concerned with developing methods for exploring the unique types of data that come from educational settings, and using those methods to better understand students, and the settings which they learn in.

Bienkowski *et al.* (2012) note that the same kinds of data that inform user or learner models can be used to profile users. These categories then can be used to make recommendations to the users and adaptations to how a system performs.Educational data mining and learning analytics have the potential to reveal data that have gone unnoticed.

While Computers speed the process of information processing, they often rely on human skills (analysis and appropriate presentation skills) that must be learned to effectively communicate the message been delivered.

Data visualization is the study of the visual representation of data, meaning "information that has been abstracted in some schematic form, including attributes or variables for the units of information". Data visualization is closely related to information graphics, information visualization, scientific visualization, and statistical graphics. According to Friedman (2008) the "*main goal of data visualization is to communicate information clearly and effectively through graphical means, but this does require data visualization to look boring to be functional or extremely sophisticated to look beautiful.*" Data presentation architecture is a skill-set that seeks

to identify, locate, manipulate, format and present data in such a way as to optimally communicate meaning and lead to knowledge acquisition. These new technologies offer the potential to replace and improve upon the tools been applied at present, the potential to refine and deliver the intended message in the most appropriate form. For example offering the potential to place the learner in a suitable place by using appropriate scaffolding and Ausubels (1960) concept of advance organizers as signposts.

2.7 Andragogy

Knowles (1984) distinguished andragogy, or adults learning, from pedagogy the sciences of helping children learn. The six key assumptions underlying andragogy:

- **Self concept:** Self concept refers to an adult becoming more self directed and independent as a consequence of life experience.
- **Experience:** Adult learners have acquired various life experiences that they bring with them and apply to new learning experiences.
- **Readiness to learn depends on need:** Maslow's understanding of motivation, hygiene factors, impact of recession on areas like security, self actualisation.
- **Problem-cantered focus:** Innovation and creativity
- **Internal motivation: S**elf-esteem, better quality of life, self-actualization, etc.

- **Adults need to know why they need to learn something.**

Multimedia facilitates collaboration and provides numerous channels to engage learners interactive material with quick and rich feedback potentially provides learners with a variety of options to learn. Bloom (1956) identified three domains of educational activities:

- **Cognitive**: mental skills (Knowledge)
- **Affective**: growth in feelings or emotional areas (Attitude)
- **Psychomotor**: manual or physical skills (Skills)

Personality can have an impact on the learning process and the potential of individuals to encode different types of content. Developing and applying suitable strategies has the potential to change the face of education.

Sarasvathy (2001) who researched the connection between the education system and successful entrepreneurs argues that a change is required. Traditional courses rely heavily on rational thinking, casual rationality begins with a pre determined goal and a given set of means and seek to identify the optimal fastest, cheapest, most efficient route to achieve a given goal, effectual reasoning however does not begin with a specific goal. Instead, it begins with a given set of means and allows goals to emerge contingently over time from the varied imagination and diverse aspirations of the founders and the people they interact with.

Multimedia in an educational sense can be very effective when the content and format engage the learner, and "active engagement" helps the student construct knowledge and organize information into meaningful schema potentially allowing the student to create a very personal and productive learning experience.

A Report of the ICT in Schools Joint Advisory Group to the Minister for Education and Science "*SMART SCHOOLS = SMART ECONOMY*" note that we are currently facing new and difficult challenges which, coupled with the need to establish Ireland as a smart economy, the efficacy of ICT in enhancing the learning experience is being proven both in the classroom and at home.

Green *et al.* (2007) note that the current generation of young people will reinvent the workplace, and the society they live in. They will do it along the progressive lines that are built into the technology they use every day of networks, collaboration, co-production and participation. The change in behaviour has already happened. We have to get used to it, accept that the flow of knowledge moves both ways and do our best to make sure that no one is left behind.

Hegarty (2006) note that evidence suggests that Northern Ireland Centre for Entrepreneurship (NICENT) has increased interest and positive attitudes towards

entrepreneurship in Northern Ireland. E-learning can meet high demand, intensive programmes are equally effective in improving the skills set. Entrepreneurship education needs sub-sequential support.

Learning technologies can promote powerful connections to content, context, and community. The creation of 'learning paths' that allow students to take their own route through different learning activities has many advantages. The exposure of learners to a wider range of examples, resources and cultures can provide learners with a greater capacity to understand. There is a move from passive consumption to active participation requiring students to adapt to a new environment there is a need for all stakeholders to become what is termed second wave adopters.

The Horizon Report (2008) focuses on the need to look at the changing environment in regard to the way information is accessed retrieved and stored, there is a necessity to marry new technologies within a sound pedagogical model to ensure that the potential is successfully utilised. The selection and application of new technologies must fit the specific needs of the particular organisational requirements. Educators and developers need to be continually aware of changes in their environment and also changes to their own role. New forms of course delivery require new teaching and management skills the emergence of an "always on" cohort of students provide new challenges, an understanding of the adoption and diffusion of new technologies is required as to guard against the emergence of a digital divide.

The emergence of free open source software and resources has seen an increase in the use of such technologies, in content production / delivery. Animations, flash, transitions often applied in a manner which in many cases is contrary to sound instructional design practices often ignoring principles proposed by experts like Mayer (2000) especially in relation to the coherence principle in that multimedia explanations are better understood when they include few rather than many extraneous words and sounds. Ongoing professional development will be required to keep pace with possible change. The adoption and diffusion of an innovation within an institution does not guarantee its successful integration into the curriculum or its continued use, integration still poses significant challenges.

Hutt (2001) believe that it is necessary to study the individual as a whole, and that individuals develop over time. The study of the self, motivation, and goals are areas of continual change and interest. The potential of reaching more students by integrating multiple intelligences with multimedia applications Alick (1999) has inspired and motivated many educationalists.

There is an argument that Universal Design for Learning (UDL) can provide a useful groundwork in facilitating a digital multimedia environment improving accessibility, help scaffold students' exploration of content, and enhance their engagement.
The potential to create a curriculum with numerous built-in tools to meet the learning needs of a wide range of students, including those with disabilities or special talents.

2.8 Universal Design

Universal Design for Learning is an educational framework that optimises opportunities for all individuals to gain knowledge, skills, and enthusiasm for learning The "universal" in Universal Design for Learning (UDL) does not imply one optimal solution for everyone, but instead underscores the need for inherently flexible, customizable content, assignments and activities, and assessments characterised by Mayer (2002).

- Multiple representations of information—as there is no single method for the presentation of information that will provide equal access for all learners (Recognition Principle);
- Multiple methods of action and expression—as there is no single method of expression that will provide equal opportunity for all students (Strategic Principle); and
- Multiple means of engagement—as there is no single way to ensure that all children are engaged in a learning environment (Affective Principle).

There is a need for a holistic approach incorporating all stakeholders, (students, administrators, parents, boards, employers, state legislatures, local governing bodies, accrediting associations, transfer institutions, and the general public) and matching resources to fit the specific needs of the project, careful instruction design and

continual evaluation. Creation over consumption and context over class should constitute an instance of a more general approach that may be characterised as ‘learning networks’. The importance of taking advantage of multimodal processing capabilities through technology based tools offer new hope in the matter of engaging learners in a more productive learning environment.

The potential of reaching more students by integrating multiple intelligences with multimedia applications has inspired many educational Alick (1999). Everyone exhibits a combination of the various intelligences. The goal is to engage as many of these different capacities as possible within the same learning event or program.

2.9 Conclusions

While many institutions are adopting the use of technologies such as virtual learning environments to facilitate learning the methods and trends of providing and delivering education are continually evolving. While there are genuine hopes to extend the boundaries of education provision, there are many barriers to overcome.
Good multimedia instruction is driven by an understanding of how the brain processes information. The emergence of what Pensky termed digital natives combined with new mobile technologies has seen learners gain a new sense of independence

There is a responsibility to, explore the possibilities of different technological configurations that can facilitate student-centered teaching and self directed learning, there are concerns in relation to the application of traditional forms of instructional design to adapt to changing times
Multimedia instructional messages can be influenced by the instructional designer’s conception of multimedia learning or by a lack of acceptance by various stakeholders
Everyone exhibits a combination of the various intelligences. The goal is to engage as many of these different capacities as possible within the same learning event or program.
The selection and application of new and evolving technologies need to be integrated in a meaningful and informed manner, guided by good instructional design and total buy in by all stakeholders.

3. RESEARCH METHODOLOGY

3.1 Introduction

This research was conducted in order to reveal if the application of integrated multimedia can play a significant role in the teaching and learning process. From literature reviewed at an early stage it became evident that in order to improve the researchers understanding of the education system, surveys of key stakeholders in the area of education provision were undertaken. There were a number of options applied for obtaining such information such as face-to-face interviews, focus groups or workshops.

The following methods of data collection were used in the execution of this project:

- Case Studies
- Interviews
- Questionnaires
- Portfolio Evaluation

Case Studies

Case study research Soy (1997) excels at bringing us to an understanding of a complex issue or object and can extend experience or add strength to what is already known through previous research. Case studies emphasise detailed contextual analysis of a limited number of events or conditions and their relationships. Researchers have used the case study research method for many years across a variety of disciplines.
Yin (1993) identified at least six sources of evidence in case studies:

- Archival records
- Interviews
- Direct observation
- Participant-observation
- Physical artefacts

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- Documents
- Archival records
- Interviews
- Direct observation
- Participant-observation
- Physical artefacts

Interviews

Interviews are one of the most important sources of case study information. There are several forms of interviews that are possible: Open-ended, Focused, and Structured or survey. In an open-ended interview, key respondents are asked to comment about certain events. They may propose solutions or provide insight into events. They may also corroborate evidence obtained from other sources. The researcher must avoid becoming dependent on a single informant, and seek the same data from other sources to verify its authenticity.

Questionnaires

The survey questionnaire was used as the primary data gathering instrument for this research. There are two forms of questions; Closed Questions where the participant has to choose one of a range of possible answers, and Open-ended Questions where the participant can give any answer. A questionnaire was selected as the most efficient and practical means to collect and the relevant information, and it proved an efficient way of obtaining the relevant information. Questionnaires are useful because they can be completed at a time convenient to the respondent, and it is easy to input results into statistical packages. The main terms of reference of the questionnaire were to evaluate the impact of multimedia on the teaching and learning process. The total number of questionnaires distributed was ten.

3.2 Design of the Questionnaire

The questionnaire was designed in two parts: Part (a) focused on the respondents experience in accessing and navigation of the course content. The questionnaires consisted of 13 multiple-choice questions that offered the respondent a number of alternatives. Open-ended questions were included giving respondents more freedom to express their experience. Part (b) focused on the respondents experience in relation to affordance and interaction with tools and resources provided. The participants were asked to strongly agree, mildly agree, agree mildly disagree or strongly disagree to 10 pre -prepared statements.

The questionnaires were designed and distributed at the relevant times; a collection deadline was applied to ensure completion. After collecting all the completed questionnaires from the participants, total responses for each item were obtained and tabulated.

3.2b Evaluation Criteria

The portfolio will be used to reveal the participants level of knowledge and also completeness of assignments. The LORI principles were applied as a tool to evaluate the content. The portfolio needs to show an understanding and practical application on a range of specified learning objectives. The brief will require the participant to research and present information in relation to the subject matter. The evidence may be presented in a variety of ways, for example, written or graphical.

The quality of information students access and eventually select will be evaluated under the following guidelines:

- Authority
- Objectivity
- Authenticity
- Reliability
- Timeliness
- Relevance

- Efficiency.
- Presentation

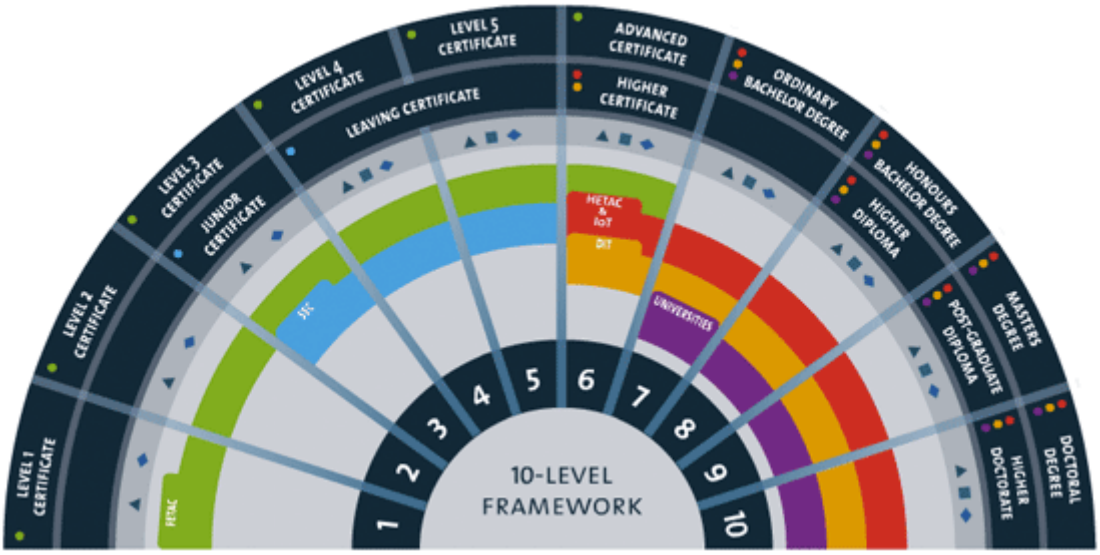


Figure 3a The National Framework of Qualifications (NFQ)

The National Framework of Qualifications (NFQ) provides a way to compare qualifications, and to ensure that they are quality assured and recognised at home and abroad. Assessment for this project has been pitched at level 6 The National Framework of Qualifications.

The NFQ provides a framework to compare and contrast the level and standard of different qualifications

Level 6 qualifications recognise a specialist high level knowledge of an area of work or study to enable the use of a students' own ideas and research in response to complex problems and situations

Analysing: the student has the ability to distinguish between the different parts:

Appraise, compare, contrast, differentiate, discriminate, distinguish, and examine, experiment, question and test

Blooms revised taxonomy will also be applied as a guide in the assessment process.

In 1956 Bloom facilitated a number of educational psychologists to develop a classification of levels of intellectual behaviour important in learning.

A former student of Bloom, Loran Anderson later updated the taxonomy to reflect relevance to 21st century work.

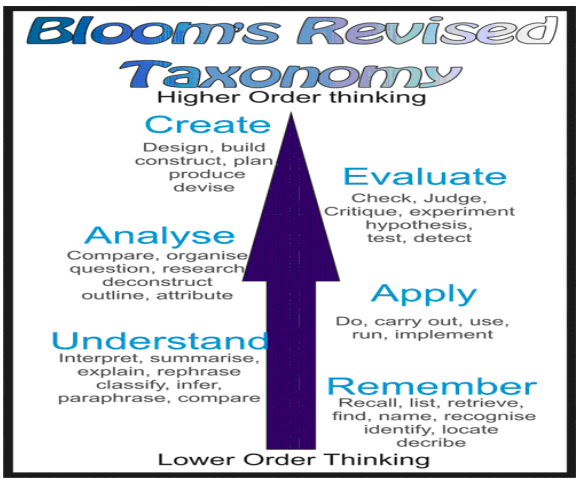


Figure 3b Blooms revised taxonomy

Qualitative Interview results

Specific techniques include placing information into arrays, creating matrices of categories, creating flow charts or other displays, and tabulating frequency of events.

Specific techniques include placing information into arrays, creating matrices of categories, creating flow charts or other displays, and tabulating frequency of events.

The presentation of data required a suitable methodology which was facilitated by the following approach

1. Selection and Implementation of suitable measurement criteria.
2. The organisation of the data collected in arrays
3. Conduct data graphing, statistical analysis.
   Observe for patterns emerging.
4. Take note of any significant or interesting results.
   Differences within people or groups, correlations, connections between 2 or more variables.
5. Interpretation of the results.

The main terms of reference of the questionnaire is to evaluate the impact of multimedia on the teaching and learning process

Selection of participants

The participants were drawn from a number of areas, reflecting a diverse range and background

- Level of education
- Level of IT skills
- Age range 20 to 70 years
- Gender balanced 5 male , 5 female
- Work experience
- Employment status

3.3 Software Considerations

Opus Pro is a visual development tool for Windows providing fast-track design of versatile e-learning, interactive applications. Opus Pro offers a wider range of functionality creating the potential to reach a diverse range of learning styles through

- Multiple representations of information (Recognition Principle);
- Multiple methods of action and expression
- Multiple means of engagement (Affective Principle).

Opus Pro can be applied to help create a very engaging and interactive learning experience potentially allowing the learner to engage with the content in a manner which suits their preferred learning style and individual circumstances:

- Text animation
- Hyperlinks
- Interactive quiz with instant feedback

Opus 6 facilitates a flexible platform to publish and distribute to Flash, SCORM and Moodle as well as .EXE, CD-Rom and DVD-video. The content for the CD was

sources from as many sources as possible but under the guidelines of The NCTE. Participants will be facilitated through the course with links to join social networks sites like LinkedIn etc. Multimedia affords the potential to accelerate or decelerate processes for purposes of understanding, time and space can be extended to meet the particular needs. The potential of the internet to assist in the location and evaluation of new material provides educators with the potential to facilitate learning in a more effective manner. The combination of software tools that allow learners space for experimentation, and the expertise of teachers who can scaffold further learning. The creation of 'learning paths' that allow students to take their own route through different learning activities based either on the choices they make or their performance in online tests.

A changing environment can have a serious impact in many areas, as learning threatens to leave the school grounds, new approaches are required to meet the new challenges encountered by the many stakeholders. Poh Meng and Kumar Puttar (2000) state that the "Old Wine, New Bottle" syndrome must end, teachers must recognize that technology has successfully removed the constraints of time and space – and has forced us to redefine our basic understanding of where, when and how learning can take place. As with any innovation – be it fire, the wheel or the computer – educators must be brave to re-examine their age – old assumptions about teaching and learning

The ability to accommodate and integrate new technologies can raise many issues. Snoeyink and Ertmer (2003) have identified these as widespread. According to the standard ISO 13407, (1999) this standard is aimed at managing the design process and is now increasingly used to ensure software quality. Context of use and user and organisational requirements were specified using stakeholder interviews. From the basis of requirement specification, a paper prototype was made and tested within end users. Changes were made to the requirements specification according to the test results. Next prototype was implemented in the design and implementation phase and it was tested again within the end users. Comments received from the tests were adapted to the implementation. Testing and implementation were iterated until no big changes occurred. The pace of change poses many challenges for education provision;

many new technologies have rewritten the rules. The ability of traditional methods to create a rich ICT teaching and learning environment which will infuse all aspects of pedagogic practice has been called into question.

Good multimedia instruction is driven by an understanding of how the brain processes information. The process of designing planning and sequencing learning tasks are essential to a successful outcome not only should care be taken to ensure the use of sound pedagogical models but also to the wider environment should be continually monitored.

3.4 Instructional Design

Instructional design is a method for systematically promoting design development, and is used as a way of improving quality in the design of educational courses and systems. In principle it enables the development of effective educational programs by going through the stages of analysis, design, development, implementation and evaluation. Traditional ISD Models are often viewed as representing a linear process -- a plan of separate steps that proceed in a linear sequence.

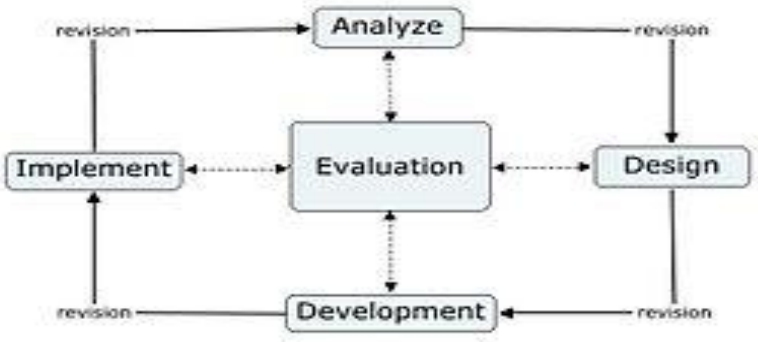
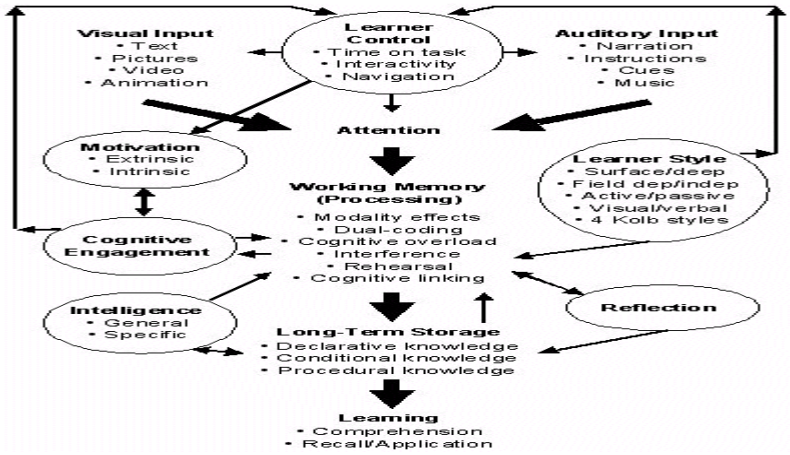


Figure 3c Traditional ISD Models

Incorporating digital media content in a presentation can greatly enhance the ability to reach a wider audience by way of appealing to a variety of learning styles; the potential to search and locate information can aid the student greatly as context can play a vital role in understanding and knowing.



