

2012

Towards Universally Designed Assistive Technology E-Learning

Karl O'Keeffe

Technological University Dublin

Follow this and additional works at: <https://arrow.tudublin.ie/scschcomdis>



Part of the [Computer Engineering Commons](#)

Recommended Citation

O'Keefe, K.: Towards Universally Designed Assistive Technology E-Learning. Masters Dissertation. Technological University Dublin, 2012

This Dissertation is brought to you for free and open access by the School of Computing at ARROW@TU Dublin. It has been accepted for inclusion in Dissertations by an authorized administrator of ARROW@TU Dublin. For more information, please contact yvonne.desmond@tudublin.ie, arrow.admin@tudublin.ie, brian.widdis@tudublin.ie.



This work is licensed under a [Creative Commons Attribution-NonCommercial-Share Alike 3.0 License](#)

Towards Universally Designed Assistive Technology e-Learning

Karl O’Keeffe

A dissertation submitted in partial fulfilment of the requirements of
Dublin Institute of Technology for the degree of
M.Sc. in Computing (Assistive Technology)

July 2012

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 text 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.

Signed: _____

Date: *24 September 2012*

1 ABSTRACT

The aim of this dissertation is to provide Assistive Technology (AT) professionals involved in the area of education and training with a set of reusable technological tools and techniques that will enable them to increase the reach, efficiency, effectiveness and accessibility of their training through online delivery. There are a number of broadly accepted reasons why an organisation in any field might choose to make training available online or partially online (blended) rather than relying on traditional face to face methods. Of the four considered here and mentioned above, accessibility is the biggest concern in the context of AT. It is essential that an AT course follows accessibility best practice and in terms of education this means adhering closely to the principles of Universal Design for Learning (UDL). Through an extensive literature review the intrinsic properties of AT that might influence its delivery as e-Learning will be examined, followed by a review of previous AT education initiatives. A suitable Learning Management System (LMS) will then be selected and the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model will be used to develop initial pilot modules. The evaluation of these pilot modules will take the form of a detailed questionnaire issued to course participants and will be supplemented by an examination of the user data captured by the LMS. There will also be a further examination of the pilot modules against the UDL checkpoints. From these findings the design process will be modified and an improved design methodology will be proposed. This improved design methodology and supporting documentation will help AT educators to identify and utilise a range of reusable tools to create Universally Designed Learning Objects that will enable them, as the experts in the field, to successfully transfer their expertise from the classroom to an online medium. On completion, the improved design methodology will be offered back to AT professionals for expert evaluation. This evaluation will be documented and will inform further work including the building of UDL AT Learning Objects and the creation of an AT Learning Object Repository where the resulting learning objects can be easily accessed for reuse.

Key words: Assistive technology, e-learning, Universal Design for Learning, Learning Objects, Moodle.

ACKNOWLEDGEMENTS

I would like to express my sincere thanks to my supervisor Dr. John Gilligan who has been a great source of knowledge, advice and support throughout writing this dissertation. I would like to thank my colleagues in Enable Ireland and indeed the organisation itself for the support given over the last two years. I would like to thank Mary for that last minute proof read and last but by no means least I would like to thank my family, particularly Maureen and Austin my mother and father who have always been there for me.

TABLE OF CONTENTS

Contents

1	ABSTRACT	II
	TABLE OF FIGURES.....	X
1.	INTRODUCTION.....	1
1.1	OVERVIEW OF PROJECT AREA	1
1.2	BACKGROUND	3
1.3	RESEARCH PROBLEM.....	5
1.4	INTELLECTUAL CHALLENGE.....	5
1.5	RESEARCH OBJECTIVES	6
1.6	RESEARCH METHODOLOGY	7
1.7	RESOURCES.....	7
1.8	SCOPE AND LIMITATIONS	7
2	ASSISTIVE TECHNOLOGY	8
2.1	INTRODUCTION	8
2.2	ASSISTIVE TECHNOLOGY DEFINITIONS AND CLASSIFICATION SYSTEMS	8
2.2.1	<i>Classification Systems.....</i>	<i>9</i>
2.3	MODELS OF DISABILITY	11
2.3.1	<i>ICF - International Classification of Functioning, Disability and Health</i> <i>12</i>	
2.3.2	<i>ICF in Education.....</i>	<i>13</i>
2.4	AT EDUCATION, INFORMATION AND SERVICES MILESTONES IN EUROPE	14
2.5	CONCEPTUAL MODELS OF AT	16
2.6	WHO? PEOPLE INVOLVED IN AT.....	17
2.7	CONCLUSION	18
3	AT EDUCATION.....	19
3.1	INTRODUCTION	19
3.2	TEN YEARS OF CERTIFIED AT TRAINING - ENABLE IRELAND	21
3.2.1	<i>Introduction</i>	<i>21</i>
3.2.2	<i>Rationale.....</i>	<i>21</i>