The Hede and Hede (2002) model shows in the range of up to 12 multiple factors and their complex interactions that multimedia and e-learning designers need to be aware of to account for multimedia effects on learning.

The Kemp Model defines different elements – not "step, stage, level, or sequential item" Morrison, Ross and Kemp (2004) of an instructional design, and emphasises the adoption of continuous updating and evaluation during the entire instructional design process.

Figure 3d The Kemp Model

3.5 Design of the System

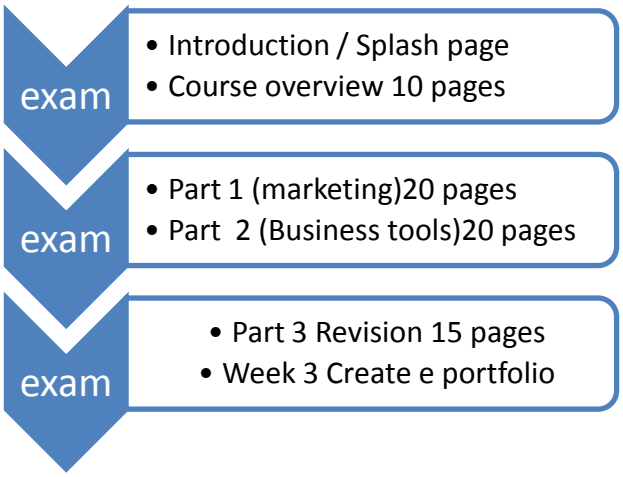


Figure 3e. Site Map

3.6 Conclusions

The observation of some students using the initial prototype was very effective, uncovering some navigational errors, user input was very important in the execution of this project and highlighted the need to apply a suitable methodology.

The selected research instruments were designed to capture as much relevant information as possible, Questionnaires will perform a major role in the execution of this project, it will combine a combination of open and closed questions in order to capture as much information as possible.

A PMI (De Bono) was added as a research tool to potentially compliment the questionnaires.

A number of instructional design methods for systematically understanding and promoting design and development were viewed as a means of improving quality in the design of the course.

The selection of a suitable software package (Opus 6) to produce the CD became important as it had good online help and support.

4. EXPERIMENT

4.1 Planning and Design Stage

A customized CD to introduce students to the world of entrepreneurship has been developed using authoring software Opus Pro 6

Students will be required to demonstrate knowledge and understanding of course content by recalling, describing, reporting, identifying, recognising, recounting and relating, through the application of the following resources:

- **Online quizzes**
- **Multiple choice** (pre test to determine students knowledge, also a post test to examine students retention and understanding of course content)
- **e-Portfolio** Work co-operatively and independently, be self-directed, manage time, manage tasks and learning through technology
- **Interactive fun tests,** roll over's, drag and drop.

Assessment techniques have been inserted in to the CD at appropriate stages, questionnaires and PMI techniques will be used to gather relevant information.

Completion dates for the return of completed EPortfolios and questionnaires have been agreed to by all stakeholders.

Suitable evaluation metrics have been selected in order to grade the returned EPortfolios.

Ethical Considerations

The participants were individually informed as to the objectives of the project and assured of issues related to confidentiality.

The CD and the questionnaire were distributed to the 10 participants on the 20th March the final participant returned the completed EPortfolio on the 22nd April.

Distribution and collection

The participants were asked to return by email on the agreed date

- The completed EPortfolio
- Completed questionnaire and PM1

Presentation of findings

The returned e-Portfolios were checked for completeness**.**

The questionnaires were checked and filed for analysis.

The CD contains numerous interactive resources and the facility to create an e-portfolio through the various exercises, these exercises range in complexity and participant input.

Exercises – 1, 2 3, 4 and 8 require less knowledge and effort to complete

Exercises 5, 6, and 7 will require course knowledge and increased workload

Assessment Overview		Skills
1	Creation of e portfolio on desktop or alternatively the creation of an online presence	IT Skills File Management
2	Interactive Multiple Choice Test 1 Participants will record scores, select the right answer from 3 possible answers Test prior knowledge, compare with Number 8 for possible impact of multimedia	FileManagement

	on the learning process	
3	Online evaluation Test	IT Skills File Management
4	My Entrepreneurs Exercise	Research Skills Presentation skills
5	Location Exercise	Research skills, Presentation Skills
6	My Customers Exercise	Research and Presentation Skills
7	My Macro Exercise	Research and Presentation Skills
8	Interactive Multiple Choice Test 2 Participants will record scores, select the right answer from 3 possible answers	File Management
A number of interactive exercises have also been applied where possible, mouse rollovers, drag and drop exercises		

Table 4.1.1 Assessment overview

4.2 Built in Assessment

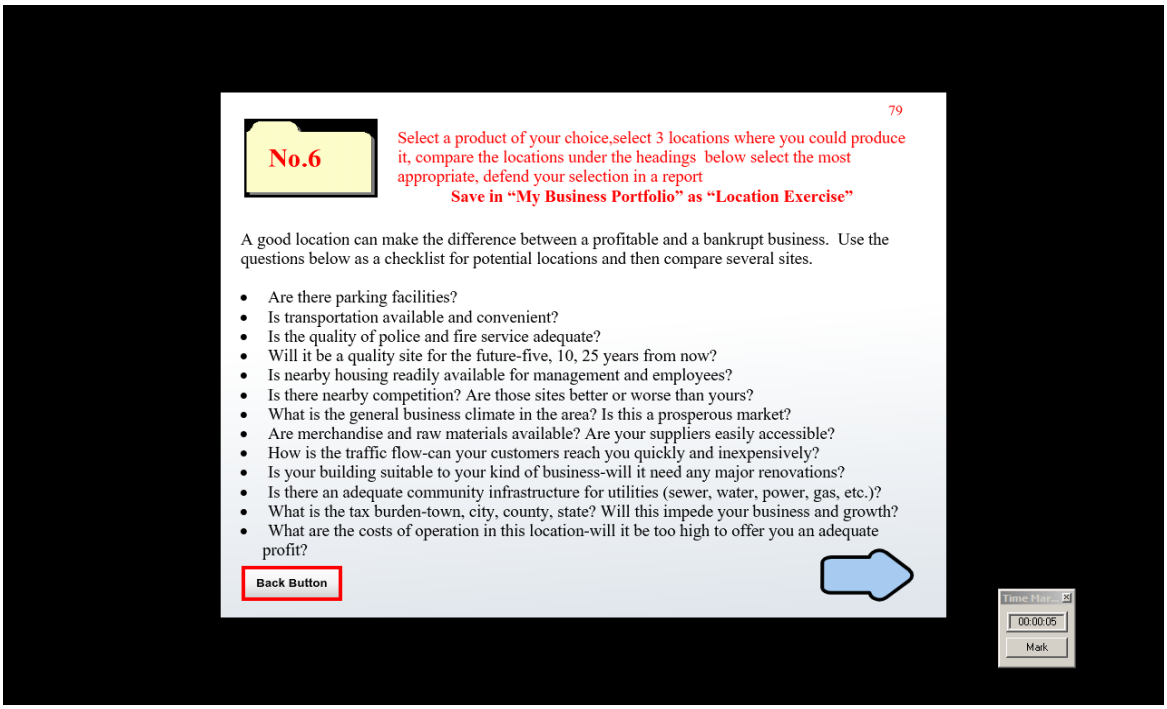
1. **Creation of e portfolio on desktop or creation of an online presence (page 5)**
2. **Interactive multiple choice test (page 7)**

   This will be used to assess participant's present knowledge and later compared with results attained in exercise 8, a multiple choice quiz based on the course content.

3. **Online evaluation (page 10)**
4. **My entrepreneurs exercise (page 45)**
5. **My macro exercise (page 74)**

The student is presented with the exercise accompanied by four relevant bullet points to help structure the exercise, there is a file graphic displayed in the top left hand corner to denote an exercise for the EPortfolio.

6. Location exercise page 79



In this exercise the student is presented with a longer exercise, there is a requirement to apply deeper knowledge

7. My customers exercise (page 89)

8. **My last test multiple choice test (page 97**

In order to help structure the CD a number of techniques were applied

4.3 Usability and Navigation Planning

Navigation

A sitemap was constructed to help assist usability and a basic prototype created.

Usability Testing Thinking Aloud

Definition:

In a thinking aloud test, participants were asked to use the CD while continuously thinking out loud that is, revealing their thoughts as they move through the user interface.

Their revelations are recorded and any breakdown between the user's expectations and the system can be noted and analysed

Usability issues

After number trials were undertaken to review the CD a number of design faults were uncovered mainly

- Poor colour contrast on some of the template pages
- Slow navigation due to too many animations and transitions
- Too much information on some pages
- Hyperlinks changes colour and could not be easily recognised
- Need for a main navigation page
- Checklist at end of course
- A need for more interactive material

It was felt that there was a requirement for a more consistent approach and that navigation needed to be more flexible

The new Interface design was guided by principles set out by experts including. Shneiderman's "Eight Golden Rules of Interface Design" These rules were obtained from the text *Designing the User Interface* by Ben Shneiderman

1. Strive for consistency, background colour to be changed to blue

2. Cater to universal usability, more flexible navigation. Navigation page to be included symbols and buttons to be included

3. Offer informative feedback, drag and drop quiz, mouse roll over exercises, instant feedback from quizzes

4. Design dialogs to yield closure, return and forward buttons

5. Prevent errors, checklist page

6. Permit easy reversal of actions, improved navigation

7. Support internal locus of control, utube videos, instant feedback, little time pressure to complete

8. Reduce short term memory, perceivable information, natural language, reduced text, application of scroll bars

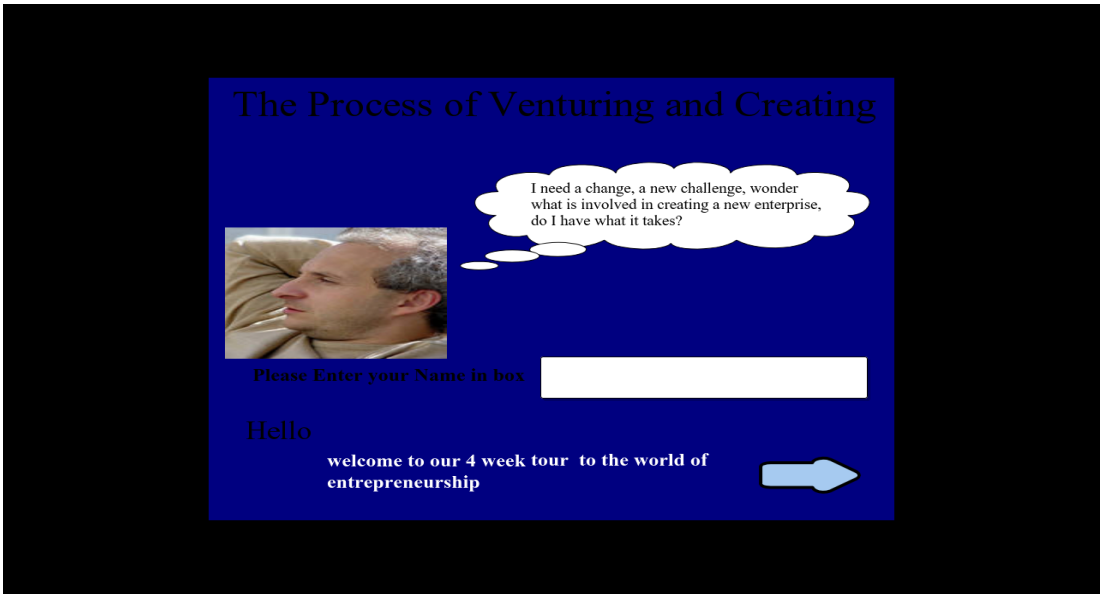
Edward de Bono developed the PMI tool and published it in his 1982 book, De Bono's Thinking Course.
PMI is a useful technique for making quick and informed decisions. Four participants were asked for their opinion of prototype 1, they were asked to complete the table below.
They were each given three minutes to complete the exercise set out below

Positive	**Minus**	**Interesting**

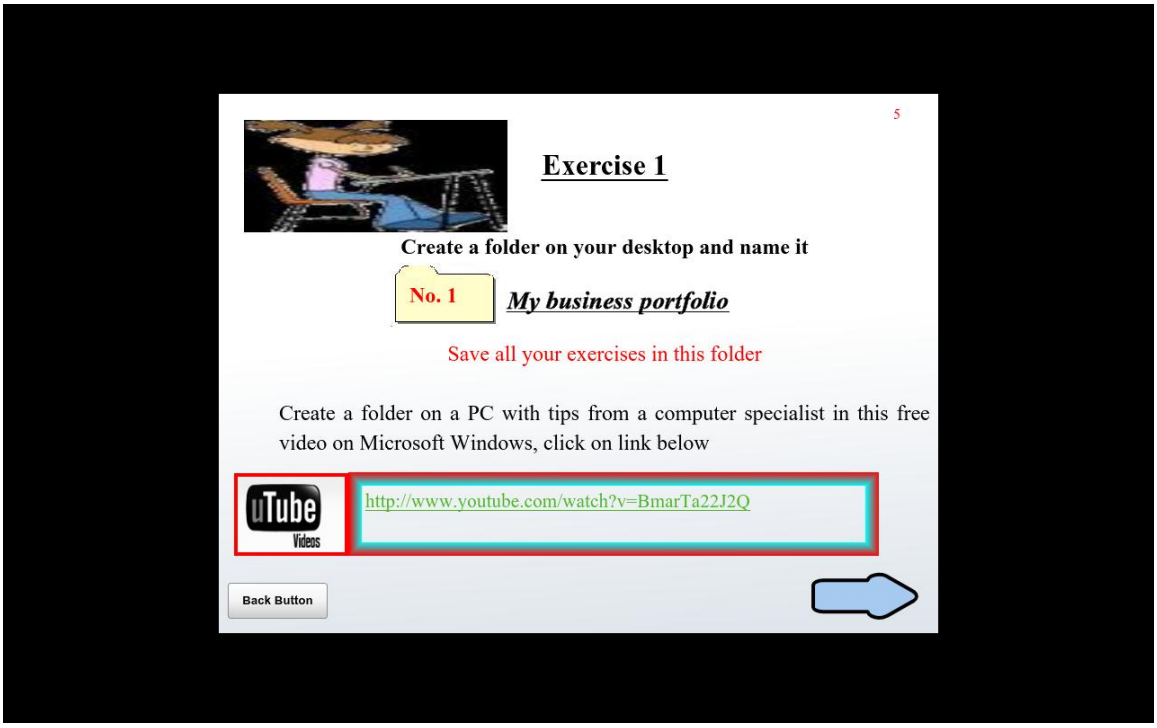
A number of recommendations were applied and a more complete sitemap developed to help complete the final product.

Figure 4a Updated Sitemap

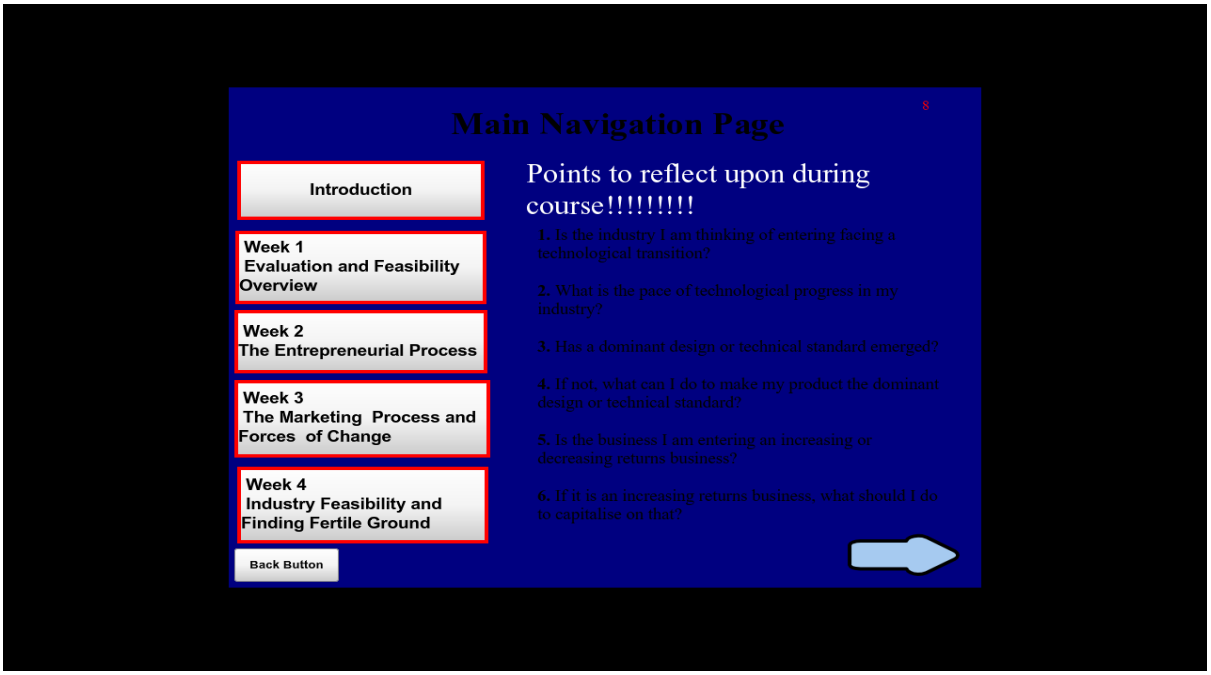
The participant will be asked to sign in on page 1



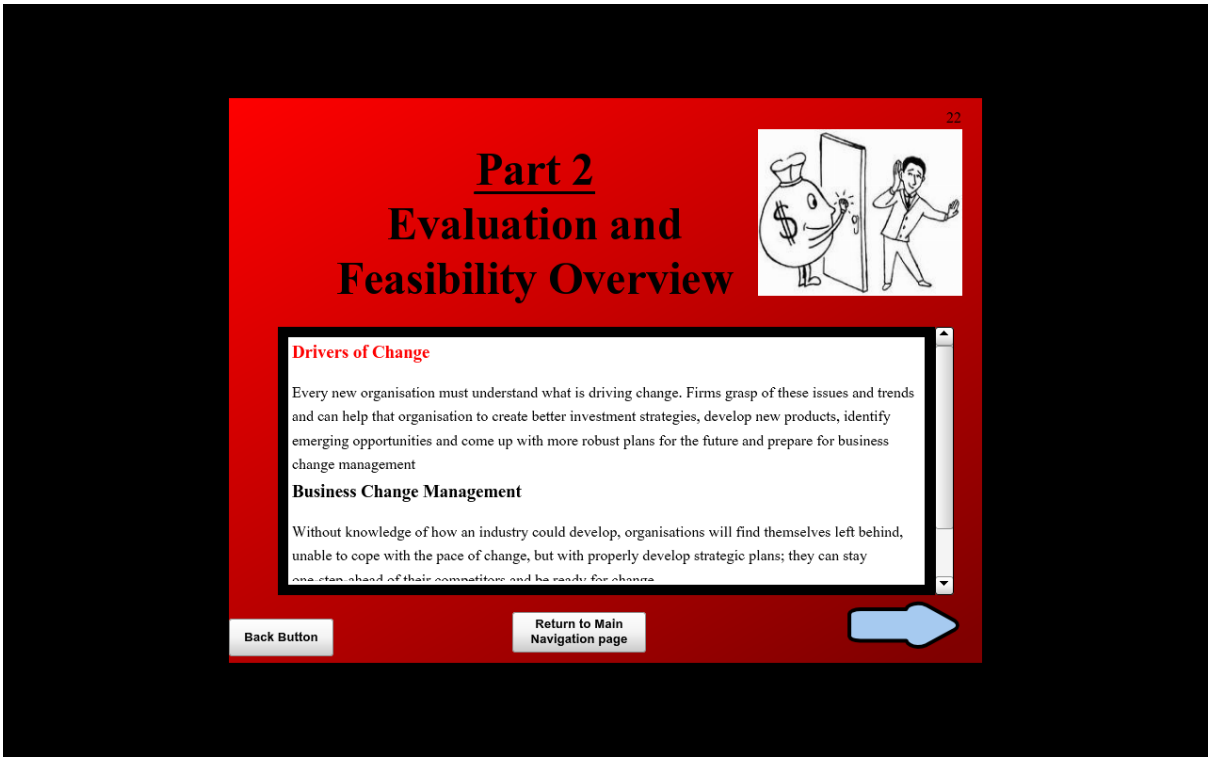
The participant will be then introduced to the learning goals of the course and then be required to create a folder on their desktop to use to store the content of their EPortfolio



The main navigation page will allow the participant to quickly access a particular week.