3.2.3	<i>Course Content</i>	22
3.2.4	<i>Teaching Methods</i>	23
3.2.5	<i>Participants</i>	23
3.2.6	<i>General Response and Developments</i>	24
3.2.7	<i>The Way forward</i>	25
3.3	OTHER SIGNIFICANT AT EDUCATION PROJECTS.....	26
3.3.1	<i>Tide: Heart Line E Study</i>	26
3.3.2	<i>TELEMATE</i>	27
3.3.3	<i>KPT</i>	28
3.4	PREVIOUS SIGNIFICANT DISTANCE AT PROJECTS	29
3.5	MULTIDISCIPLINARY AT EDUCATION	30
3.6	INTERPROFESSIONAL EDUCATION	31
3.6.1	<i>Blended Learning</i>	32
3.6.2	<i>Time and Geography</i>	33
3.6.3	<i>Teamwork</i>	34
3.6.4	<i>Roles/Responsibilities</i>	35
3.6.5	<i>Learning and Reflection</i>	36
3.6.6	<i>Patient/Service User</i>	36
3.6.7	<i>Conclusion</i>	36
3.7	IPAT CASE STUDY	37
3.7.1	<i>Background</i>	37
3.7.2	<i>Videoconferencing and web conferencing</i>	38
3.7.3	<i>The use of an AT loan library for delivery of distance training with specialist AT hardware.</i>	39
3.7.4	<i>Conclusion – What was learned from IPAT?</i>	40
3.8	CONCLUSION	41
4	DISTANCE EDUCATION – E-LEARNING	42
4.1	INTRODUCTION	42
4.2	THE ADDIE MODEL	42
4.3	LEARNING MANAGEMENT SYSTEM – WHY MOODLE?	43
4.4	POTENTIAL DIFFICULTIES – ACCESSIBILITY.....	45
4.5	CASE STUDY – NDA, CREATING AN ACCESSIBLE E-LEARNING MODULE.....	46
4.5.1	<i>Production Process</i>	47

4.5.2	<i>Tendering and the e-Learning Specification Document</i>	47
4.5.3	<i>Accessibility</i>	50
4.5.4	<i>User Testing</i>	52
4.5.5	<i>Analyses and Reflection</i>	53
4.6	UNIVERSAL DESIGN FOR LEARNING	54
4.6.1	<i>Principle I. Provide Multiple Means of Representation</i>	56
4.6.2	<i>Principle II: Provide Multiple Means of Action and Expression.</i>	57
4.6.3	<i>Principle III: Provide Multiple Means of Engagement.</i>	58
4.7	CONCLUSION	59
5	STEP 1: TOWARDS UDL AT E-LEARNING	60
5.1	INTRODUCTION	60
5.2	ANALYSIS	60
5.2.1	<i>Who is the audience and what are their characteristics?</i>	61
5.2.2	<i>Instructional Goals and Learning Objectives of proposed Online Modules</i> 63	
5.2.3	<i>Module Content</i>	64
5.2.4	<i>What are the delivery options?</i>	64
5.2.5	<i>What were the constraints?</i>	65
5.2.6	<i>Requirements of course participants?</i>	65
5.2.7	<i>Difference between classroom and web delivery</i>	65
5.2.8	<i>What are the online pedagogical considerations?</i>	66
5.3	DESIGN	67
5.3.1	<i>Chunking</i>	67
5.3.2	<i>Microsoft Word</i>	67
5.4	DEVELOPMENT	68
5.4.1	<i>TinyMCE</i>	69
5.4.2	<i>Moodle Page Resource</i>	69
5.4.3	<i>Moodle Quiz Activity</i>	70
5.4.4	<i>The Forum</i>	71
5.4.5	<i>AT Assessment Models Module</i>	72
5.4.6	<i>Lesson Activity</i>	73
5.4.7	<i>Book Resource</i>	74
5.4.8	<i>Universal Design for Learning (UDL)</i>	76

5.5	IMPLEMENTATION	78
5.6	EVALUATION	80
5.6.1	<i>Overall Satisfaction</i>	81
5.6.2	<i>Universal Design for Learning</i>	82
5.6.3	<i>Moodle Usability</i>	87
5.6.4	<i>Moodle Logs</i>	88
5.6.5	<i>UDL Evaluation</i>	91
5.7	CONCLUSION	93
5.7.1	<i>Action Points arising out of Evaluation</i>	94
6	EMBEDDING UDL IN THE DESIGN PROCESS	97
6.1	INTRODUCTION	97
6.2	UDL AND AT EDUCATION	97
6.2.1	<i>Moodle UDL Toolkit – MUDL Chart</i>	98
6.3	IMPROVED DESIGN METHODOLOGY	99
6.3.1	<i>Analysis</i>	101
6.3.2	<i>Design</i>	106
6.3.3	<i>Development</i>	107
6.3.4	<i>Implementation</i>	107
6.3.5	<i>Evaluation</i>	108
6.3.6	<i>Example of process used on a Switch Access Module</i>	108
6.4	CONCLUSION	109
7	EVALUATION.....	110
7.1	INTRODUCTION	110
7.2	EVALUATION	111
7.3	CONCLUSION	113
8	CONCLUSION.....	114
8.1	INTRODUCTION	114
8.2	RESEARCH OVERVIEW	114
8.3	CONTRIBUTIONS TO THE BODY OF KNOWLEDGE	116
8.4	FUTURE WORK & RESEARCH	117
8.4.1	<i>Introduction/Orientation Module</i>	117
8.4.2	<i>First Round of Test Modules</i>	117