Back and forward icons are clearly marked to help navigation



4.4 Guiding Principles

The following principles were applied to the greatest extent possible.

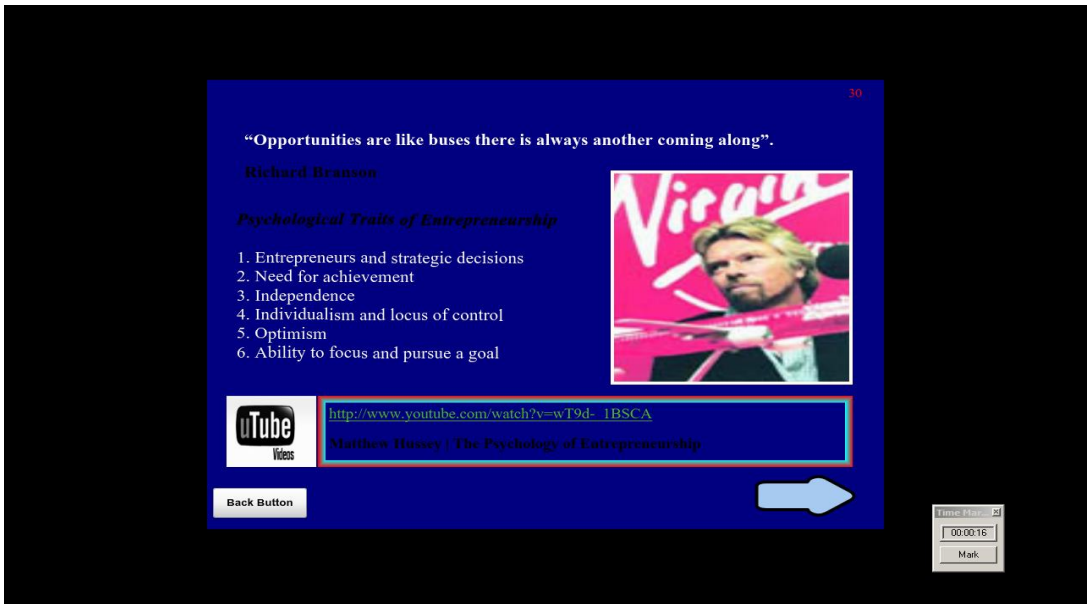
- The multiple representation principle states that it is better to present an explanation in words and pictures than solely in words.

- The contiguity principle is that it is better to present corresponding words and pictures simultaneously rather than separately when giving a multimedia explanation.

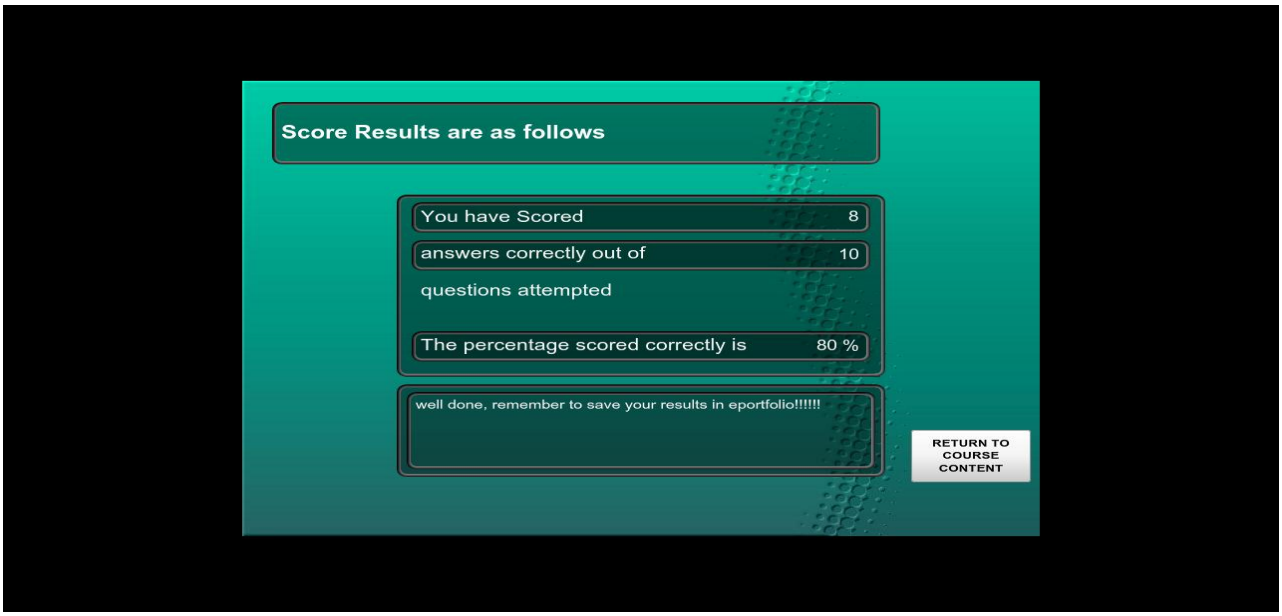
- The coherence principle is that multimedia explanations are better understood when they include few rather than many extraneous words and sounds.

- The modality principle is that it is better to present words as auditory narration than as visual on-screen text

- The redundancy principle is that it is better to present animation and narration than to present animation, narration, and on-screen text.



On this page the student is presented with animated Quotes, graphics and links to course content via utube



Here the student is presented with their score from the multiple test quiz, there is a button provided to return to the course content

Student can access all 8 assignments from the final page and email completed EPortfolio to forwarding address

4. EXPERIMENT

4.5 Project Objectives

This project focused on the development of a course of study that introduces the topic of entrepreneurship in a real world scenario, it is not the intention of the course to concentrate on any particular business area or content, but to introduce the participant to some of the concepts in relation to marketing, strategy and the general business environment.

The assessment exercises are designed to introduce the topic of entrepreneurship and also to allow the participant to use their IT skills to locate, store and present information.

This course will provide an introduction to the world of entrepreneurship, potentially promoting collaboration and understanding through various hyperlinks and tools.
Learning through the use of technology, rather than with it.

- Identification of characteristics of prospective entrepreneurs and intrapreneurs.
- Opportunity identification and recognition process.
- Analysis of the different sources of entrepreneurial opportunities (personal, economic, industry).
- Market and industry analysis for products/services (new or improvement of existing products).
- Overall feasibility and planning process within new or existing organisations.
- Initial support and financing essential to the implementation of the identified opportunity

4.6 Distribution of CD and Questionnaires

The CD and the questionnaire were distributed to the 10 participants on the 20th March the final participant returned the completed EPortfolio on the 22nd April.

Design of Questionnaire

Part (a)

This section focused on the respondents experience in accessing and navigation of the course content.

The questionnaires consisted of 13 multiple-choice questions that offered the respondent a number of alternatives.

Open-ended questions were also included giving respondents more freedom to express their experience.

Part (b)

This section focused on the respondents experience in relation to affordance and interaction with the tools and resources provided.

The participants were asked to strongly agree, mildly agree, agree, mildly disagree or strongly disagree to 10 pre -prepared statements

PM1

The PMI technique was employed as a tool to gain a more in-depth knowledge and to potentially reveal some unconscious thoughts of the participants.

PMI stands for Plus/Minus/Interesting.

PMI potentially helps make quick and informed decisions by weighing the pros and cons of a situation, also useful for widening your perception of a problem or a decision, and for possibly revealing issues that you might not ordinarily have considered

4.7 EPortfolio as Assessment

The adoption of EPortfolio as an alternative to traditional forms of assessment has many advantages and is very relevant to this particular subject area. Chang Barker. K (2005) notes

The EPortfolio is about– with both process and product. EPortfolio tools interventions by teachers or mentors - help creators / users to identify and reflect on the outcomes of learning experiences. Creators can be individuals, organizations, even businesses – and they can be the receivers / processors as well. In the context of adult literacy, the

Portfolio has the capacity to be a learning tool, an assessment tool, and a record of achievement. It is inherently motivational in that it focuses on what the person can do, rather than what they can't, as measured by standardized tests. In fact, portfolio assessment and portfolio learning are common practice in primary literacy education, and in adult literacy and basic education programs

Collection of EPortfolio and completed Questionnaires

The CD and the questionnaires were distributed to the 10 participants on the 20th March and a return date fixed for the 20th April.

The returned EPortfolios were checked for completeness**.**

The questionnaires were checked and filed away for analysis

From the information extracted from the questionnaires the following overview of the participants was constructed.

4.8 Overview of Participants

	M2	M4	F2	M5	M3	F3	F4	F1	M1	F5
Age	50	68	48	20	55	50	30	27	40	30
Gender	M	M	F	M	M	F	F	F	M	F
IT Literacy	ECDL	ECDL	ECDL	Novice	ECDL	Novice	NOVICE	ECDL	ECDL	ECDL
Level of Education	Inter Cert	National Cert	Leaving Cert	Early School Leaver	Junior cert	Junior Cert	Inter Cert	Leaving Cert	Inter Cert	DIP Level 8

Table 4.1.2 Overview of the respondents in relation to age, gender, IT literacy and level of general education

Level of previous education	Level according to NFQ
1 Early School leaver	Level 2
2 Junior Certs	Level 3
2 Intermediate Certs	Level 4
3 Leaving Cert	Level 5
1 National Cert	Level 6
1 Diploma	Level 7

Table 4.1.3 Breakdown of Respondents level of education

4.9 Conclusion

The design of the questionnaire was important as it is one on the main research tools used to gather relevant information; it was decided to add open questions and to apply the PMI technique as a means to capture the experience of the participants in a more holistic manner.

The questionnaire was used to present an overview of the participants in relation to age, gender, IT experience and previous level of education.

5 PRESENTATION & EVALUATION

The information gathered from the questionnaires (Appendix A) was arranged in a logical sequence and presented in the manner set out below. The information was analysed to detect any significant trends and later evaluated and discussed in more detail

5.1 Questionnaire Replies

Number of responses (completed Questionnaires returned on time) = 10

There was a 100% completion of the Questionnaires

The replies from the questionnaires were recorded and place in the format set out below.

The replies were then analysed in more detail, displayed in graphical form and then discussed in more detail.

5.2 Presentation of responses to Closed Questions

When questioned about their present level of IT literacy, the 10 respondents replied as follows

Novice	5
Intermediate (ECDL)	4
Professional	1

Did you find the resources on the CD useful?

Yes	10
No	0

How many times a week during the course did you access the content?

1 -3	4
4 – 6	4
7-10	2
Rarely	0

Did you find the CD easy to navigate?

Very Easy	6
Easy	2
Difficult	2

In which of the following areas did you find the CD the most useful?

Revision	1
Collaboration	3
Information Gathering	6

5 - Do you intend to use the CD after the completion of the course?

Yes	6
	4

No

Would you recommend this CD to a fellow student?

Yes	10
No	0

Have you ever used a similar approach to learning, prior to the commencement of the course?

Yes	4
No	6

Do you feel you had the required skills required to extract the full potential of the CD?

Yes	8
No	2

Did you find the approach to learning to be?

Very Satisfactory	5
Fairly Satisfactory	4
Unsatisfactory	1

Did you find the adoption of multimedia in the learning process to be?

Very Helpful	7
Mildly Helpful	3
Unhelpful	0

Did you join any of the social network sites e.g. LinkedIn which were accessible through the CD?

Yes	7
No	3

5.3 Presentation of Replies to Set Statements

The replies to the set statements were completed by all of the 10 participants and resulted in the responses displayed below.

Statement	Strongly Agree	Mildly Agree	Agree	Mildly Disagree	Strongly **Disagree**
I found the content challenging	7	2			1
I found the interactive Quiz Very useful	8	1	1		
I was able to have creative input in the project	2	3	4		1
I became better able to present the concept using digital multimedia	1	6	2		1
The CD allowed me to be more creative in my thinking	2	2	5		1
I understood the subject matter better after the project development	3	5	1		1
The CD enhanced my understanding of the subject	3	4	2		1
I felt increased motivation doing the project	1	2	6	1	
I was able to learn more working through social media	2	2	4	1	1
The CD allowed me to think critically about the topic	2	4	3		1
SCORE	31	31	28	2	8

5.4 Presentation of responses to Open Questions and the PM1 Exercise

The responses from the open questions from the questionnaire and the PMI Exercise have been presented in a combined manner.

POSITIVE	**Minus / Negatives**	**Interesting Aspects**
networking	Bookmarking	Bit whacky
simplistic		Narrative

Comments

1. More networking opportunities throughout course
2. Mahara was good, broadcast yourself.
3. LinkedIn exercise good
4. Could make more use of interactive quiz , say one after every ten pages

Respondent M1

Positive Aspects	**Minus / Negatives**	**Interesting Aspects**
Navigation	Sometimes too simplistic	Concepts different

1. More and simpler exercises

Respondent F1

Positive Aspects	**Minus / Negatives**	**Interesting Aspects**
Quiz	Quiet Long	Not Modular
Simple approach	No Accreditation	Flexible 24/7

1. More of a blended approach required
2. More simple quiz's with feedback

Respondent M3

Positive Aspects	**Minus / Negatives**	**Interesting Aspects**
Own time	Time consuming	Networking
Real-time	Uneven structure	New concepts

1. Create more mouse roll over's etc
2. More scroll bars
3. Interactive quiz could be used much more

Respondent F2

Positive Aspects	**Minus / Negatives**	**Interesting Aspects**
Instant feedback	A lot of pages	Quotes
	Have to start from the start each time	Learning resources

1. Bookmarking would improve navigation
2. Break up the lessons more

Respondent M4

Positive Aspects	Minus / Negatives	Interesting Aspects
Easy to use	Links slow due to broadband	Showing things through utube
Found More graphics in part 1 and 2 It difficult to know where I was in the course content, when I would be finished **Respondent F3**		

Positive Aspects	Minus / Negatives	Interesting Aspects
Feedback	CS sometimes slow	Outside learning
utube	Monitoring of work completed	Lifelong learning
1. E mail address of other students 2. Some of the exercises too long **Respondent M2**		

Positive Aspects	Minus / Negatives	Interesting Aspects
Different from books	Exercises difficult	Guy thinking to himself
1. The stuff on the CD was difficult for someone like me who never studied it before, I think you need to have some computer skills, otherwise you could find yourself getting fed up if you can't progress. 2. I could not print off exercises, I had to keep returning to it to remember what was been asked **Respondent M5**		

Positive Aspects	Minus / Negatives	Interesting Aspects
Like a story	Too many utube	Narrative
1. More of a collaborative approach , help on line 2. I believe it would be beneficial for the teacher to monitor progress every few days 3. Could be more chapters added 4. A instruction manual could be useful to get a full view of the course, an overall view, for example at the start, I could not exit the program, did not realise I could of pressed the esc button **Respondent F4**		

Positive Aspects	Minus / Negatives	Interesting Aspects
Easy to use	No feedback from portfolio	EPortfolio
1. Create more online assessment **Respondent F5**		

5.5 Presentation and Overview of Completed EPortfolios

The 10 EPortfolios were returned with the completed Questionnaires, each EPortfolio was checked for completeness and later analysed, each respondent's EPortfolio was examined and a grade assigned as set out in the Table below

Grades Assigned to returned EPortfolio

	M1	M2	F2	M5	M3	F3	F4	F1	M4	F5
Grade	40%	50%	60%	45%	70	40%	55%	65%	60%	45%

Table 5.1.1 EPortfolio grades assigned to participants

The identity of the respondents was given a lot of consideration and for the purpose of this project the respondents will be identified in the following manner.

Male 1	M1	Female 1	F1
Male 2	M2	Female 2	F2
Male 3	M3	Female 3	F3
Male 4	M4	Female 4	F4
Male 5	M5	Female 5	F5

Table 5.1.2 Identification of Participants

The information leveraged from the research tools employed for this project was examined in order to determine if any significant trends were emerging.
The information was then placed in appropriate categories in order to refine and make the process more logical.
The information was then presented in the most appropriate form to make evaluation more scientific.

6 EXPERIMENTATION & EVALUATION

The importance of taking advantage of multimodal processing capabilities through technology based tools offer new hope in the matter of engaging learners in a more productive learning environment.

The aim of this project is to evaluate if the selection of multimedia tools and resources can be used to promote a more inclusive and deeper learning environment.
This project has looked at models and techniques from the existing body of ICT and educational literature and proceeded to develop software relating to the subject of entrepreneurship.

The results from the information gathered from the various research tools was presented in Chapter 5

6.1 EXPERIMENTATION

The CD and the questionnaire were distributed to the 10 participants on the 20th March and a return date fixed for the 20th April.

The participants were asked to return by email

- The completed EPortfolio
- Completed questionnaires

The participants were left to their own devices to select and apply from a wide range of multimedia tools and resources.
The participants were observed where possible in relation to navigation and affordance.

6.2 Evaluation

A survey questionnaire was used as the main primary data gathering instrument for this research, there was a 100% return of completed questionnaires.

Questionnaires

- Closed questions: The participant has to choose one of a range of possible answers.
- Open-ended questions: The participant can give any answer.

6.3 Analysis of Replies to Questionnaire (Closed Questions)

In order to ascertain the respondent's level of IT literacy the following replies were recorded

Novice	5	Intermediate (ECDL)	4	Professional	1

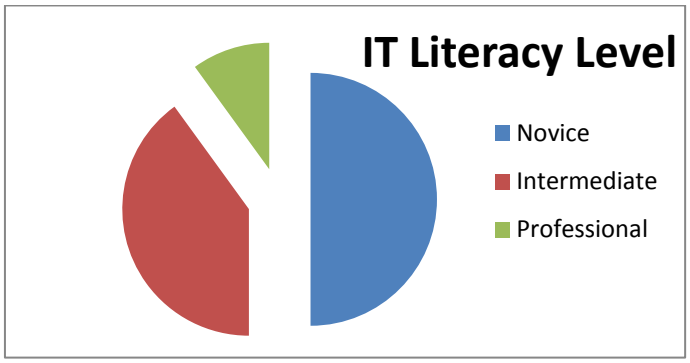


Fig 6a IT Literacy Level

While 50% of the respondents described themselves in the novice category in relation to IT literacy, 80% responded positively when asked

Do you feel you had the required skills required to extract the full potential of the CD?

Yes 8 No 2

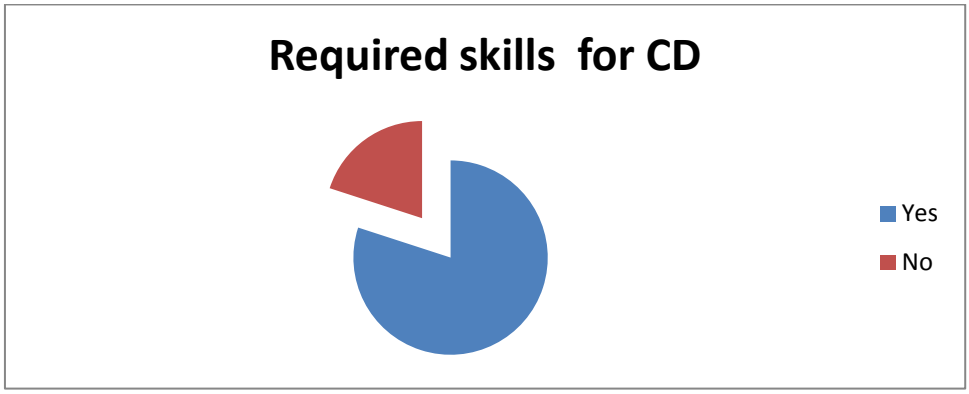


Figure 6b required skills for CD operation

In the design phase of the software, navigation proved a particular challenge; through the questionnaire the participants were asked.

Did you find the CD easy to navigate?