8.4.3	<i>CAST</i>	118
8.4.4	<i>AT Learning Object Repository (ATLOR)</i>	118
8.4.5	<i>Test Moodle Site http://www.electroat.com/Moodle</i>	119
8.5	CONCLUSION	120
BIBLIOGRAPHY		121
APPENDIX A. GUIDELINES FOR LIFELONG LEARNING IN ASSISTIVE TECHNOLOGY- TEMPLATE FOR DESIGNING A LEARNING PROGRAM – ON ACCOMPANYING DISK		129
APPENDIX B. CONDUCTING DISTANCE ASSISTIVE TECHNOLOGY SERVICES - PRESENTERS: MARCI KINAS-JEROME, GEORGE MASON UNIVERSITY AND PEGGY SHIRELEY, NORTH DAKOTA INTERAGENCY PROGRAM FOR ASSISTIVE TECHNOLOGY INTERVIEW TRANSCRIPT AND EMAIL CORRESPONDENCES ON DISK.		129
APPENDIX C. NDA TENDER DOCUMENT - ON ACCOMPANYING DISK		129
APPENDIX D. NDA E-LEARNING SPECIFICATION DOCUMENT - ON ACCOMPANYING DISK		129
APPENDIX E. NDA USER TESTING TENDER DOCUMENT - ON ACCOMPANYING DISK		129
APPENDIX F. NDA INTERVIEW NOTES - ON ACCOMPANYING DISK		129
APPENDIX G. PLUS MINUS INTERESTING TECHNIQUE DONE ON E-LEARNING		129
APPENDIX H. QUESTIONNAIRE AND RESULTS – ON ACCOMPANYING DISK		130
APPENDIX I. AT COURSE E-LEARNING USABILITY RESPONSES		130
APPENDIX J. UDL CHECKLESS COMPILED FOR EACH MODULE.....		131
APPENDIX K. ADDITIONAL FIELDS FROM DESIGN FORMS 2.0, 2.1, 2.2		131
APPENDIX L. SWITCH MODULE EXAMPLE ANALYSE AND DESIGN FORMS		133

**APPENDIX M. EVALUATION BY ENABLE IRELAND AT TRAINING
TEAM 135**

TABLE OF FIGURES

FIGURE 1: THE COMPONENTS OF THE HAAT AND THE SETT MODELS ALIGNED UNDER THE ICF.	16
FIGURE 2: RANGE OF PROFESSIONALS WORKING IN AT.....	17
FIGURE 3: FROM THE 2008 PAST PARTICIPANT SURVEY	23
FIGURE 4: PAST PARTICIPANTS OF AT COURSE FROM THE 2008 SURVEY.	24
FIGURE 5: PAST PARTICIPANTS' OPINIONS OF AT COURSE FROM THE 2008 SURVEY.	24
FIGURE 6: PAST PARTICIPANT PREFERENCES FOR FUTURE TRAINING.....	25
FIGURE 7 DIAGRAM ILLUSTRATING THE STAGES OF THE ADDIE MODEL AND ILLUSTRATING ITS ITERATIVE NATURE	43
FIGURE 8: ILLUSTRATION OF THE COMPLEXITIES OF ACCESSIBILITY IN AN LMS	46
FIGURE 9: USER IS PROVIDED WITH A LINK TO THE VIDEO FILE AND PLAY IT IN A STANDALONE MEDIA PLAYER (LEFT) AND THE WINDOW THAT POPS UP CONTAINING TRANSCRIPT OF AUDIO IN THE VIDEO (RIGHT).	51
FIGURE 10: DROPDOWN MENU OF DISPLAY PREFERENCES (LEFT) OFFERING DEFAULT, HIGH CONTRAST (TOP RIGHT) AND LOW CONTRAST (BOTTOM RIGHT).....	52
FIGURE 11: THE COURSE VIEW OF FUNDING ASSISTIVE TECHNOLOGY MODULE (LEFT) AND ADDITIONAL NAVIGATION BUTTONS ADDED TO THE PAGE RESOURCE (RIGHT). 70	
FIGURE 12: THE ANSWER WAS CORRECT SO THE PARTICIPANT GETS A LITTLE TICK AND THE COLOUR GREEN (LEFT) AND IF PARTICIPANTS GET THE QUESTION WRONG THEY GET A HINT AS TO THE CORRECT ANSWER (RIGHT).....	70
FIGURE 13: IF ALL ANSWERS ARE CORRECT THE PARTICIPANT WILL BE CONGRATULATED AND DIRECTED TO THE NEXT SECTION (LEFT) OR IF THE PARTICIPANT GETS ONE OR MORE QUESTIONS WRONG THEY WILL BE DIRECTED BACK TO THE SECTION JUST COVERED (RIGHT).....	71
FIGURE 14: AN EXAMPLE OF A SINGLE SIMPLE DISCUSSION FORUM.....	72
FIGURE 15: THE COURSE VIEW OF THE AT ASSESSMENT MODULE.....	73
FIGURE 16: COURSE VIEW OF THE EFFECTIVE USE OF SYMBOLS MODULE (LEFT) AND THE LAYOUT OF THE LESSON MODULE (RIGHT).	73
FIGURE 17: COURSE VIEW OF THE FUTURE TECHNOLOGIES MODULE (LEFT) AND THE FUTURE TECHNOLOGIES MODULE (RIGHT).	75

FIGURE 18: AN EXAMPLE OF THE GLOSSARY AUTO-LINKING FEATURE (LEFT) AND THE ACCESSIBILITY BLOCK PLUGIN (RIGHT).....	76
FIGURE 19: THE SPEECHSTREAM TOOLBAR FROM TEXTHELP LTD.	77
FIGURE 20: SPEECHSTREAM TTS WITH HIGHLIGHTING (LEFT) AND THE TEXTHELP TOOLBAR BUTTON THAT WAS CREATED TO RESOLVE AN ISSUE WITH IE8 BUT ALSO RESULTED IN A MUCH BETTER IMPLEMENTATION OF THE APPLICATION (RIGHT).....	78
FIGURE 21: COMPARISON OF HOSTING OPTIONS.	79
FIGURE 22: RESULTS OF SURVEY QUESTION 1 (LEFT) AND QUESTION 2 (RIGHT).	81
FIGURE 23: RESULTS OF SURVEY QUESTION 3 (LEFT) AND QUESTION 4 (RIGHT).	81
FIGURE 24: RESULTS OF SURVEY QUESTION 5.....	82
FIGURE 25: RESULTS OF LIKERT SCALE QUESTIONS RELATING TO UDL PRINCIPLE 1.....	83
FIGURE 26: RESULTS OF LIKERT SCALE QUESTIONS RELATING TO UDL PRINCIPLE 2.....	84
FIGURE 27: RESULTS OF LIKERT SCALE QUESTIONS RELATING TO UDL PRINCIPLE 3.....	86
FIGURE 28: RESULTS OF LIKERT SCALE QUESTIONS RELATING TO BLENDED LEARNING.	86
FIGURE 29: NEGATIVE RESPONSES FROM MOODLE USABILITY QUESTIONNAIRE.....	87
FIGURE 30: HOURS PARTICIPANTS SPENT LOGGED ONTO THE LMS.....	88
FIGURE 31: GRAPH ILLUSTRATING THE AMOUNT OF FORUM VIEWS, POSTS AND REPLIES	89
FIGURE 32: SCATTER GRAPH ILLUSTRATING THE RELATIONSHIP BETWEEN FORUM VIEWS AND POSTS.	90
FIGURE 33: SCATTER GRAPH ILLUSTRATING THE RELATIONSHIP BETWEEN FORUM POSTS AND REPLIES.	91
FIGURE 34: COLOUR CODED TABLE ILLUSTRATING WHAT CHECKPOINTS OF UDL HAD BEEN SATISFIED BY THE MODULES.	92
FIGURE 35: FIRST PAGE OF THE MUDL CHART, GUIDELINE 1.....	98
FIGURE 36: IMPROVED DESIGN METHODOLOGY.....	100
FIGURE 37: THREE FORMS (1.0, 1.1, 1.2) TO BE USED IN THE ANALYSIS STAGE OF THE PROCESS.....	101
FIGURE 38: FOUR FORMS 2.0 (KTLO), 2.01 (ALTERNATIVE TEXT), 2.1 (ALO), 2.2 (ILO) TO BE USED IN THE DESIGN STAGE OF THE PROCESS.....	106

TABLE OF TABLES

TABLE 1: IPAT DRIVERS FOR DISTANCE TRAINING.....	38
TABLE 2: ADVANTAGES AND DISADVANTAGES OF WEB CONFERENCING.....	39
TABLE 3: OUTLINE OF MODULE TITLES, INSTRUCTIONAL GOALS AND LEARNING OUTCOMES	63
TABLE 4 OUTLINE OF MODULE TITLE, MOODLE RESOURCE OR ACTIVITY TO BE USED AND THEIR FEATURES	64
TABLE 5 LEGEND FOR FIGURE: 34.....	91
TABLE 6: FIELD FROM ANALYSIS FORM 1.0 SECTION 1.0A	102
TABLE 7: FIELD FROM ANALYSIS FORM 1.0 SECTION 1.0A	102
TABLE 8: FIELD FORM ANALYSIS FORM 1.0 SECTION 1.0A	103
TABLE 9: UDL FIELDS IN FORM 1.0.....	103