Very Easy 6 Easy 2 Difficult 2

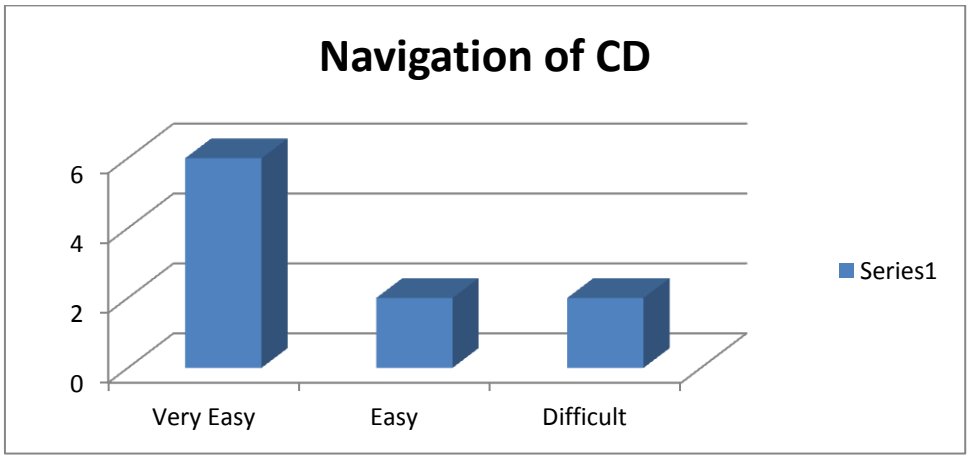


Figure 6c Required skills for CD Navigation

60% of the respondents found the CD very easy to navigate but 20% found it difficult which could possibly be a reflection on some of the respondent's previous exposure to multimedia or previous experience of IT.
There was some evidence of a digital divide in relation to the tools accessed and applied; this view was confirmed in the overall grades of the completed EPortfolios for example, 2 respondents produced Google maps in their location exercise while others just relied on essay type / bullet point responses to describe the location.

However there was unanimous agreement in relation to the usefulness of the resources and tools accessible through the CD, there was also a positive response in relation to the adoption of multimedia in the learning process.

When asked
Did you find the adoption of multimedia in the learning process to be?

Very Helpful	7	Mildly Helpful	3	Unhelpful	

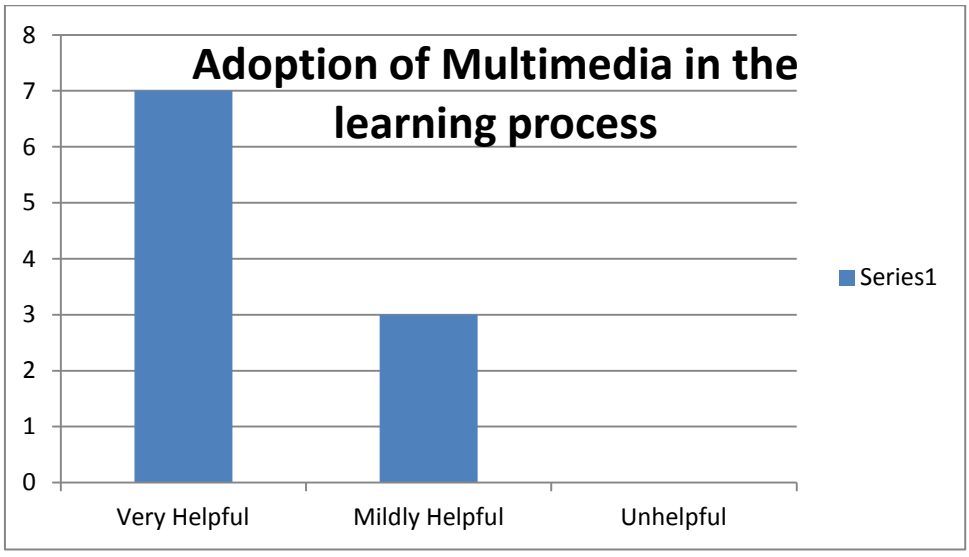


Figure 6d Adoption of Multimedia in the Learning Process

70% of the respondents found this approach to learning as very helpful.

The respondents were asked in which areas did they find the CD most useful.

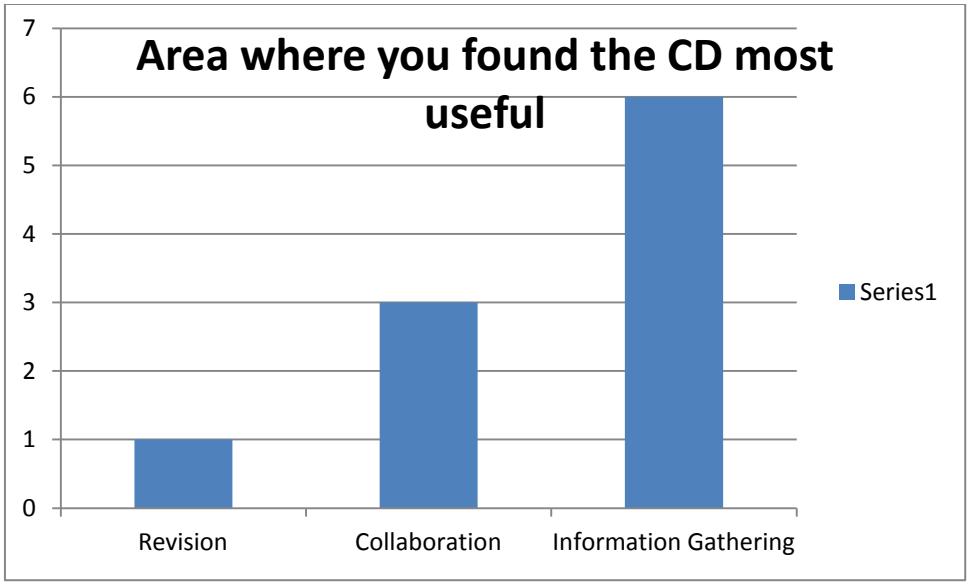


Figure 6e Area where CD was found most useful

The respondents found the CD most useful in information gathering and collaboration, an interesting point is that only10% found the CD for useful for revision.

The CD was designed to encourage the user to join a number of social networks.
Did you join any of the social network sites e.g. LinkedIn which were accessible through the CD?

Yes	7	No	3

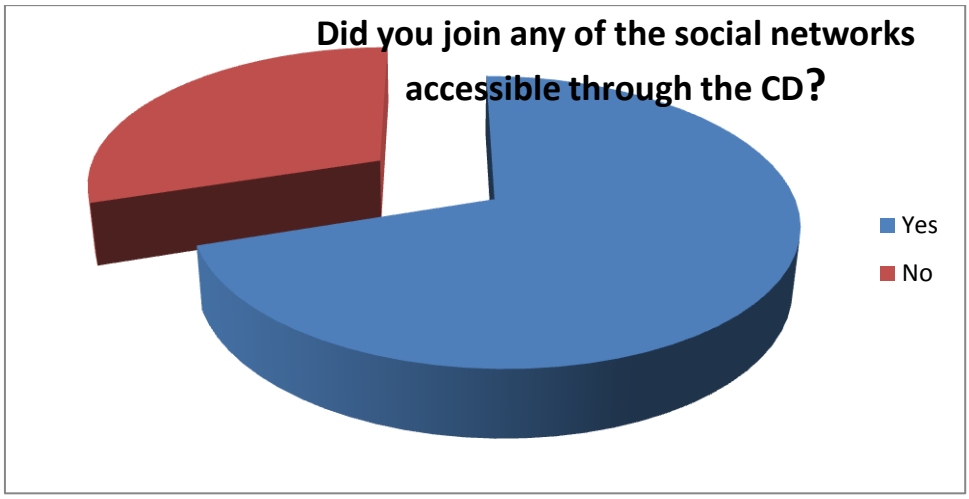


Figure 6f Social Networks joined through the CD

70% of respondents joined a social network, but an interesting contradiction is that only 30% found the CD most useful for purposes of collaboration.

As the respondents only had the use of the CD for a month, it was interesting to see how many times they accessed the content on a weekly basis.

How many times a week during the course did you access the content?

1 -3	4	4 – 6	4	7-10	2	Rarely	

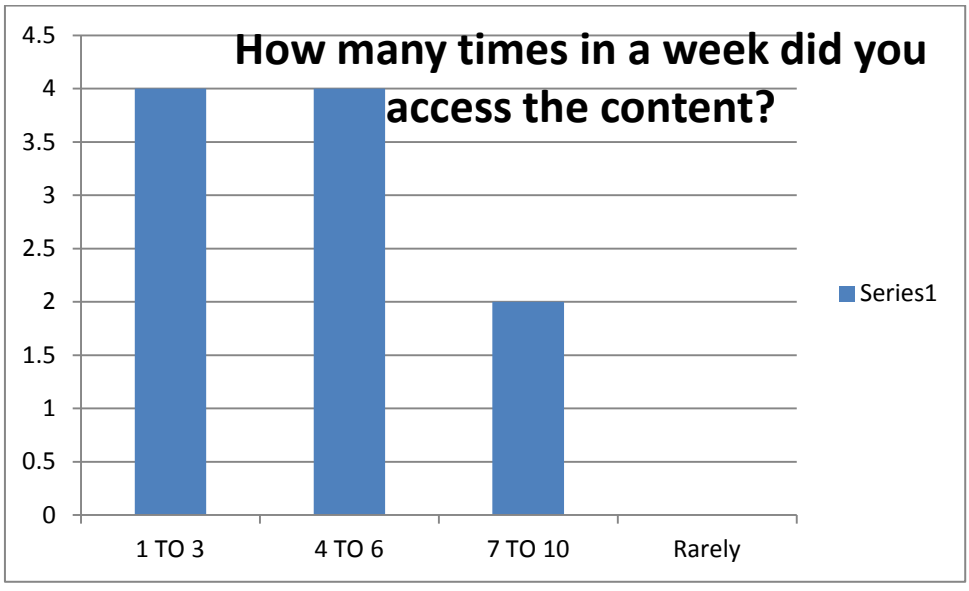


Figure 6g Weekly number of times CD was accessed

There was a variance in the number of times the respondents accessed the content on a weekly bases possibly reflecting the participants previous exposure to the subject matter or in some cases time available.

Have you ever used a similar approach to learning, prior to the commencement of the course?

Yes	4
No	6

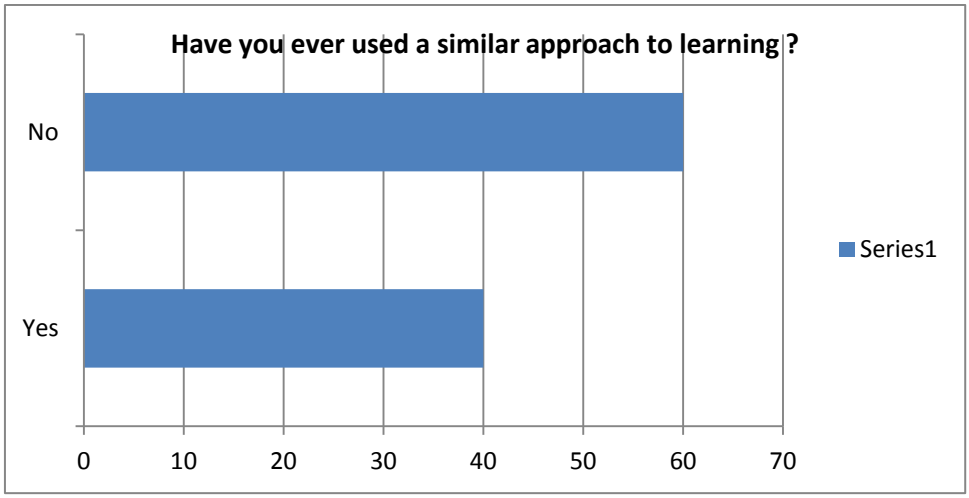


Figure 6h Previous experience of similar approach to Learning

An interesting point is that 60% of the respondents had no previous experience of such an approach to learning, yet there was generally a positive attitude to this form of learning.

Overall the respondents found the approach to learning in the manner shown below

Very Satisfactory	50%	Fairly Satisfactory	40	Unsatisfactory	10%

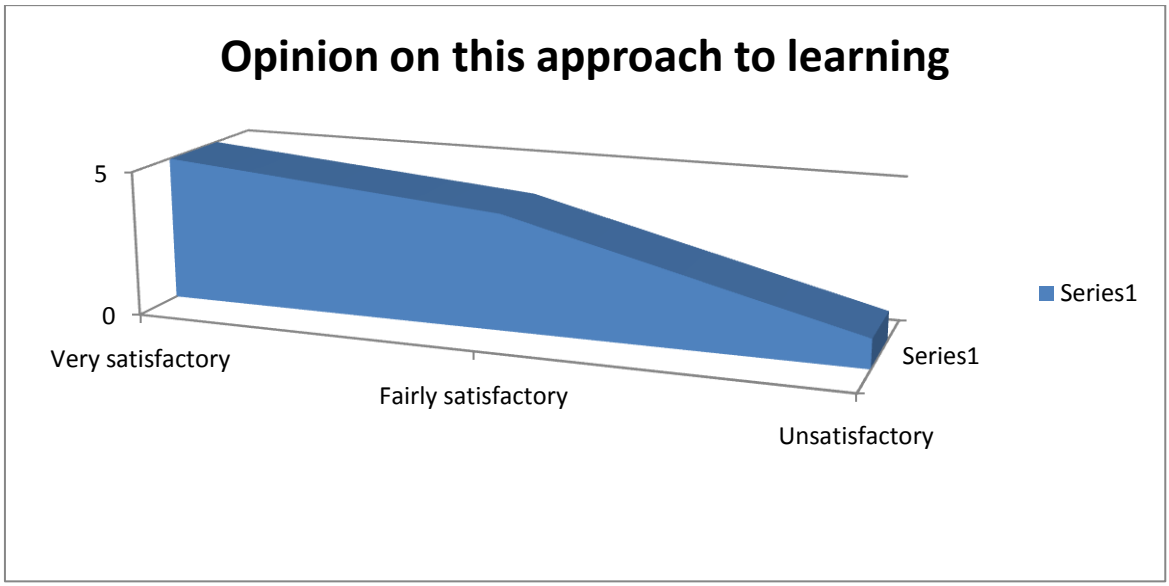


Figure 6i Opinion to this approach to learning

Do you intend to use the CD after the completion of the course?

Yes	6	No	4

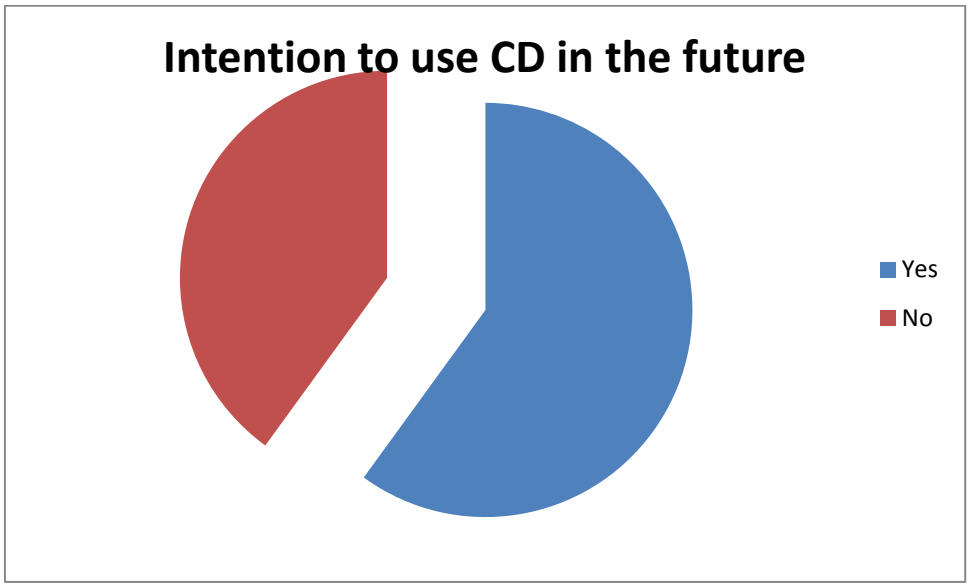


Figure 6j Future use of CD after completion of Course

All of the respondents would recommend the CD to fellow students but interestingly only 60% intend to use the CD after the completion of the project.

While there was a generally positive response to the CD and the application of multimedia tools in the learning process, it should be stressed that in general the respondents had a reasonable level of IT skills; it would be interesting to look at the attitude of learners with fewer IT skills in a deeper manner.

6.4 Analysis and Evaluation of Set Statements

Statement	Strongly Agree	Mildly Agree	Agree	Mildly Disagree	Strongly **Disagree**
I found the content challenging	7	2			1
I found the interactive Quiz Very useful	8	1	1		
I was able to have creative input in the project	2	3	4		1
I became better able to present the concept using digital multimedia	1	6	2		1
The CD allowed me to be more creative in my thinking	2	2	5		1
I understood the subject matter better after the project development	3	5	1		1

The CD enhanced my understanding of the subject	3	4	2		1
I felt increased motivation doing the project	1	2	6	1	
I was able to learn more working through social media	2	2	4	1	1
The CD allowed me to think critically about the topic	2	4	3		1
SCORE	31	31	28	2	8

The feedback from the statements are generally consistent with the feedback from the questionnaire, there was little signs of difficulty in relation to navigation, but interestingly there was some signs of difficulty with the content in which a number of the respondents found challenging.

Results confirmed the usefulness of the assessment tools employed, while the respondents found the content challenging there was positive evidence in relation to using social media and presentation skill.
The feedback was also quiet positive in relation to developing creativity and critical thinking.

The feedback in relation to the interactive quiz also continued in a positive vein.
It is interesting to note that while the majority of the respondents had little difficulty in relation to pocessing the required IT skill to navigate the CD, there was some difficulty encountered with the subject / content matter which could be related to the level it was set at (level 6 NFQ) or possibly the absence of prior knowledge in this particular area.

6.5 Analysis of Open Ended Questions

The open ended questions uncovered a number of design deficiencies which did not come to the fore through the analysis of the closed questions.

The participants expressed a number of interesting points both from a positive and negative perspective.

In relation to navigation and orientation **M4** remarked bookmarking would improve navigation and to break up the lessons more (structure / Chunking) **F3** found too many graphics in part 1 and 2 and found difficultly in relation to orientation.

F4 recommended the availability of a course manual, for example at the start she could not exit the CD, did not realise she could of pressed the esc button.

Both **RN, M3** felt a blended approach should be taken, there was a need for a more collaborative approach, and also there could be a better use of graphics and also better use made of available space (interface). They also recommended more online assessment

M5 Found there was no facility to print off pages**,** could not print off exercises for example, *"I had to keep returning to it to remember what was been asked*

The stuff on the CD was difficult for someone like me who never studied it before, I think you need to have some computer skills, otherwise you could find yourself getting fed up if you can't progress"

It should be noted that M5 was not as long in education and is less exposes to IT than many of the other participants.

The lack of IT skills and possibly lack of prior knowledge could be a barrier to using the CD especially in areas such as affordance and motivation, emphasising the importance of placing the student in their comfort zone, or Zone of proximal Development.

The application of universal design principles for instruction could be a very important factor in overcoming such barriers.

M2 suggests E mail address of other students could be made available to aid networking etc

M1 makes some good suggestions for improvement in relation to networking and collaboration

- More networking opportunities throughout course
- Mahara was good, broadcast yourself.
- LinkedIn exercise was good

Also M1 has some concrete suggestions in relation assessment and chunking

"Could make more use of interactive quiz's, say one after every ten pages"

M2 suggests more simple quiz's with feedback **F1**More and easier Quiz's **F2** suggests that Interactive quiz could be used much more, create more mouse roll over's etc

F5 recommends making use of more online assessment

The open ended questions and the PMI were informative and provided some thought for future work.

The PMI technique was a useful tool in gaining a more informed view, it provided an insight into the possibility of improving the CD and more importantly gave some food for thought for future work, areas of possible improvements included the following

1. Collaboration
2. Use of narratives, analogies, metaphors

6. 6 EPortfolio Analysis

Each portfolio was examined and appropriate grades were applied in line with the relevant metrics**.**

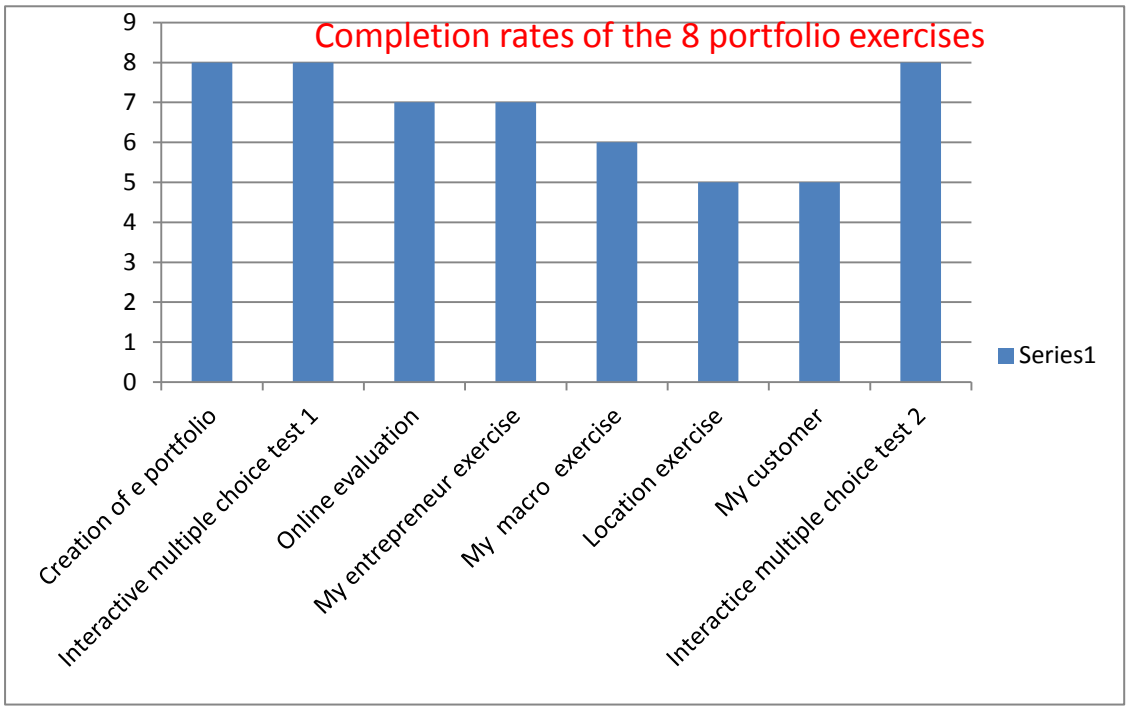


Figure 6k Assignment completed overview

Pre-Test and Final -Test Comparisons (Multiple Choice)

Pre Test contained 10 general business questions and 3 possible solutions

Final Test contained 10 questions with 3 possible solutions (all questions were based on course content)

Multiple choice tests have some advantages which include:

- easy to score,
- students can retake the quiz
- may lower test anxiety,
- requires little instruction,
- Can take time to consider correct answer, cognitive rigor
- Provide instant feedback

The role assessment, pre- and post-, formal and informal, is becoming more and more important in the instructional design process. Participants were required to answer

multiple choice questions to help determine the level of pre course subject knowledge and a second test at the completion of the course to measure their progress.

The results were recorded in the EPortfolios and later compared for any variances.

Participant	Test 1 Score	Test 2 Score	Variance T1 / T2
M1	5	7	+2
M2	8	9	+1
F1	7	7	0
M3	7	7	0
F2	8	9	+1
M4	6	8	+2
F3	6	8	+2
M5	6	8	+2
F4	5	9	+4
F5	5	8	+3
Average	**63**	**80**	**+17**

Table 6.1.1 Multiple Choice Results and Comparison

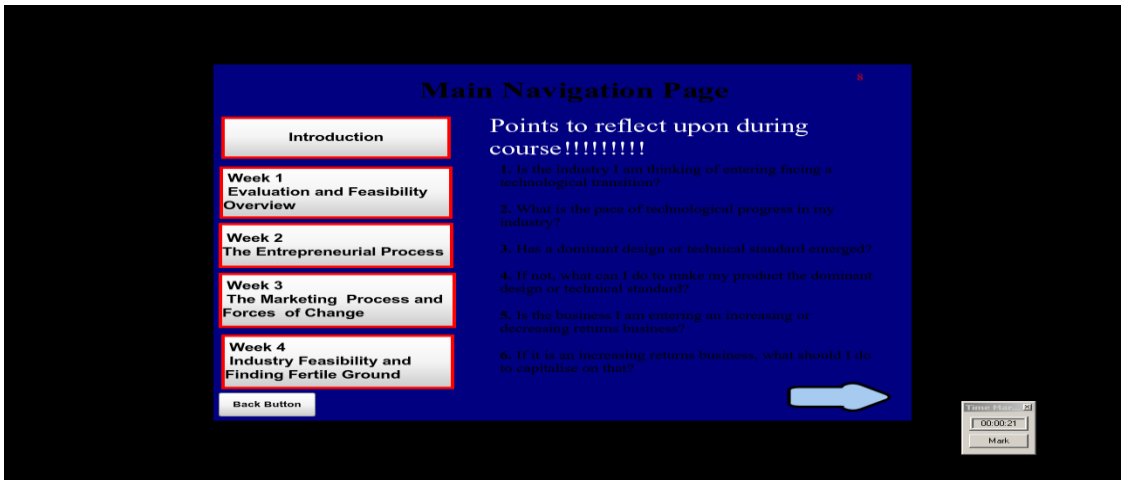
The results detected a very positive trend with only 20% of the respondents not revealing any improvement.

Some caution should be applied to the scores as there is no information available in relation to how many attempts were made before the scores were submitted in the EPortfolio, possibly reflecting some of the concerns where self assessment and EPortfolio are concerned in relation to assessment.

6.7 Software Difficulties / Compromises / Problems Encountered

The research did uncover a number of design faults and also some concrete recommendations to improve the overall design of the CD.

- Hyperlinks colour change resulting in difficulty viewing them, poor colour contrast
- Difficulty sending CD as an Email attachment due to anti virus protection
- Application of transitions and animations took up a lot of memory / processing power which resulted in the program freezing or running very slow
- Screen size



The above screen shot demonstrates the waste of screen space

Usability issues

Scroll Bars

In order to communicate as much information as possible within the 100 pages, scroll bars were applied, this in hindsight was a mistake and there was some negative comments in this regard.

Studies conducted by elearningminds.com indicate that, scrolling should be minimised. A single screen of endless scrolling data, even if broken into headings, creates a navigational and comprehension barrier. When information is not appropriately "chunked", students will become overloaded with information and retention will decrease. This would possibly have negative impacts upon affordance and motivation.

Studies conducted by Wright *et al* (1983) show reading information from a computer screen can be as much as 30% slower than from a printed page but the application of video etc could counteract some of the barriers encountered.

One respondent for example still preferred a text book to access and retrieve information confirming the individual needs of a learner and to some extent the difficulty of applying universal design, often compromises will be required in this matter.

Animation can be a very effective tool in displaying content, but should be used sparingly and not as a special effect.

It should be also noted that it is not suitable in relation to the application of screen readers thereby possibly excluding a large number of learners.

Stroop Effect

The Stroop Effect, named after John Ridley, Stroop is a demonstration of the reaction time of a task Ander is often used to illustrate the nature of automatic processing versus conscious visual control.

Great care should be taken in the design stage in relation to the stroop effect as there was evidence of over use of colour, text and information overload.

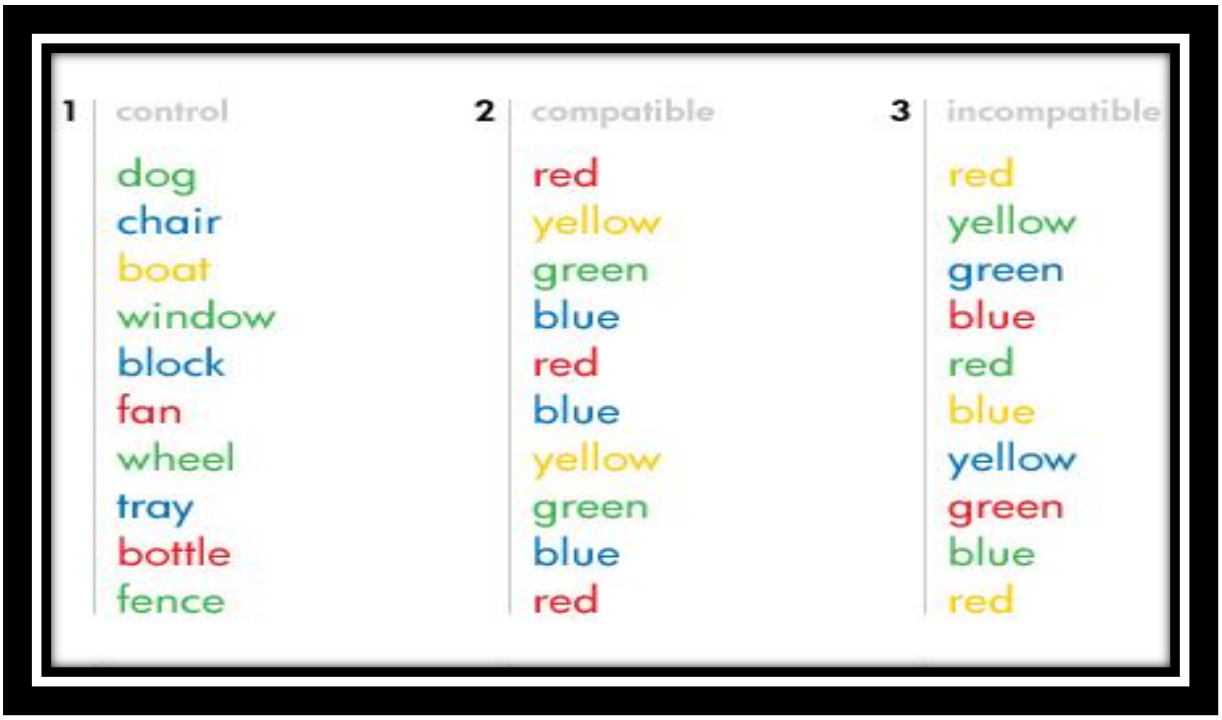


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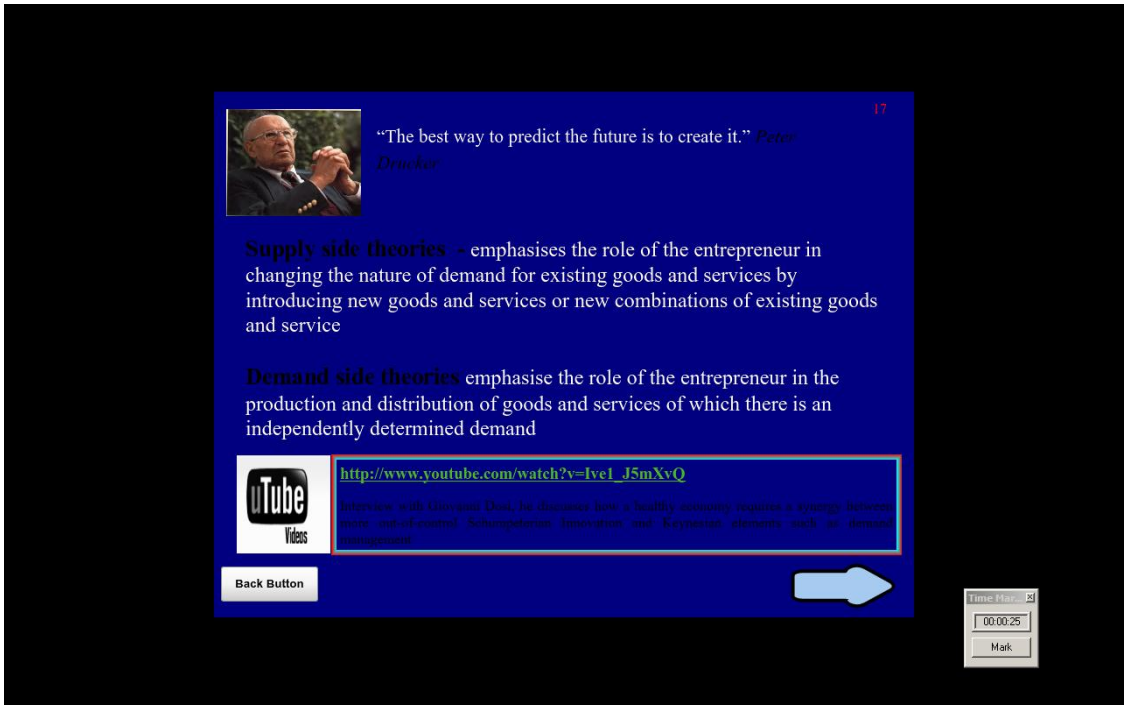
Figure 6k Example of Stroop Effect



Example of stroop effect from CD

Animations and Transitions

elearning minds, (2012) notes Information presentation is one of the key principles in determining if an online instructional medium has met the instructional goal. Interface design should be consistent and aesthetically pleasing to orientate the learner and gain their attention.

Gestalt theories could have possibly been applied in a more consistent and wide spread manner.

Graham. (2008) notes, Gestalt theory provide rational explanations for why shifts in spacing, timing, and configuration can have a profound effect on the meaning of presented information. While gestalt visual principles are easy to grasp, they are very powerful. Ignoring Gestalt visual theory may result in unexpected interpretations by the reader.

With the advent of virtual reality in many new applications the importance of space, timing and consistency take on a more important role.

File Management and email Difficulties

This was another area where difficulties emerged, some email service providers (Gmail and Eircom) would not sent the CD and Questionnaires as the CD was considered a security risk.

This had serious consequences in relation to the distribution and collection of the CD and accompanying questionnaire.

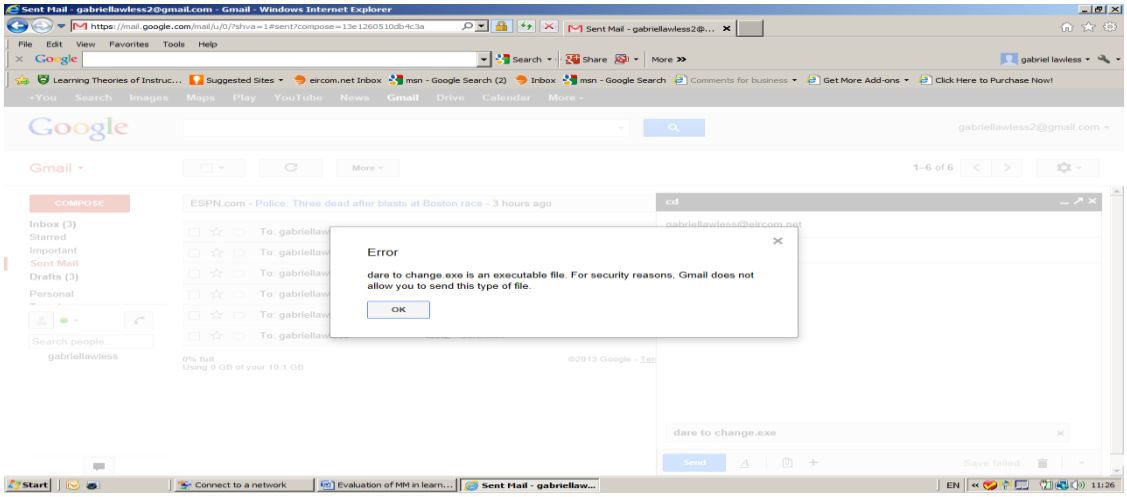


Figure 6 l Error Message in relation to emailing completed EPortfolio

Printing

There is no facility to print off the course content

Broadband Provision

There was some difficulties experienced by some of the respondents in relation to downloading and viewing videos which could have a negative impact of motivation and affordance Chohan N. Nichols,T. (2001) noted that the unavailability of course materials due to technical problems is likely to increase student dissatisfaction and impact on any future use of their environment

Dermody. J (2012) confirms the uneven provision of broadband coverage, in his article he quotes Neelie Kroes, the EU Commission vice-president responsible for the EU's 'Digital Agenda', "that only three EU states have less than 90% 'basic' broadband. Ireland has among the worst drops from urban to rural 'superfast' broadband".

A separate study by broadband specialists Point Topic shows that Ireland is now nearly 36% towards achieving its 'superfast' target. This means that 36% of Irish homes can subscribe to superfast broadband.

Navigation

A Lack of a sitemap or side bar displaying and providing access to a particular page was also uncovered as a negative.

Assessment / Chunking

There was a clear preference for the multiple choice questions as a form of assessment with a 100% completion rate, the essay type questions where more knowledge needed to be applied were less popular and there was evidence of a possible digital divide and different levels of previous knowledge, for example some of the better replies based their assignments on their work areas or life experiences.

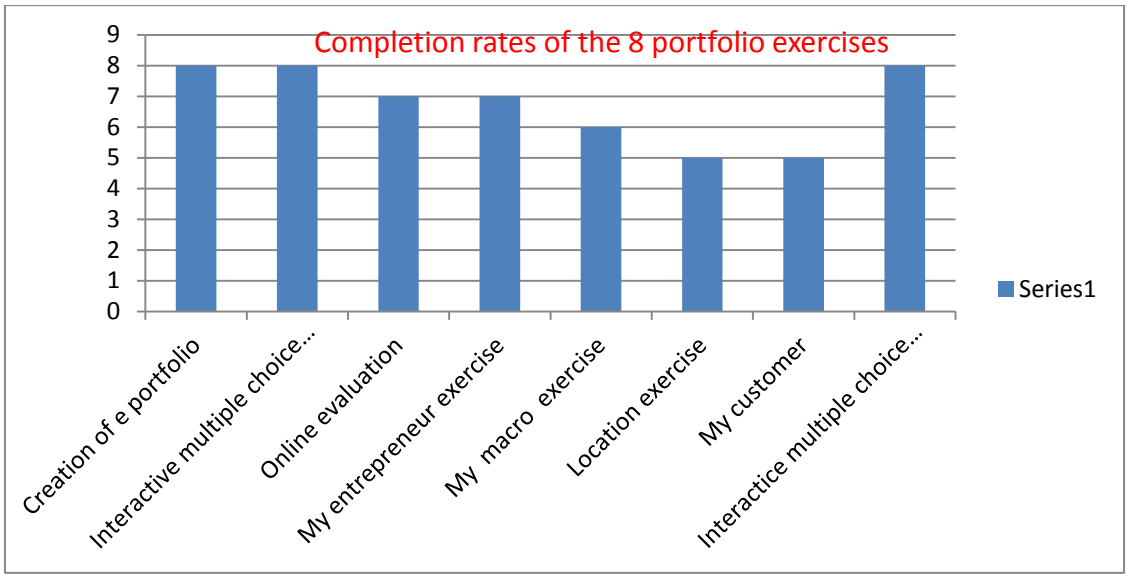


Figure 6 m Completion rate of EPortfolio exercises

An interesting observation from the completion rate of the EPortfolio exercises was there was a 100% completion rate for the 2 multiple choice quiz's and also an excellent return for both the online evaluation and "My Entrepreneur Exercise" which would have needed some internet research.

This could potentially indicate a preference for a particular type of assessment or even learning preference.

There was also evidence from the questionnaire that the respondents wanted more multiple choice and a combination of interactive assessment tools.

There was some evidence from the completed EPortfolios that prior knowledge is important, for example some of the respondents based their assignments on their work background, there was also evidence of the use of templates downloaded from educational websites and the more advanced participants applied resources like Google maps.

Prior knowledge / Affordance / Lotus of Control

There is widespread agreement that prior knowledge can influences learning.

Learners construct concepts from prior knowledge and experience / culture , a very interesting point noted from the assignments was that the participants used a lot of American content, downloads etc and also in the entrepreneur exercised mainly focused on people like Bill Gates, Steve Jobes and Anita Ruddock.

The potential to use hyperlinks in a non linear manner offer many possibilities, and challenges opening up new experiences, allowing learning to leave the school walls, while there are legitimate concerns in this regard often creativity and innovation may be diluted in an attempt to focus on short term gain, personal /instructional and cultural preferences could be influenced by the community that "owns" the subject matter, rather than opening to diverse modes of participation. There is an onus for the educational sector to adapt to change.

Personality

Personality can play an important role in the instructional design process, prior knowledge and the environment from which an individual comes can influence behaviour.

CASEL (2011) note, some people are considered as "lumpers" and some are "splitters,", a "lumper" takes a gestalt view and applies approaches generally believing that differences are not as important as similarities. A "splitter" attempts to build new categories to identify approaches that differ from each other.

Matching personality traits to suitable content and delivery mechanisms can be vital to a successful outcome.

Gemmell.R (2011) for instance found in his study of engineering that it relies upon "formism" as an underlying philosophy of knowledge and that it is more likely to attract someone with a converging learning style, but he found that in the study of marketing and sales it would be more likely based upon contextualism or pragmatism which would likely attract an accommodating style.