1. INTRODUCTION

1.1 Overview of Project Area

Regular and up to date Assistive Technology (AT) training is acknowledged as being essential in maintaining a high quality AT service (Elsaesser & Bauer, 2011, Feyerer et al., 2002, Long & Perry, 2008, Mavrou, 2011, Verdonck, 2011). The rapid pace of innovation in the field coupled with greater public awareness and demand has resulted in increased pressure on professionals involved in the supply and support of solutions (KPT, 2006, Miesenberger et al., 2006). In the last decade there has been a shift away from dedicated AT to the use of mainstream hardware running AT software applications. While this shift can be seen as a largely positive one for the average AT consumer as it has resulted in a dramatic reduction in cost, the support mechanisms that were in place when the hardware and software originated with the same manufacturer or even vendor are no longer available in many cases. Although some of this gap in the support structure is being filled by such as AT professionals; Occupational Therapists (OT), Speech and Language Therapists (SLT), AT Technicians etc., those with the right training already have full caseloads. In 2002 the fledgling Enable Ireland Assistive Technology Training Service ran its first Certified Assistive Technology Training Course with the support of Microsoft and Dublin Institute of Technology. This 9 day course gave participants a broad introduction to all areas of Electronic Assistive Technology. The model behind the course was to enable all stakeholders involved in AT (AT users, friends, family and professionals) to come together, to learn about the latest developments in technology and service delivery, to use the equipment and to learn from the people who actually use AT. They would then return to their places of work and be able to share what they had learned and put it into practice. This model worked then and is even more appropriate today due to the issues outlined above. The Certified Assistive Technology Training Course is still going strong with over 300 graduates to date.

Although the phrase “If it isn’t broken, why fix it?” might come to mind, this research is about looking for ways to replicate or even improve on this successful model by developing a framework for delivering it online as e-Learning. Why do this? There are

a number of broadly accepted reasons why an organisation in any field might choose to make training available online or partially online rather than using traditional face to face methods. The four considered here are efficiency (in terms of time and cost for both those receiving and providing training), effectiveness, reach (scale) and accessibility. By making some training available as e-learning, two of the biggest barriers are removed, i.e. time and geography (Casimiro et al., 2009, Juntunen & Heikkinen, 2004, MacDonald et al., 2006) or, as has been put more eloquently, it allows "high temporal and regional flexibility" (Miesenberger et al, 2006).

The aim of this dissertation therefore is to identify reusable technological tools and techniques that will enable those in the field of AT to increase the reach, efficiency, effectiveness and accessibility of their training through online delivery. It will also provide a framework within which these tools can be utilised. The last reason, accessibility, is probably the biggest concern in the context of AT. It is essential that an AT course follows accessibility best practice and in terms of education this means adhering closely to the principles of Universal Design for Learning (UDL). Through an extensive literature review this paper will first establish the core principles of AT that will influence how education should be approached. Previous AT education projects will then be examined followed by research into potential difficulties that might be encountered, such as accessibility. An appropriate Learning Management System (LMS) will then be selected. Once the LMS is selected the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model will be used to develop initial test modules. The analysis stage will be done in consultation with the Manager and training team of Enable Ireland's National Assistive Technology Training Service. From this a number of modules will be selected from the Certified Assistive Technology Training Course, designed, developed and implemented using the chosen LMS. The modules used in this initial working prototype will be selected both for the appropriateness of the subject for delivery online and also their suitability for delivery using the widest range of tools available in the LMS. This approach will help to insure effective training while also allowing user information gain from the testing to be maximised. The evaluation will take the form of a detailed questionnaire issued to course participants in order to ascertain the usability, effectiveness and overall satisfaction with the tools used and will be supplemented by an examination of the data captured by the LMS and evaluation against the UDL checkpoints. From the findings

of this evaluation the design process itself will be modified and an improved design methodology will be proposed. This improved design methodology and supporting documentation will help AT educators to identify and utilise a range of reusable tools to create Universally Designed Learning Objects that will enable them as the experts in the field to successfully transfer their expertise from the classroom to an online medium. Once the improved design methodology has been completed it will be offered back to the AT professionals for expert evaluation. This evaluation will be documented and will inform further work. Some of this further work will include test modules and the building of an AT Learning Object Repository where the resulting learning objects can be easily accessed for reuse.

1.2 Background

There are several definitions of AT depending on the area or model of disability. Cook and Hussey define it as “Any piece of equipment or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of individuals with disabilities” (Cook and Hussey, 2002). AT is a relatively new field of study. It is still viewed as an add-on skill rather than a profession in its own right. This is due to the lack of a formal career path where most of those involved in AT have come to it from a variety of professional routes which can be grouped into three broad backgrounds: Clinical, Technical and Socio-Economic (TELEMATE, 1999).