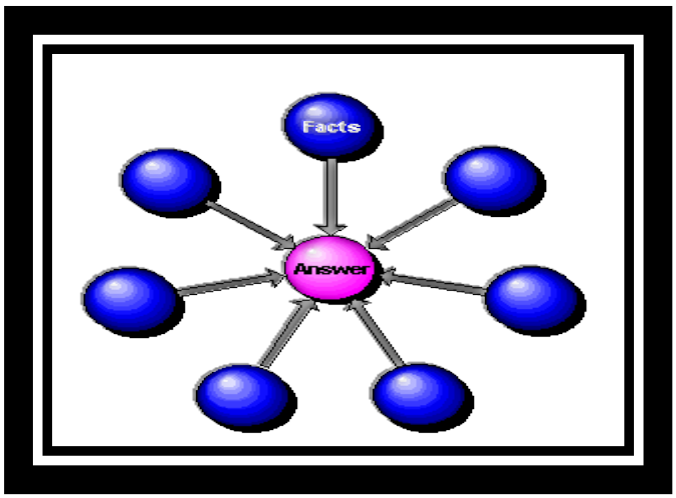
Convergent and Divergent Thinking Styles

Hudson, L. (1967) contends that there were two different forms of thinking or ability

Convergent thinking in which the learner is good at bringing material from a variety

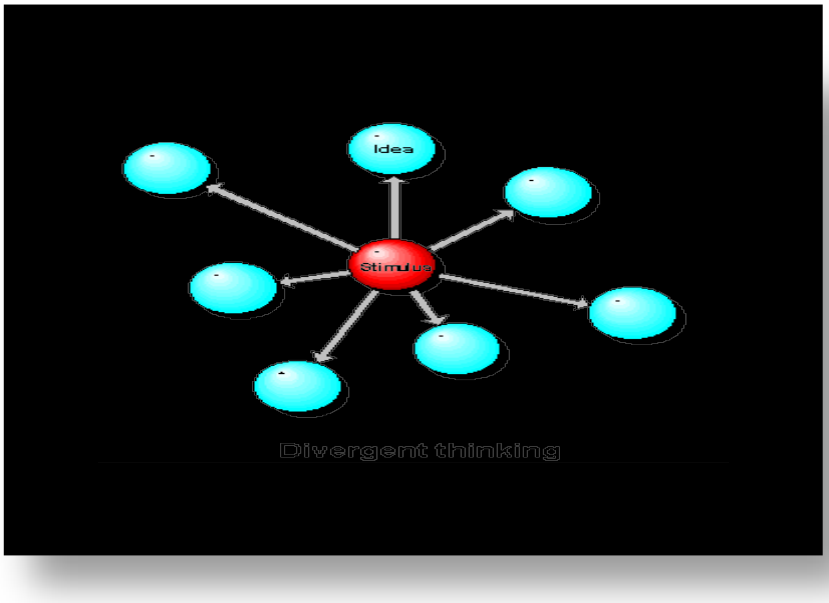
Of sources to solve a problem, in such a way as to produce the "correct" answer.

This kind of thinking is particularly appropriate in science, maths and engineering.



Divergent thinking.

According to Guilford, (1960) divergent or "synthetic thinking" is the ability to draw on ideas from across disciplines and fields of inquiry to reach a deeper understanding of the world and one's place in it



Hudsons argument could potentially have important implications in relation to assessment, the possibility that we are presently seriously under-estimating the talent of a sizeable part of the school population.

This potentially causes problems of assessing and properly measuring areas like creativity and innovation.

Gardeners. H (1999) idea of multiple intelligences for example could potentially provide a framework to provide a more informed opinion.

Assessment, both summative and formative are often categorised as either objective or subjective. Multimedia potentially affords the opportunity to present assessment in a variety of forms allowing for a greater choice while also providing instant feedback.
It potentially allows for different forms of assessment to be used or combined in the most effect manner, integrating assessment in to the instructional design process in a novel and holistic manner.

Objective assessment is a form of questioning which has a single correct answer.
Objective question types include true/false answers, multiple choice, multiple-response and matching questions. Well designed oobjective assessment is potentially well suited to the increasingly popular computerised or online assessment format.

Subjective assessment is a form of questioning which may have more than one correct answer (or more than one way of expressing the correct answer) Subjective questions include extended-response questions and essays.

The results from the research did provide some food for thought, the potential to reduce time and space in the learning process provides many opportunities, improved techniques to assess and understand learners needs, monitor their progress potentially provide us with a greater awareness of what is required allowing for a more informed opinion.

Management of Content and Context

Becta (2007)

e-learning 2.0 takes a ‘small pieces, loosely joined’ approach that combines the use of discrete but complementary tools and web services – such as blogs, wikis, and other social software – to support the creation of ad-hoc learning communities.
The exposure of learners to a wide range of resources allows for greater flexibility and learner control, the move to mobile learning is extending the boundaries as never seen before, new visualisation tools provide the potential to communicate in a more effective manner.
There is the potential to learn through technology

Visual Analytics and the Human Analyst

Keim.D, *et al* (2010) notes, visual analytics integrates the analytic capabilities of the computer and the abilities of the human analyst, thus allowing novel discoveries and empowering individuals to take control of the analytical process. Visual analytics sheds light on unexpected and hidden insights, which may lead to beneficial and profitable innovation.

Visualization tools provide a platform for student and instructor engagement, an opportunity to gain insight into the nature of a problem and discover a new understanding of a specific problem. Card, S (2005) In theory, visual resources enhance cognition by expanding human working memory, representing large amounts of (properly designed) data in a condensed space, and enhancing the recognition of patterns (Card et.al).

Visualisation techniques can be applied with a view to presenting information which is flexible offering the potential to deliver the message at different levels allowing the learner to pace their progress at a speed which suits them.
Fry (2008) notes, that given the complexity of data, inputs from diverse fields are required to provide meaningful solutions.

Visualization can be viewed as a combination of many disciplines Statistics, Data Mining, Graphic Design, Computer Science, Data/Info Visualisation. Data can be displayed in both exploratory and explanatory forms

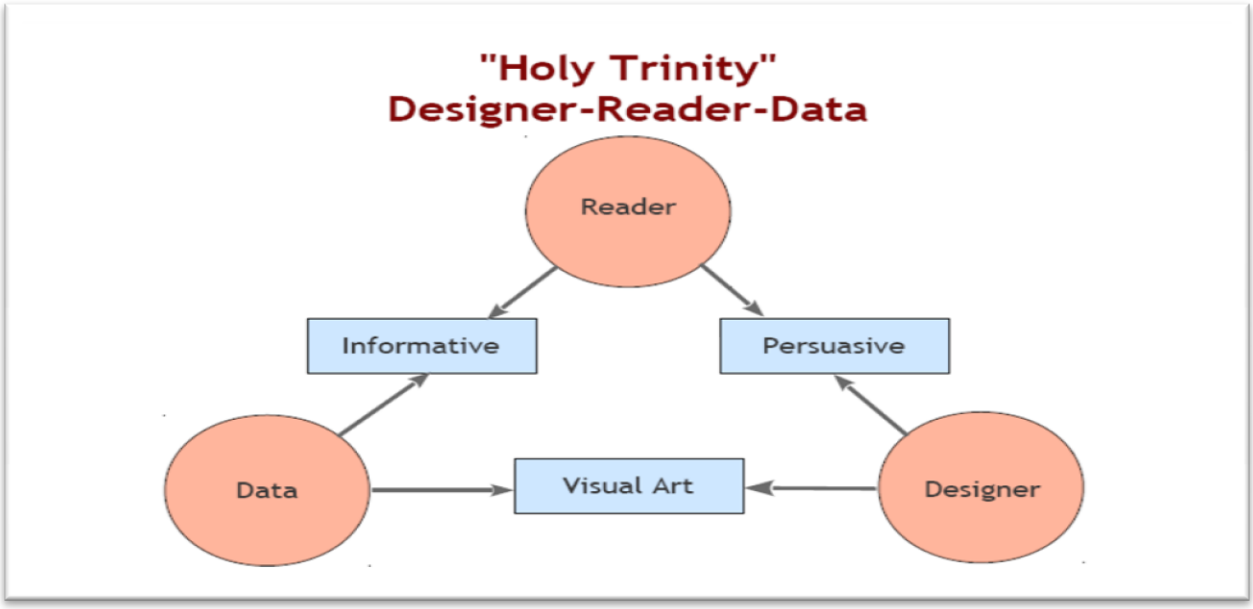


Figure 6 n Holy Trinity of Data Visualization (The nature of the visualization depends on which relationship (between two of the three components) is dominant)

Ausabels (1960) and Vyogsky (1978) work in relation to signposting and determining the zone of proximal development have been seen to much advantage within the teaching and learning process, but the potential to gain a deeper knowledge can advance the potential of these techniques even further.

There is a requirement to place the learner in an environment which suits the individual needs, a comfort zone where the learner can build on previous knowledge, reflect and build on past experiences.

Kolbs (1994) learning theory could have potential in identifying and placing the learner in a comfort zone allowing the learner the freedom of application of previous knowledge at a pace and time that suits.

There is the potential to marry multimedia to a sound pedagogical framework creating learning cycles based on preferences, experience. Determining and guiding learning.

The pull approach to e-learning

www.aurionlearning notes what they refer to as the pull approach to e-learning based on what the learner wants to learn**.** It believes that some learners enter the e-learning programme with different levels of knowledge. A pull approach to e-learning allows the learner to select which modules they want to take in order to fill in their knowledge gaps.

Kolb D. (1984) learning theory sets out four distinct learning preferences, which are based on a four-stage learning cycle. In this respect Kolb's model is particularly interesting and could have particular application in areas such as adaptive learning programmes.

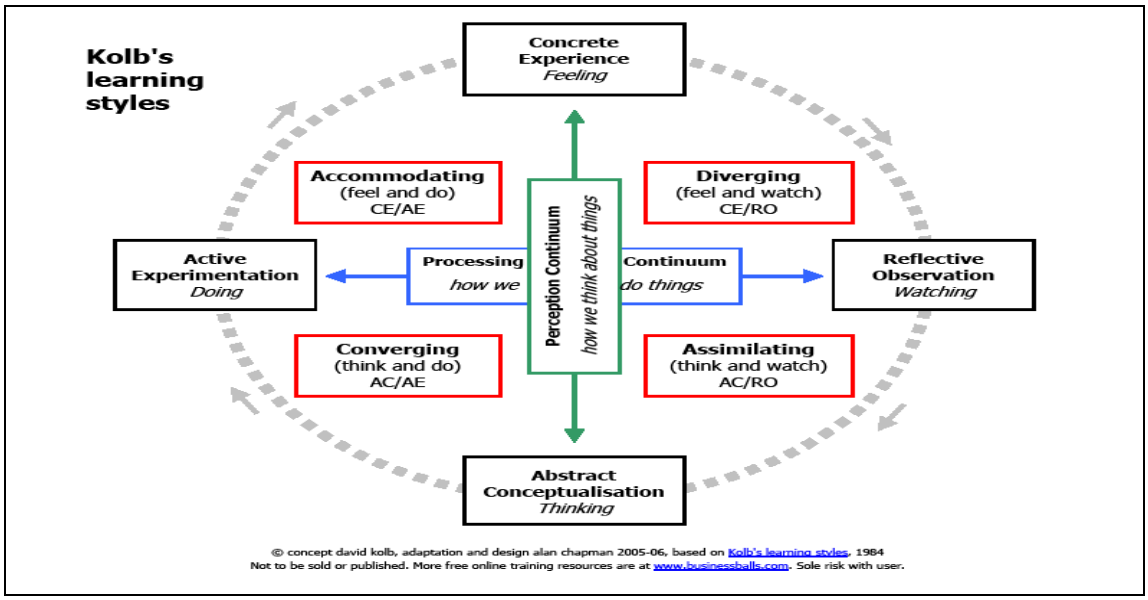


Figure 6.0 Kolb's, a four-stage learning cycle

Kolfs four stage learning cycle potentially offers a way to understand an individual's different learning preference, but also demonstrates a cycle of experiential learning that applies to us all.

Kolbs model works on two levels, a four stage cycle:

1. Concrete Experience - (CE)
2. Reflective Observation - (RO)
3. Abstract Conceptualization - (AC)
4. Active Experimentation - (AE)

Accompanied by a four type definition of learning styles

1. Diverging (CE/RO)
2. Assimilating (AC/RO)
3. Converging (AC/AE)
4. Accommodating (CE/AE)

Teachers often tend to use their own learning style this model allows the student to enter the circle at their preferred point and then progress in a circular manner experiencing a more holistic educational experience.

Pedagogical v Andropogy

The emergence of life-long and blended learning have extended the boundaries of education provision.

Often the terms learning and pedagogy are used interchangeably, but in fact pedagogy usually refers to how children learn, there is now a distinct term and theory for how adults learn called andragogy.

Andropogy Knowles (1984) has important lessons in the design of this project, prior knowledge, affordance and motivation were important elements.

The human is at the heart of visual analytics human interaction, analysis, intuition, problem solving and visual perception. In cognitive information processing theory, learners are viewed as active seekers and processors of information.

Information processing theories focus mainly

1. **The attention of the learner** to environmental events
2. **The encoding** information to be learned and related to knowledge in memory.
3. **The storage of** new knowledge in memory, dept of understanding
4. **The retrieve** of information when needed.

The processes that keep information active or facilitate transfer from one memory stage to the next depends on the potential of the learner to

- Focus attention
- RehearsE
- Chunk / Recognise
- Encoding
- Retrieval.

It is essential to actively engage the learner, create a clear channel between the content and the learner, offering clear and perceivable information.

Walther. *Et al* (2005) note, there is psychophysical and neuro physiological evidence that the brain employs visual attention to select relevant parts of the image and to serialise the perception of individual objects.

Selective visual attention enables learning and recognition of multiple objects in cluttered scenes.
Selective attention relates to the learners ability to select and process relevant information while at the same time deleting other information

Perception and Cognition / Visual Analytics

Stickiness is anything about a Web site or interface that encourages a user to stay longer, the potential to actively engage the user often design aided by metaphors or analogies

Possible approaches in relation to stickiness

- Universal design principles

- Provide appropriate content that the user is searching for, hyperlinks, combination of audio visual, text
- Affordance / lotus of control / perceivable / flexible / reversible
- Developing online communities inviting user interaction / activity
- Using extensive hypertext

Knowledge construction

Gestalt psychology suggests gaining insight is about restructuring existing information
The focus of Gestalt theory is the idea of "grouping"; characteristics of stimuli cause us to structure or interpret a visual field.
Gestalt psychology has shown the importance in human thinking and problem solving of the behaviour that it labels “intuition,” “insight,” and “understanding.”

Gestalt psychologist emphasise the importance of organisational processes of perception, learning, and problem solving. They believed that individuals are programmed to organise information in certain ways. This can be very useful to the understanding of the interaction between man and machine.

Gestalt laws can be applied as a guideline in relation to context, navigation, the grouping of information in a manner which is potentially easier to process, retain and retrieved by the individual learner.

There is the potential to create an environment that is accessible to a variety of learning styles and personalities, an environment where numerous channels can be used to reach learning objectives.
Gestalt laws of organisation can be applied in the context of perception and problem-solving. The main factors that determine the grouping include.

(1) Proximity - elements tend to be grouped together according to their nearness
(2) Similarity - items similar in some respect tend to be grouped together
(3) Closure - items are grouped together if they tend to complete some entity

(4) Simplicity - symmetry, regularity, and smoothness.

Mayer (2003) describes five interrelated views of insight based on the assumptions of Gestalt psychology:

1. Insight as completing a schema
2. Insight as suddenly reorganising visual information
3. Insight as reformulation of a problem
4. Insight as removing mental blocks
5. Insight as finding a problem analogue

Norman (1988) coined the term affordances in relationship of human – machine interaction action possibilities that are naturally perceivable by a user.

- Aligning essential information to instructional goals.
- Resist the temptation to present extraneous information and animations (extraneous information as a barrier in the learning process).
  The application of Multimedia resources is more effective when learner attention is focused and undivided.
- The application of Multimedia resources are more effective when it is interactive and under the control of the learner.

- Multimedia learning is more effective when learner knowledge structures are activated prior to and during exposure to multimedia course content. Mayer (2003) and Ausubel (1960) ZPD / Advanced organisers

Helping students recall or acquire structures that will help them organize and understand the content.

Multimedia instruction that includes animation consistent with the Gestalt principles can improve learning.

- Multimedia leaning is most effective when the learner is engaged with the presentation.
- .Active engagement can facilitate the learner construct knowledge and organise information into meaningful schema

- Multimedia learning is most effective when the learner can apply their newly acquired knowledge and receive instant feedback.

6.8 CONCLUSIONS

The importance of an understanding of how individuals process information is essential in the teaching and learning process, appropriate instructional design can be underpinned by new and emerging technologies, visualisation tools can be applied in both an expletory and explanatory manner.

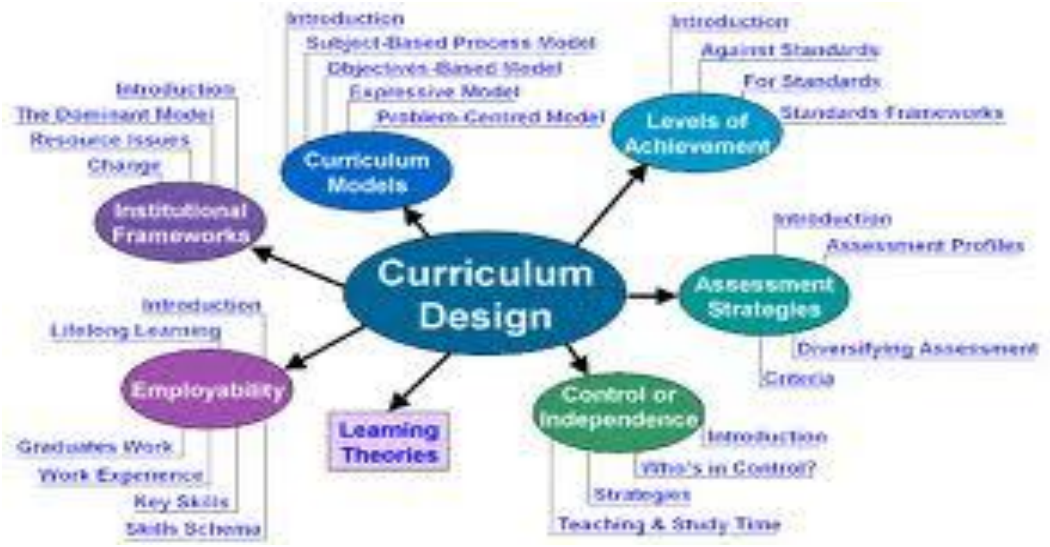


Figure 6. p Curriculum design environment

There is a need to integrate all resources in a very integrated manner, combining all resources and stakeholders in a well informed curriculum design.

The UK National Curriculum - Principles of Curriculum Design note,

A school's curriculum consists of everything that promotes learners intellectual, personal, social and physical development, it includes approaches to teaching, learning and assessment, the quality of relationships within school, and the values embodied in the way the school operates." .

There is a need to adapt to change recognise the pull effect and the potential of informal learning.

7 CONCLUSIONS

7.1 RESEARCH DEFINITION & RESEARCH OVERVIEW

This research was conducted in order to reveal if the application of integrated multimedia can play a significant role in the teaching and learning process. Interactive multimedia as a subject is still in its early stages creating the potential to extend the boundaries of education provision, motivating educationalists and technologists alike.

However, the design and development of interactive multimedia content is a complex process usually involving a team of experts, including content providers, multimedia developers, graphic designers, and instructional designers.
Instructional design is an essential component in the successful delivery of the intended message, there is a need to apply a relevant framework.

Traditional learning theories are still useful and potentially provide a sound platform in understanding the teaching and learning process, however as the boundaries of education provision are expanding at a fast rate new research is required to meet a changing environment.
Instructional design to some extent is evolving but not necessarily keeping with the pace of change, there is the potential to apply new tools and techniques like data mining and visualization to create a more informed opinion.
Gestalt psychology still has its place especially in areas such as man and machine interaction.

More interactive tools provide great advantages but also challenges, open source resources are increasingly becoming available but some genuine fears remain as to the quality and relevance of some of this content.
There is a need for continual professional development within the education community, the ability to provide and access good multimedia resources, be able to select and parse relevant content.

Embedding multimedia tools into the learning environment is a rewarding but yet a complex and challenging process. A good understanding of the information processing system and skilled instructional design will not guarantee success, good multimedia design in isolation might not succeed, and there is a need to understand the wider environment, often complex and continually evolving.

Local and Global Approach Required

Asthana, (2012) notes the importance of regional and also curriculum integration "all this expensive technology will yield little educational return until schools and districts address the need for professional development, technical support, the availability of appropriate software, classroom management, and curriculum integration."

For example, the provision of resources for teaching Irish would probably have to be developed in-house, there is a requirement to meet the demands on a local, regional and global front.

7.2 New Technology Leads to New Research

New innovations usually require change and a willingness to adapt to a changing environment**.** The concept of creative destruction provides a view that an economy never remains stable; it is a continual process of change. There is a need to be aware and embrace change in a positive manner, the ability to properly manage change could be critical.

Economic recessions often facilitate change, the potential to develop a smart economy could depend on how the education community adapt or buy in to the change. It could be beneficial to identify the potential drivers of change and anticipate the probable consequences. The ability to view or create the future can reduce the fear of change.

A move towards a knowledge economy has some far reaching impacts upon a variety of stakeholders, government policy often view education as a vehicle to promote growth through delivering innovation and creativity. Governments provide resources, infrastructure and human resources to try and enable economic development.