The disparate nature of education and training in the field of AT has been recognised as a major issue since the first European Commission study into the area in the early 1990s. This study called the HEART (Horizontal European Activities in Rehabilitation Technology) project found that the field of AT in the EU was fragmented and uncoordinated. The HEART Line E section was specific to AT Education. It consisted of a detailed study of all teaching and training programs in Europe and North America, devised a common framework for AT training and made several recommendations for continued work in the area. Of particular interest to this project was the recommendation on the creation of distance education courses in assistive technology.

“It is probably necessary to use distance learning in order to cover all of Europe in a new, relatively small and multidisciplinary subject such as assistive technology. This is

essential for the updating of in-service training of professionals and other actors actively involved in the field. ...” (Azevedo et al,1994).

As a result of HEART a Four-area Action Plan was presented in Madrid in 1995. Education and Training was identified as the second area where progress needed to be made. This initial framework proposed by HEART Line E informed all subsequent major research projects in AT education in the EU. This project hopes to draw on that work and provide a framework that is suitable for Enable Ireland’s Assistive Technology Training Service’s needs that makes use of recent technological developments in the area of on-line education.

While there has been some progress in other areas of AT education (Whitney et al: 2011), to date there have been much fewer developments in regard to its delivery as e-learning. One notable exception is the TELEMATE project (1998-2001). TELEMATE was built on the model of AT devised in the Heart report. Although it was relatively short lived its legacy is in the conceptual framework for multidisciplinary education in the field of AT it developed (Turner-Smith & Devlin, 2005). This model, which will be discussed in detail later, was used as the basis for the KPT Training-needs analysis that was carried out in 2005 in Ireland and in three other European countries. Based on the subsequent report and informed by the new model of disability proposed in the International Classification of Functioning, Disability and Health (ICF) (WHO, 2001) the “Guidelines for lifelong learning in Assistive Technology” was published in 2007. Although designed as general guidelines for AT training this publication is a valuable resource whose ideas can be applied for use in distance AT training also. There are a couple of reasons why AT education is particularly suited to delivery by e-learning. First, like many related areas of technology, AT is rapidly evolving. New devices and software are frequently released offering better solutions for users. E-Learning offers a more efficient means of training professionals in the use of new solutions. Secondly, AT is quite a specialised area. Professionals from the same discipline tend to be geographically dispersed rather than working in the same location. This, combined with the recent economic downturn, has resulted in reduced funding for training and travel and leaves e-learning as the only viable option for some professionals. Also, e-learning has become an accepted, almost expected, means of delivery of Continuous Professional Development (CPD) courses due to the advantages it offers professionals who may find it difficult to find a free day in their diary for a full day course. E-

learning can be self-paced and fits into a busy schedule. Finally, due to the multidisciplinary nature of AT teams it can often be difficult to coordinate training events.

1.3 Research problem

The primary problem addressed in this research is how to transfer the skills, knowledge and successful approach used in face to face AT training to AT e-Learning. Both modes of delivery have their advantages and disadvantages, strengths and weaknesses. Techniques used in one are not directly transferable to the other. Through the design of pilot modules and the subsequent detailed evaluation of those modules this dissertation aims to propose an improved design methodology and supporting documentation that is specifically tailored to the field of AT education. This design methodology will enable AT Educators as the experts in the field to successfully transfer that expertise from the classroom to an online medium. It will also ensure that all content created is as inclusive and effective as face to face instruction.

1.4 Intellectual challenge

A thorough understanding of the field of AT is required so that its core principles that will influence how education should be approached can be established. AT is a complex area in its own right but its inextricable link to the concept of disability compounds the complexity. What AT is and how it is approached depends on the model of disability. This all needs to be understood fully before proposing any educational strategy. While research done into AT education and some limited examples of AT distance education will form the foundation for this project, it will also aim to reflect subsequent advances in e-learning and recent research into the pedagogy and instructional design of e-learning designed for Interprofessional Education (IPE) in the medical domain. This is necessary because AT, being quite a specialised area, has limited research available into strategies for delivering AT education as e-learning, particularly in recent years. The medical domain is obviously much larger and better funded than AT and because of the World Health Organization's (WHO) formation of a Study Group on Interprofessional Education and Collaborative Practice in 2007 and the subsequent 2010 report, there has been a great deal of research into the area in the last few years, some of which is concerned

specifically with the pedagogical characteristics of e-learning and how they relate to IPE educational theory. E-Learning designed for IPE is of particular interest because it is designed for multidisciplinary teams working towards a common shared goal. In medicine that goal is the care of the patient whereas in AT it is a solution for a service user, although the goals are similar. It is designed to foster cooperation and to develop a common language, again essential for any multidisciplinary team. The pedagogical theories underpinning IPE are therefore of interest to this project. What is learned from recent literature in the field of IPE will need to be applied to AT. As the deliverable of this dissertation will most likely be a combination of Moodle, of Universal Design for Learning and of Assistive Technology, it is expected that there will be some difficulty finding expert evaluators with experience in all three areas for feedback.