Scoilnet is the Department of Education and Skills official portal for Irish education. It is responsible for the promotion and use of the Internet in education under the Government's ICT in Schools Programme.

Scoilnet provides a wide range of impressive resources for teachers, parents and students. Scoilnet is part of a plan to integrate ICT into the Irish education system; it comes under the control of NCTE (National Centre for Technology in Education)

NCTE promotes and supports the integration of a high quality ICT infrastructure into learning and teaching for schools. It provides relevant and up-to-date ICT advice and supports to schools on a range of technology-related areas. The NCTE also coordinates the Schools Broadband Programme, which provides broadband connectivity, content filtering, webhosting, and security services to all Primary and Post Primary schools.

But with shrinking budgets uneven broadband coverage, questions remain as to how effective these bodies are?

- What percentage of the population knows of the existence of Scoilnet?
- Have teachers and parents the required knowledge to take advantage of such resources?

The ICT in Schools-Inspectorate Evaluation Studies (2008) note that younger teachers are more likely to use digital resources in the teaching and learning process, there are Continual Professional Development courses available for teachers but it reveals that,

Only 18% of the post-primary lessons observed by the inspectors involved an ICT-related activity. Students' interaction with the technology was observed in only about a quarter of these instances. The most common ICT-related activity observed was the use of a data projector to make a presentation to a class group. Inspectors judged that effective integration of ICT. Teaching and learning was occurring in approximately half of the lessons in which the use of ICT Was observed (**i.e. in approximately 11% of all lessons observed**).

The successful integration of ICT in to the Irish education system depends on many variables, successful technology adoption relies on a number of factors, the provision

of ICT resources needs to be complemented by the skills of society having the ability to extract the true potential of such resources.

Kalmbach (1996) neatly describes the situation "*One of the most difficult challenges of technology in a computer-supported classroom is keeping up with the relentless pace of change in the computer industry*." …as soon as we become comfortable… something newer, more exciting, and potentially even more useful appears.

elearning for example has facilitated both a push and pull element to education provision, learners in a sense have the opportunity to manage their learning and enter the learning cycle at an opportune time, pulling what they require from the content rather than the traditional push approach.

7.3 Understanding the Adoption Process

Adoption can also be seen as a process of information diffusion, culminating in a rational choice to use (or not use) the new technology. The adoption and diffusion of new technologies has been accelerated by everyday exposure as Weiser, M. (1991) remarks, the most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it. But not all technologies will weave their way in to everyday life.

Bennett, S. J. Maton, K. (2010) casts some on the emergence of a tech savvy generation The idea of 'the digital natives', a generation of tech-savvy young people immersed in digital technologies for which current education systems cannot cater, has gained widespread popularity on the basis of claims rather than evidence. Recent research has shown flaws in the argument that there is an identifiable generation, or even a single type of highly adept technology user.

For educators, the diversity revealed by these studies provides valuable insights into students' experiences of technology inside and probably more importantly outside formal education.

The fundamentals of teaching may not change, but the delivery mechanism and media will change, and that will impact upon all stakeholders.

Cost can be a critical issue impacting upon the rate of change and indeed acceptance of the applications of the new technologies, but not the main one.
New technology presents risk for many stakeholders. They react differently toward this risk based on their innate characteristics, their wants and needs and life experiences.

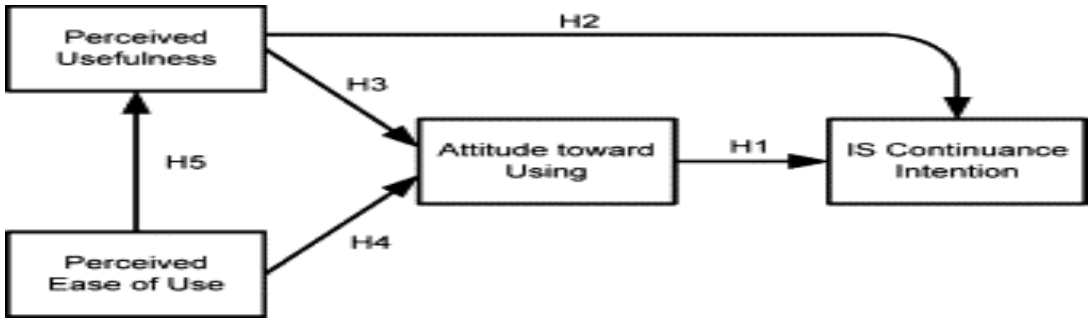


Figure 7 a The Technology Acceptance Model (TAM)

The **Technology Acceptance Model** (TAM) is an information systems theory that models how users come to accept, the perceived usefulness and the perceived ease of use.

There are some concerns expressed about the use of technology in education often students focus on presentation rather than content, skim over material, unreliability of some sources, there is a need to learn use these new technologies in a more efficient ma Dockstader, (1999) "True integration comes when students learn through computers, not about them. There is no value of learning word processing unless it is used to further content comprehension."

The Technology Adoption Life Cycle (TALC) models how different groups of customers adopt to discontinuous innovation at different times.
There is a requirement to use technology as an enabler of change, there is a need to facilitate the adoption of new technologies through profession development of staff and collaboration, often leadership and change must be embedded in policy.

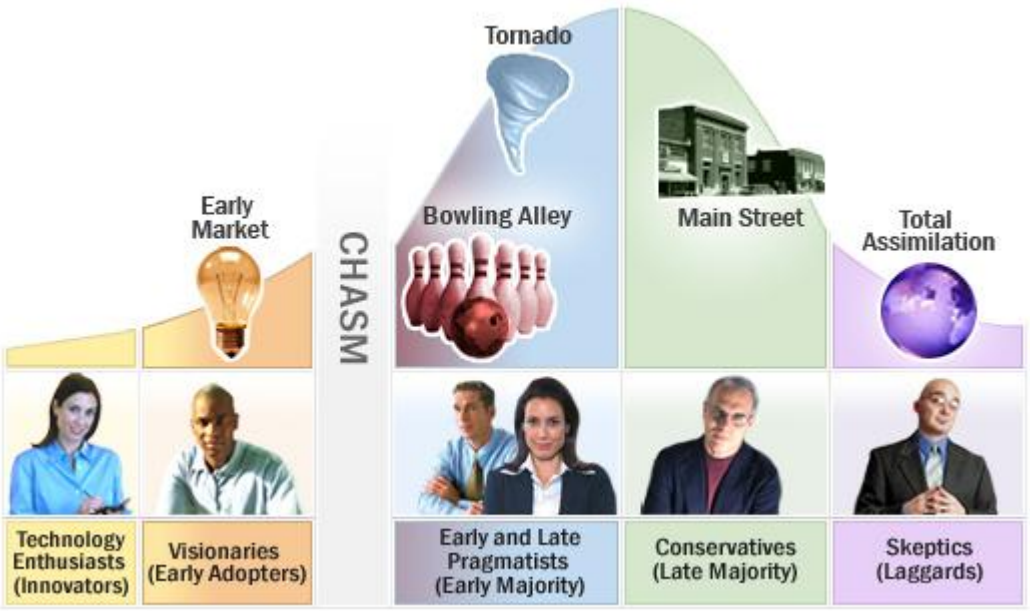


Figure 7b The Technology Adoption Life Cycle (TALC)

McCausland, et al (1999) notes, there is a need for sufficient levels of information literacy, the ability to properly identify, locate and evaluate relevant information in order to engage with the content or to solve a problem arising from it

Technology adoption can be seen as the assimilation of new tools and practices. Blamire, R. (2008) notes, Content, infrastructure alone, without quality content and services, is useless. New tools and technologies should be viewed in relation to:

- Complexity
- Compatibility
- Diffusion
- Service

Dissemination

The act of disseminating or spreading widely.
Technology transfer and diffusion are two aspects of technology dissemination, which is the process by which innovations are transmitted between donor and receiver, technology can take the form of an object or a concept /technique (social technology)
The user's everyday decisions to adopt or reject a technology play a critical role in determining whether a new technology will be disseminated.

The Internet allows for the rapid dissemination of information, but does not by itself guarantee successful acceptance of an innovation or a technology.

A common theme underlying various models that try to explain information technology adoption is the notion of ***perceptions*** of an innovation as key independent variable.

Bernstein, G. (2012), notes market failure occurs because a technology is dependent on network effects and the accumulation of a critical mass of users

Technology is having a profound impact in the field of education especially in the delivery mechanisms, networking and collaboration tools are changing the way we interact, to some extent education is leaving the school walls, embarking on a new and unfamiliar journey.

The idea of a staged approach was put forward by Salmon, G. (2003) following research based on the Open University Business School's distance education programmes

Stage one: access and motivation
Stage two: online socialization
Stage three: information exchange

Stage four: knowledge construction

Stage five: development.

While technology adoption models are useful tools in helping to better understand the adoption process, there is some concern that they can be too general there is a need to uncover more specific information.

Networks are becoming increasingly important as a delivery mechanism

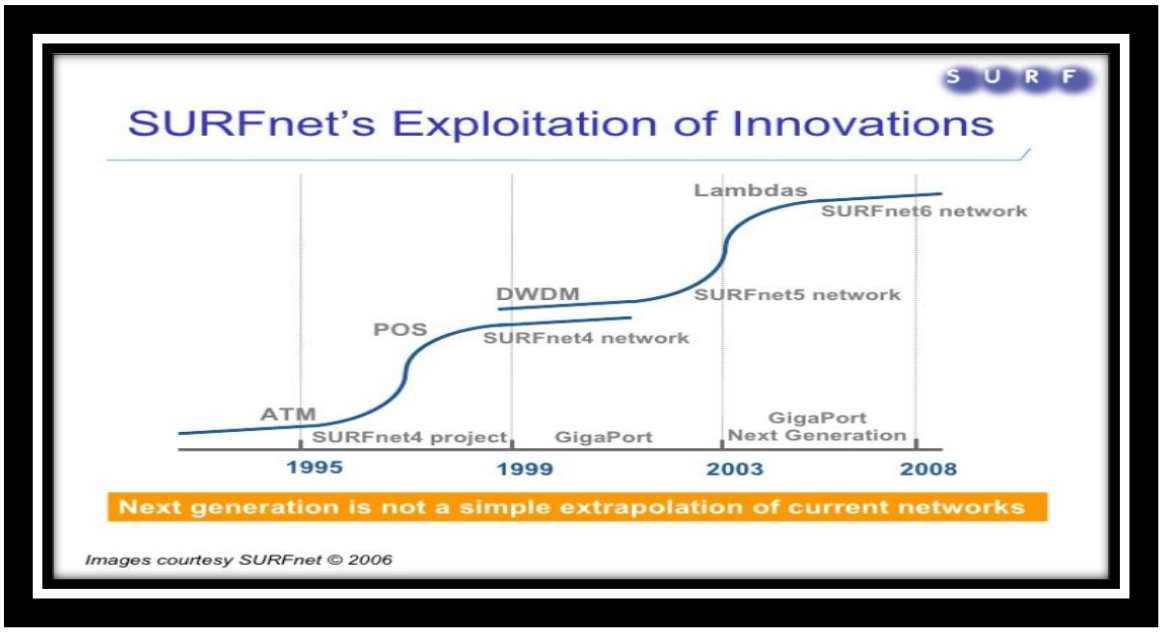


Figure 7c Exploitation of innovations

But Surf nets for example have researched the exploitation of innovations, the adoption of new ideas and note that the next generation is not a simple extrapolation of current networks.

7.4 Adapting to a Changing Environment

There is a need be flexible and adapt to a changing environment Donnelly, R. (2004) notes, Classroom practice is increasingly made up out of responses to changing external demands. The demands and expectations that are being placed on Irish higher

education institutions by Government, industry, social partners, and professional bodies are formidable.

An article Mary Fitzgerald in The Irish Times First published: Sat, Jun 1, 2013, notes Minister for Education Ruairí Quinn described a joint project by Google and Trinity initiative to provide computer training to 1,000 secondary teachers and over 1,000 mini-computers to develop student's computer science and coding skills as a fantastic initiative.
"*It's just that the technology is developing so quickly that the education system has been slow to focus in on it,"* remarked Mr Quinn.

A HEA (2009) Submission to the National Strategy for Higher Education confirms Mr Quinns view noting, *that he pace of change renders the future increasingly unpredictable and the key characteristic that we desire of graduates, and of the system from which they graduate, is responsiveness, or adaptability to change. This refers to the internal responsiveness of the academy to the needs of learners and researchers and also to the external responsiveness of the system to the key challenges of our time, social, economic, environmental and civic.*

These developments are leading to enormous challenges for teachers in relation to the role multimedia tools and devices play in the learning process. Some educators believe, that technology should only be applied as a tool to help facilitate student understanding of the current curriculum.

But other educators believe that technology is as fundamental to learning as reading and writing and therefore technology is seen as a resource that can be applied not just within the confines of the present curriculum, the potential to learn through technology rather than with it.

The shift in paradigm can be viewed in both an evolutionary and revolutionary manner. It is evolutionary by applying instructional best practices, and greater access to resources.

It is revolutionary by advances that are discontinuous and disruptive, mobile learning for example is impacting upon the sales of traditional school books with greater access

to digital libraries and e books reducing cost dramatically technology is driving change.

The Horizon Report (2011) attempts to identify six emerging technologies that are likely to enter mainstream use within three selected timeframes

- The near-term (technologies that will see adoption within the next year) Near-term: *mobile computing and open content*
- The Mid-term (technologies that will be adopted over a 1-3 year timeframe) Mid-term: *electronic books and simple augmented reality*
- The Longer-term (those that will be pursued over the 3 – 5 year time frame). Long-term: *gesture-based computing and visual data analysis.*

The report reveals the necessity of digital media literacy in every discipline and profession but it warns that formal training in digital literacy skills and techniques is rarely found in teacher education programs. The Report maintains that, clearly the digital world is headed firmly in this direction and education must follow suit.

While many educators are working on the topic in an informal manner, the fact remains that digital literacy is seen to be "less about tools and more about thinking." Therefore, a systems approach to digital literacy is necessary if we are to ensure that teachers are ready and able to lead students down this ever-evolving path.

There are worries that the traditional methods in areas such as instructional design are not evolving quickly enough.

There are numerous challenges facing educators in implementing these short-term, mid-term, and long-term technologies

The (2011) report identified the following specific areas as technologies to watch

1. Mobile Technology Everything from smart phones to netbooks.

2. Open Content Facilitating and providing n individual choice as to when and how to learn 24/7 access, the ability to learn in an informal manner, reducing the need for direction and supervision,

3. Electronic Books Augmented by electronic reading devices like screen readers etc

4. Augmented Reality

Augmented reality (AR) is a live, direct or indirect, view of a physical, real-world environment whose elements are *augmented* by computer-generated sensory input such as sound, video, graphics or GPS data

5. Gesture Based Computing Ubicomp, Prenskys view of how technology will evolve and weave its way unnoticed in to everyday living
6. Visual Data Analysis Visualization tools like Soup, Python

Visual data analysis is an evolving field that helps blend highly advanced computational methods with sophisticated graphic generating tools.There are a number of tools and techniques developed in the business area which can be applied to help understand a changing environment.

The Components of the Economic Environment

There is a need to understand The Components of The Economic Environment which are potentially driving change in the education community.

- Economic Conditions
- Economic System
- Economic Polices
- International Economic Conditions
- Economic Legislation

The forces associated with such globalisation have impacted the context in which educators operate, and altered people's experience of both formal and informal education.

Globalisation is having some far reaching impact on nearly every facet of life, the internet is moving us towards a global village, and there is an ever increasing need to understand the interaction of the various stakeholders and variables.

There are several factors to assess in the external situation analysis:

- **Markets** (customers) Consumerism Single market, competition, globalisation, accreditation
- **Competition**
- **The internet as a delivery mechanism**
- **Technology**

  The digitising of human knowledge, cloud computing, social networking, touch-screen technology, and the convergence of mobile and PC technologies

- **Supplier markets**

  Lifelong learning and the application of new tools have changed the way content is delivered, online courses are continually evolving, emphasis often on knowledge sharing and collaboration, networking and peer learning, there is a need to adapt to a new form of delivery and also to understand the way in which learners adopt and interact with new technologies.

- **Labour market**

  Expectations OF Employers and Business

- **The economy**

  Move towards a knowledge economy

- **The regulatory environment**

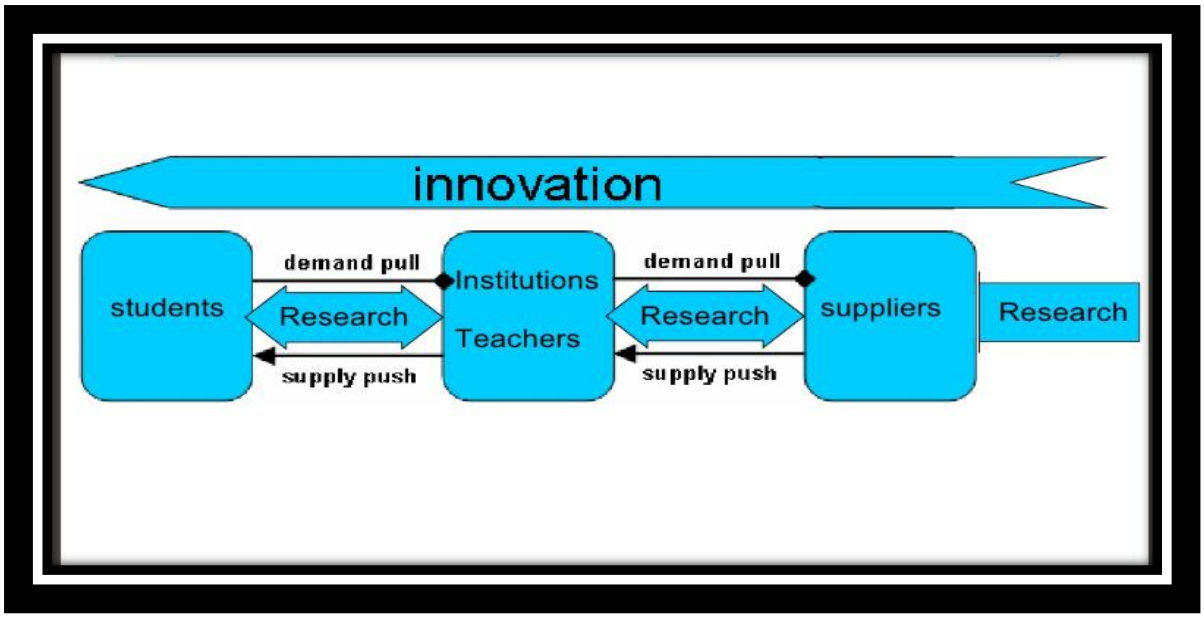


Figure 7d Innovation environment Taken from surfnet 2006

The rate of technological development is so great, Stiles, M. (2007) believes, one must consider the future of learning environments, especially with the onset of Web 3.0 and Web x.0

7.5 Identifying the Drivers of Change

A changing environment can have a serious impact in many areas, as learning threatens to leave the school grounds, new approaches are required to meet the new challenges encountered by the many stakeholders.

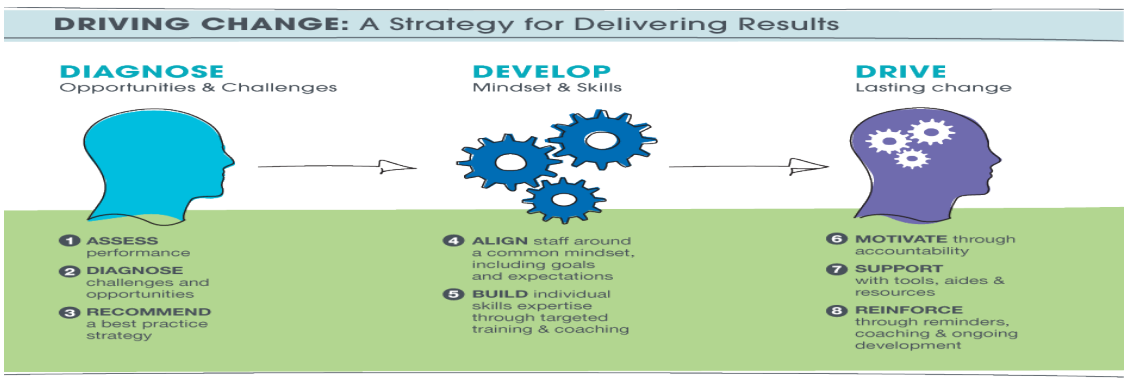


Figure 7 e Driving Change a Strategy for Results

There is a need to investigate both the internal and external environments, identify what is driving change and impacting upon the sector.

Globalisation in Higher Education.

Globalisation is leading to increased emphasis on internationalisation of the curriculum,

JISC (2004) the widening participation agenda places a responsibility on institutions to assess potential barriers to learning, and to address these through more flexible learning opportunities. Accessibility and inclusion are requirements that have moved beyond the 'special needs' agenda.