1.5 Research objectives

The following research objectives were identified;

1. Establish through literature review the intrinsic properties of Assistive Technology and how they might influence an approach to AT education.
2. Review previous AT Education and Distance AT Education projects and those used in more contemporary Interprofessional Education e-learning and identify techniques and successful approaches.
3. Identifying best practice approach in terms of its implementation and select an appropriate instructional design methodology and Learning Management System.
4. Address potential difficulties that AT delivered as e-learning might face. Use a Case Study of a successful e-learning project to examine successful strategies taken to insure accessibility.
5. Investigate Universal Design for Learning as a possible solution to accessibility and also as a prospective pedagogical strategy.
6. Develop a Beta Prototype. Evaluate Beta Prototype and design methodology used.
7. Bases on evaluation develop improved design methodology and supporting literature and offer it for expert review.
8. Reflect on expert feedback. Identify future work and outline conclusions.

1.6 Research methodology

A detailed literature review will first be carried out into the area of AT in general to establish the core principles that will affect how training should be approached. Previous AT education projects will then be examined. There will be a focus on general AT education from within the European Union. Two distance AT education projects will then be examined as will multidisciplinary education in AT, followed by a review of recent literature on e-learning techniques used in IPE. There then will be a Case Study on an organisation from the US called IPAT on how they utilise videoconferencing and a loan library to facilitate distance “hands-on” practical training with specialist AT hardware. This will be followed by a review of some literature into good practice approaches to e-learning followed by research into potential difficulties that might be encountered such as accessibility. An appropriate Learning Management System (LMS) will then be selected and the feasibility of using Universal Design for Learning will be examined. Pilot e-learning modules will be created and evaluated. The evaluation will inform subsequent improvements of the design methodology and supporting documentation.

1.7 Resources

DIT library, Trinity library and Google Scholar were used predominantly for literature. The CAST website was the source of most UDL research and Moodle.org community and documentation was used for information on the Moodle LMS. Interviews were done with representatives of the National Disability Authority (NDA) and Interagency Program for Assistive Technology (IPAT) for the case studies. Survey Monkey was used for surveys.

1.8 Scope and limitations

This dissertation is about formulating a design methodology that can be used by those in the field of AT to create high quality engaging and inclusive learning content in the most efficient and cost effective manner possible. Due to time limitations it is not possible to produce e-learning to this standard as an artefact of this work. In effect the process for creating the learning content rather than the learning content itself is the artefact that is being evaluated in this paper.

2 ASSISTIVE TECHNOLOGY

2.1 Introduction

The purpose of this first chapter is to examine what is meant by Assistive Technology (AT). This task requires more than simply listing definitions. AT sits at the intersection of a number of fields and is intrinsically linked to the concept of disability. It therefore can have different meanings depending on the model of disability, the perspective of the user or role of the professional. In many respects the term AT could be considered a boundary object. *“Boundary objects are objects which are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites.”* (Star, 1989) This concept will be explored further in terms of the International Classification of Functioning, Disability and Health. The research question this chapter hopes to answer is; what are the characteristics of AT that will influence how training in the area should be structured and delivered? In order to answer this question all aspects AT must be examined in order to first identify its intrinsic properties.

2.2 Assistive Technology Definitions and Classification Systems

AT is a broad term which can also be referred to as Adaptive Technology and sometimes used interchangeably with the older term Rehabilitation Technology. It has numerous definitions, some of which are outlined below. The difficulty pinning down a definition of AT has two roots. The first is its close association with the concept of disability, a tricky and hotly debated subject. Secondly from the fact that although often thought of as the actual device, product or system the term AT also encompasses the process within which the product is selected, used and even supported. This AT process includes the AT device, product or system, but it also includes a user “a human operator”, an environment and an activity or task (Cook and Hussey 2002). A closer look at three of the most common AT definitions will give a better understanding of the complex nature of AT. Cook and Hussey’s often used definition states that AT is; *‘a broad range of devices, services, strategies, and practices that are conceived and applied to ameliorate the problems faced by individuals who have disabilities.’* (Cook & Hussey 2002). The World Health Organisation (WHO) has defined AT as:

'An umbrella term for any device or system that allows individuals to perform tasks they would otherwise be unable to do or increases the ease and safety with which tasks can be performed.' (WHO, 2004). Alan Turner Smith who was one of the leaders of the TELEMATE project which will be examined later defined AT as;

'any device or system that allows an individual to perform a task that they would otherwise be unable to do, or increases the ease and safety with which the task can be performed.' (Cowen, Turner-smith 1999).

There are in fact many more definitions but the above three are enough to plot the trend that is emerging. AT is non-specific, terms like *"a broad range"* *"an umbrella term"* *"any"* immediately give the impression it covers a wide variety. AT can be a *"device"* or a *"system"* even a strategy or practice or a combination of any of them. The important point all definitions have is it only becomes AT when it either *"ameliorate the problems"* or *"increases the ease and safety"* of the individual who is performing the task. This illustrates that although many people mean the equipment when they refer to *"AT"* the actual meaning of AT is much more complex. It only becomes AT when it is successfully used.