Donnelly, R. (2004). Notes, The Bologna Declaration (1999) is having a direct impact on Irish HE, the process of convergence in education policies which is currently observable across the globe.

Donnelly, R. (2004). A central question remains from all this: what will be the implications of Commodification? Making higher education a purchasable and saleable good and subject therefore to international trade law. It is important to look at an answer for this within the Irish context previously outlined.

While the potential to create a new era in education through the application of new technologies are immense, caution should be advised, there are many barriers to overcome in the implementation of a successful strategy.

A lack of standardised concepts and procedures for design and management contributes to this dilemma. The only solution is to embrace evolution and change from the outset through the design of flexible systems.

Newhouse, P. (1999) notes,

That many of the common barriers associated with the adoption of the innovation were still present. Some of the barriers preventing teachers from integrating technology

were poor computer literacy, lack of time, lack of confidence, and hardware malfunctions

Internet and Global Information Infrastructure

Horizon Report (2008) notes the changing landscape,

Video is everywhere—and almost any device that can access the Internet can play (and probably capture) it. From user-created clips and machinima to creative mashups to excerpts from news or television shows, video has become a popular medium for personal communication. Editing and distribution can be done easily with affordable tools, lowering the barriers for production. Ubiquitous video capture capabilities have literally put the ability to record events in the hands of almost everyone. Once the exclusive province of highly trained professionals, video content production has gone grassroots.

Internet and Global Information Infrastructure (GII) development potentially changes the main paradigms in Education and Research, and raises new issues to be confronted Demchenko Yu.V. (2000) notes the need to understand the information revolution and start building an information society which is defined as post-technological society.

The trends in technology are potentially creating the future, a future that is possibly arriving faster than the education community are prepared to accept.

7.6 The Merging of Moore's and Metcalfe's Law

Moore's Law suggested that technology doubles in processing power every 18 months and simultaneously the price for the technology usually declines by in the region of 35% a year.

Metcalfe's Law states that the more people that are connected to a network, the more powerful that network becomes. the power of sharing information and ideas grows.

The driving force of Moore's Law combined with Metcalfe's Law, technology fusion, and a changing world economy are continually impacting upon the provision of education. The application and development of new innovative technologies can be complex, the concept of innovation: the introduction of new products, new

technologies, new resources, new organisational forms and also importantly new markets.

Often new technological breakthrough can lead to what Schumpeter referred to as "creative destruction" changing the rules of the game making some traditional technologies and **processes** obsolete.

Digital Disruption

The recent ***Digital disruption: Short fuse, big bang?*** Report Deloitte (2012) examined 18 key Australian industry sectors, including education comparing their exposure to disruption.

The report analysed how the arrival of new digital technologies will drive change for business, the economy and its potential impact on society in general changing the very nature of consumption, competition and how markets work.

Digital Disruption will be facilitated by digital innovation and is critical to any economic plan, it is seen as important a force on the Australian economy as the lowering of tariffs, deregulation, oil shocks and even the mining boom.

Organisations can no longer define the market, it defines them

Figure 7f Technologies potentially driving change

Forbes (2012) note, Technology is an exceptional source of disruption. New or improved technologies such as iphones, data analytics, big data, social medial and cloud computing are creating dimensions of disruption that go beyond traditional tradeoffs between price and performance.

7.7 Focus on Content versus Focus on Network

In traditional education, *content* is considered as the main value driver of a learning experience, successfully delivering to the students the best content available on the market.

But it can be argued that now content is becoming a less important learning asset compared with access to a relevant and capable knowledge network.

Educational content to some extent has become secondary to the network that supports students in the learning process. Students build learning networks by blogging and collaborations through social networks, LinkedIn and Facebook.

This is evident recently in the approach adopted by The Massachusetts Institute of Technology and The Open University both offering free digital access to the content that supports their educational offer.

MIT and Open University charge for what they consider as the core value of their educational proposition, access to the knowledge networks of their institutions.

As MIT President Charles M. Vest puts it "We think that Open Course Ware will make it possible for faculty here and elsewhere to concentrate even more on the actual process of teaching, on the interactions between faculty and students that are the real core of learning."
Changes to the profile of the learners are critical in all of this, changes in the mechanisms of course delivery is influencing change.

Digital disruption can strongly influence company and product strategy through

Access disruptions change how customers, suppliers, and others interact. Amazon can be seen as pursuing successive strategies of access disruption, including an access based approach to cloud services.

A firm disrupts its competitors by changing how customers and companies assign, attribute and percieve value.

- **Performance**

Digital disruption is often driven by the availability of free tools, and more free tools are becoming available. Microsoft, Apple, Google, Facebook Amazon.

7.8 The Sources of Digital Power

- The availability of free tools and services that facilitate disruptors to build products and services continually driving change
- The availability of digital platforms that are easily exploited by the increasing number of digital natives / consumers, technology adoption rates have combined to launch a disruptive force that has the potential to totally change the face of business.
- The combination of 3D printing technology and human creativity offers endless opportunities

An October report from ACUS Atlantic Council of the United States, Could 3D Printing Change the World? (2011) notes, the potential impact emerging technologies like 3D Printing is having on everything from medicine to education, The power and potential of Its online community *Project Shellter*, 6,000 Maker Bot printers. While not all projects are collaborative, there is increasingly an opportunity to leverage the widespread potential available

7.9 Impact on Organisations

Organisations are being judged against global market best practice not just their historical competitors.

Isaacson. W (2011) toward the end of his bestselling biography on the late Steve Jobs, Isaacson recalls a private meeting between Jobs and President Obama, Jobs brought up the subject of education. Isaacson notes,

Jobs were taken by the notion that the iPad could ultimately, in effect, replace student's heavy backpacks. He saw the textbook industry as "ripe for digital destruction," and was in the process of hiring top textbook authors to write alternative, digital versions for the iPad. These iPad friendly textbooks would be free and, in Jobs opinion, allow schools to circumvent state adoption processes.

To survive and thrive, there is a need to focus on increasing the organisations capacity to act, making business easier, more efficient, innovative

There is a need to understand the unique problems**,** how are we impacted and to what extent. There is a need to understand and identify the drivers of change.

7.10 Conclusions

BECTA (2007) note that there that there is a move from passive consumption to active participation this requires stakeholders to adapt to a new environment there is a need for all stakeholders to become what they term "second wave adopters"

There is a requirement to avoid a digital divide.

Research conducted by Rowlands, I. Nicholas. et al. (2008) indicates that the technological skills of society are becoming more balanced; the differences between the technological skill sets of people in general are becoming less acute.

Both educators and developers can be catalysts and proactively drive innovation, but also need to react to changes in their environment. An adequate methodology for the support of change can provide help for the development, management and maintenance of teaching and learning systems. Standard methodologies for the development of software often address the problem of change and evolution.

Extracting the benefits of change

Learning technologies can promote powerful connections to content, context, and community. Unfortunately, they can also offer broad access to poorly designed and executed courseware. There are deliberate choices to be made in how to accommodate a generation of students who expect independent investigation, collaboration, and peer contacts to be facilitated in an online environment.

Green, H. Hannon, C. Demos, (2007) note,

The current generation of young people will reinvent the workplace, and the society they live in. They will do it along the progressive lines that are built into the technology they use every day of networks, collaboration, co-production and participation. The change in behaviour has already happened. We have to get used to it, accept that the flow of knowledge moves both ways and do our best to make sure that no one is left behind.

Widening participation mainly through the advances in technology is forcing many providers to reflect on many areas of provision**.**

One possible impact of evolving technologies is a move away from institution based delivery of education to more flexible, learner-selected options.

Mack, R. Masullo, M. (1997) as far back as 1997, concluded that the Internet is taking educational multimedia authoring, and education in general, closer to the telecommunications industry. While the desire to apply more, and more varieties of media, seem to be moving educational multimedia closer to the media industry.

All this is leading to a shift in the creation and design of educational material, eventually; we may see the further evolution of educational multimedia, the product of the publishing industry into a form of telecommunications and media product. It could integrate, rather easily, with (digital) broadcast television.

While Credaro, A. (2006) reflects**,** paradoxically, the very same factors that produce the need for change present barriers for the achievement of that change. School culture, stakeholders perceptions, societal effects, organisational structure and the nature of

change itself are together creating both the need for, and method of, continuous improvement to education and its outcomes

Zur O. and Zur, A. (2011) note, not all digital immigrants and digital natives are created equal The divide between native/immigrant is one of generations - people were either born in the digital era or they were not. But digital immigrants should be viewed as a highly diverse group in terms of their attitudes and capacities in regard to digital technologies.

They define the digital immigrant world in three broad categories:

- The avoiders**,**
- The reluctant adopters
- The enthusiastic adopters.

They view adoption of technology as a process often requiring informal learning or collaboration, suggesting that a learner situated in the first two categories but seeking to move to the final would be best served by finding "a patient, pleasant digital native to help build up the skill set."

Gardner, J. Mallon, M. Cowa, P. McArdlE, M. (2005) observed,
The large volume of resources available creates a number of structural design difficulties, the input of technical experts is crucial to ensure effective navigable design.

The Identification, quality assurance and structural design processes required considerable time and expertise.

Set up under the auspices of the Department of Education and Skills (**DES**) in 1998, the role and function of the NCTE was to:

1. Provide a range of ICT-related support services to schools

2. Policy development, strategic and administrative functions

With effect from 1st June 2012, the role and functions of the National Centre for Technology in Education (NCTE) came under the remit of the Professional Development Service for Teachers (PDST)

The holistic integration of ICT in schools can create a dynamic, relevant learning environment

Pahl. C, (2000) notes

Evolution and change are ubiquitous for computer-based educational systems and processes, which can, as we have seen, pose some difficulties for educators and developers alike. Both educators and developers can be catalysts and proactively drive innovation, but also need to continually aware of changes in their environment

The Digital Content initiative

For instance develops and provides access to digital content appropriate to the Irish school curriculum. This includes the development of satellite websites within specific curriculum areas, as well as sourcing and evaluating software suitable for educational use. Software licensing agreements also fall under the remit of Digital Content.

The ongoing evolution of such technologies or configurations of technologies as VLEs is interesting from simple VLE to a Learning Management System to Personal Learning Environment

The Adaptive Learning Platform – the thinking MLE Managing Learning Environment

Huang, S.-L., & Shiu, J.-H. (2012).

Adaptive e-learning is able to provide efficient and formal learning by supporting different learning paths and materials to fit learners' diverse needs and backgrounds

They propose adaptive presentation mechanism which considers both material difficulty and learner ability because these factors affect the suitability of materials to a learner.

Ubicomp as a Driver of Change

Anderson. P (2006) reflects on the pace of change, the dizzying speed of technological innovation and the continual demands of the market, the highly complex new world of

third wave (ubicomp) computing, if we are going to be able to understand and develop systems that work correctly and function in a safe and trusted manner then it is essential that we take a more scientific approach.
Combining a multitude of resources, repositories and tools into an effective learning environment is a complex process.

Cross Disciplinary Approach

There is a requirement for a cross disciplinary approach, Love, *T.* Cowan. E, note the realisation of a more holistic approach.
Interest in the development of a unified body of knowledge and theory about designing and designs is increasing. But a unified and integrated body of work has not yet emerged in spite of extensive research undertaken over several decades, and across several hundred domains, and from a wide variety of perspectives.
The realisation of this goal appears to be reducing with the ever increasing number of activities, tasks and evolving technologies
.
There is evidence to indicate that ICT can be used to enable activities that could not have been undertaken, or in some instances to facilitate tasks that would have been more difficult without it.

An OECD Report (2011) notes, external project funding, links with universities all place additional pressure on a school to make good use of ICT.
It contends that Innovative ideas are more likely to be carried through to fruition aided by these external pressures.

Hannafin. R, Savenye.W, (1993)
Examined the reasons why some school teachers resist computers, and discusses the changing role of teachers who do use computers. Societal resistance to new instructional methods, educational reform and the development of effective educational software.

Kovel-Jarboe. P (2002) notes, the primary drivers are likely to be accountability and new ideas about teaching and learning with secondary influences coming from technological change and restructured employment.

Legislation Demand for Accountability and Accessibility Issues

Ireland for example, the Disability Act 2005 requires that where a public body communicates in electronic form with one or more persons, the contents of the communication must be, as far as practicable, "accessible to persons with a visual impairment to whom adaptive technology is available" (Section 28(2)). The National Disability Authority has produced a Code of Practice giving guidance to public bodies on how to meet the obligations of the Act. This is an approved code of practice and its provisions have the force of legally binding statutory obligations. It states that a public body can achieve compliance with Section 28(2) by "reviewing existing practices for electronic communications in terms of accessibility against relevant guidelines and standards", giving the example of "Double A conformance with the Web Accessibility Initiative's (WAI) Web Content Accessibility Guidelines (WCAG)".

Expectations by Employers and Business

The response to the growth in knowledge has often been to expand our institutions - more disciplines, more departments; given the reduced resources at our learning intuitions' disposal there will be a need to adapt to different conditions.

Lifelong learning and the application of new tools have changed the way content is delivered, online courses are continually evolving, emphasis often on knowledge sharing and collaboration, networking and peer learning, there is a need to adapt to a new form of delivery and also to understand the way in which learners adopt and interact with new technologies.

Saffo. P **(1997)** director at the Institute for thee Future in Menlo Park, CA, predicts, *it's my belief that technology does not drive change. Technology merely enables changes. It creates options and opportunities that as individuals and as communities and as entire cultures we choose to exploit. And it's our response to the technologies that drive change. In other words, first we invent our technologies and then we use our technologies to reinvent ourselves…our families, our societies, and our entire cultures.*

Educational paradigms need to reflect those changes in outlook and philosophy to offer better and more comprehensive education for all students.

7. 11 Contributions to the Body of Knowledge

While the research was generally consistent with similar research undertaken in this area it potentially provides a broader view of the forces of change, potentially creating a platform for examining possible change.
The application of visualization techniques as a form of communication and active controlled engagement

7.12 Experimentation, Evaluation and Limitation

The selection of Opus 6 as an authoring package was generally positive, but there were difficulties in relation to navigation, the inability to provide a side bar where the learner could quickly access a page was a major negative.
The overuse of animations and transitions were other negatives, but overall it allows a lot of flexibility in displaying content.
One important note, I would of applied Nielsen's heuristics in relation to interface design if I had become aware of them earlier.

Jakob Nielsen's **10 Usability Heuristics for User Interface Design http://www.nngroup.com/articles/ten-usability-heuristics/**

Small Number of Participants all hindered the research as a larger group might have revealed more information.

Time scale of the project also impacted upon the project as it does not consider medium to long term impacts

7.13 Future Work and Research

The research did uncover possible areas of future research
The potential of a Cross facility approach to the design and delivery of content
Development of more flexible instructional design framework
The identification of the drivers of change to facilitate a possible change in present mindset
Universal design in the future for example ubiquitous computing
Adaptive Learning Environment
The adoption of a broader concept of the academic year and the academic timetable

7.14 Recommendations

Gemmell.R (2011) Learning facilitates the development and enactment of entrepreneurial behaviours and provides perhaps the "only sustainable source of competitive advantage"
The application of integrated multimedia could have a very positive impact upon the teaching and learning process but it requires a lot of planning and constant monitoring.
Digital Media in Education
This project undertook to look at the influence of integrated multimedia on the teaching and learning process, the research revealed that multimedia covered a wide and diverse range of tools and resources
Types of digital media which are useful in this endeavour include:
The use of these digital media tools provide many advantages

- The ability to develop real world problem solving skills
- Exposure to more global experiences

Potentially better understanding of subject matter /content through interaction with applications tools and resources including some of the following, utube, simulations,

online evaluation, digital storytelling, graphics, modelling programs, multimedia production tools and templates.

The importance of a good agile instructional design methodology is crucial to a successful outcome, the ability to understand how humans process information and the potential to reach a diverse range of learners through the application of integrated multimedia is a very attainable goal.

The increasing number of tools and resources available offer much potential must should be applied in a well informed manner.

Some Recommended Principles of Online Design for eLearning Resource in relation to information presentation should include the following.

1. Organise the information in a clear manner.
2. Place adequate amount of information on a screen avoid scroll bars if possible
3. Use shorter lines of text if the page is intended to be read from a screen
4. Place the key information at the top of the web page
5. Use off white space to increase the page's visual appeal and aid information selection (contrast)

While The NCTE and Scoilnet are the bodies charged with technology integration in Ireland this research recommends a bottom up approach with emphasis on a creating an environment which will facilitate technology integration.

Dissemination is essential

Technology transfer and diffusion are two aspects of technology dissemination, which is the process by which innovations are transmitted between donor and receiver, technology, can take the form of an object or a concept /technique (social technology) The Breath, depth and speed of technology adoption can depends on a lot of variables; there is a need for a multifaceted approach.

Strategies for Multimedia Applications

For multimedia to have an impact on education the following strategies are recommended:

Establish Partnerships

- Digital partnerships involve the support of local IT businesses, volunteers / internships, support from local / regional colleges.
- Internships could be used to help teachers with technology integration and provide help and support for students.

Provide training for ICT / Digital Classroom Support Teachers

- These specific teachers could support teachers integrate digital media in lessons and projects, and provide support to students in developing their own digital media skills.

Assessments based on interactive multimedia resources allowing for greater engagement through instant feedback

- Instead of only using standard assessment tools integrate the use of EPortfolio and projects that provide both summative and formative evaluations.
- These alternative assessments would potentially provide a more relevant evaluation than traditional methods incorporating problem solving and reflective thinking.

These strategies should be enhanced by the adoption of the following

1. Continual professional development
2. Induction manual for learners prior to course start
3. Application of Gestalt principles in design for interactive material
4. Provision of graphics containing alternative text.

5. Provision of tools where learners can customise digital content and backgrounds
6. Better use of navigation and orientation through sidebars, sitemaps
7. More use of interactive quiz's, roll over's, drip and drop
8. Facility to turn off transitions and animations
9. Ability to bookmark and print off content
10. The sourcing of more utube with captions
11. Creation of a file / database containing graphics and resources
12. Provide more resources to facilitate and encourage collaboration and networking, peer learning
13. Eliminate the use of scroll bars where possible
14. Attention to overuse of text and animations concentration on Gestalt principals in relation to cognitive overload or the Stroop effect

- The application of a flexible and responsive Instructional Design Framework

- Universal Design strives to facilitate equitable use through flexibility in use, simple and intuitive usage, perceptible information, tolerance for error, low physical effort and appropriate size and space for approach and use. Burgstahler, S. (2005) *Universal Design of Instruction: Definition, Principles and Examples*.

- The use of visualisation techniques to gather information on students, monitor progress and display content in a universal and integrated manner

- The application of proven guidelines
- Proper monitoring of internal and external environment

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APPENDIX A

Questionnaire

Name

Level of Education

I would describe my present level of IT literacy as

Novice ☐ Intermediate (ECDL) ☐ Professional ☐

Please place a x in the appropriate box

1- Did you find the resources on the CD useful?

Yes ☐
No ☐

2- How many times a week during the course did you access the content?

1 -3 ☐
4 – 6 ☐
7-10 ☐
Rarely ☐

3 - Did you find the CD easy to navigate?

Very Easy ☐
Easy ☐
Difficult ☐

4 - In which of the following areas did you find the CD the most useful?

Revision ☐
Collaboration ☐
☐

Information Gathering

5 - Do you intend to use the CD after the completion of the course?

Yes ☐

No ☐

6 - Would you recommend this CD to a fellow student?

Yes ☐

No ☐

7 - Please comment on any area where improvements could be made or ideas you might hold that could improve the design of the CD

Comments

8 - Have you ever used a similar approach to learning, prior to the commencement of the cou☐

Yes

No ☐

9 - Do you feel you had the required skills required to extract the full potential of the CD?

Yes ☐

No ☐

10 - Did you find the approach to learning to be?

Very Satisfactory ☐

Fairly Satisfactory ☐

Unsatisfactory ☐

11 – Did you find the adoption of multimedia in the learning process to be?

Very Helpful ☐

Mildly Helpful ☐

Unhelpful ☐

12 – Please comment on any ideas you have which you feel would improve the approach used on this course

Part 2

Statement	Strongly Agree	Mildly Agree	Agree	Mildly Disagree	Strongly Disagree
I found the content challenging					
I found the interactive Quiz Very useful					
I was able to have creative input in the project					
I became better able to present the concept using digital multimedia					
The CD allowed me to be more creative in my thinking					
I understood the subject matter better after the project.					
The CD enhanced my understanding of the subject					
I felt increased motivation doing the project					

I was able to learn more working through social media					
The CD allowed me to think critically about the topic					

After completing the course through the medium of various multimedia tools

Could you please quickly fill in the table below in relation to your personal experiences?

Positive Aspects	**Minus / Negatives**	**Interesting Aspects**

Thank you for completing the Questionnaire