2.2.1 Classification Systems

An AT product or device then is a tool that can enable someone with a disability accomplish any task or activity that they might otherwise find difficult or impossible. This makes AT a vast area. AbleData, a US Government funded organisation that provides objective information on assistive technology and rehabilitation equipment has almost 40,000 different AT products listed in their database (www.abledata.com). Since 1992 all AT available commercially is covered by the International Standards Organisation (ISO) *"Assistive products for persons with disability – Classification and terminology"* ISO 9999. The ISO 999:2011 document is divided into 12 chapters. Each chapter or *"class"* refers to the main functions of the products within that class. The classification consists of three hierarchical levels and the codes each consist of three pairs of digits. The first pair of digits indicates a class, the second pair of digits a subclass and the third pair of digits a division.

The problem with classifying the AT device in isolation as the ISO 9999 does is “*that technical aids bring about a state change. For example, glasses bring about an improvement in what a user can see. Any description of the device must surely concern itself with this state change since this defines the enablement potential of the device*” (Gilligan 2011). This has led to criticism of the ISO 9999 that question its suitability for use in service delivery (Elsaesser & Bauer 2011) and the development of alternative classification systems such as the Cliq and ATDC. The Cliq (Classification implements Quality) is a Dutch classification instrument that links the ISO with the ICF (discussed below) which was developed by order of the Dutch Health Care Insurance Board (CHZ). Cliq focuses on the product intended use of AT (Bernd et al., 2009). It is derived from the ISO 9999 but provides more detailed categories than the original classification. To the original six-digit codes (3 pairs of two digits) of ISO 9999, a maximum of six extra digits (three pairs of two digits) are added. With these additional digits, the 'product related intended use' of the products can be described. '*Product related intended use*' is a legal term that indicates what the user can and may expect of the assistive product. The Cliq classification system allows the users goals to be matched with the products intended function making it much more useful in practice than the ISO 9999 and references the WHO's International Classification of Functioning, Disability and Health (ICF) Activity and Participation and Functions and Structures domains (discussed below)(Heerkens et al. 2012). Another classification system built on the ISO 9999 is the AT Device Classification (ATDC) which was also devised to address the perceived shortcomings of the ISO 9999, namely its inconsistency with US legislation, use of non-standard language, terminology and coding and lack of extendibility (Elsaesser & Bauer 2011). Detailed classification rules were developed to link AT devices to corresponding ICF chapters and domains and it used the same coding, language and terminology as the ICF. “*The ATDC provides a means by which to identify products associated with specific impairments, limitations and restrictions in reference to the standard ICF framework.*” (Elsaesser & Bauer 2011). What both these alternative classification systems highlight are the shortcomings of the ISO 9999 taken by itself in terms of its usefulness and potential application to AT education while at the same time showing that if combined with another classification system that dealt with activity it offers a great deal of potential. By dealing with AT devices in isolation and not linking to function in a direct and specific way it loses value. A classification system which is linked to the ICF Activity

and Participation and Functions and Structures domains would hold much more potential in terms of metadata for Learning Objects (LO) for example.

2.3 Models of Disability

How every aspect of AT is approached changes depending on the concept of disability, from its very definition to how a service or training is provided. This causes difficulties because the definition of disability is constantly evolving. Kate Seelman outlines four models of disability and observes how these four models often appear at sequential stages in the history of many industrialised nations: the traditional model, medical model, social model, and integrative model (Seelman 2002). What Seelman terms the Integrative Model has come to be more commonly understood as the Biopsychosocial model as it is closely aligned with the WHO ICF. She also outlines how these models have implications for professional education and training of people with disabilities (Seelman 2004). Here three models are selected for closer examination; the Medical Model and the Social Model because they represent radically different perspectives on disability and finally the Biopsychosocial Model because it is an attempt to span the divide between the previous two.

The Medical model as its name would suggest is based on scientific views and practice, typically in the medical and health knowledge base. The Medical Model views disability as a problem or defect that needs remediating. Persons with disabilities are considered patients and services are located in a clinic or institution. The knowledge and authority lies with the healthcare professionals. It is based in the bio-medical perception of normality and disability is measured by impairment level. The Medical Model doesn't usually consider the perspective of the person with the disability or the social factors involved.

The Social Model of disability considers the ways that society disables individuals through social, structural, cultural, and environmental barriers and exclusionary practices (Barnes and Mercer, 2004). It is based on an understanding of the experiences, perspectives and practices of people with disabilities. Rather than focusing on remediating the individual with a disability the focus is put on the problems within society that restrict full participation. Within the social model of

disability, impairments are the affected body structures, while disability refers to exclusion and oppression that result in the inability of an individual to participate fully in society (Ripat & Woodgate 2011, Oliver 1998). The social model perspective incorporates research that examines problems of quality of life, user satisfaction, participation, and accessibility of various domains of the environment (Seelman 2004). The person with the disability is central to the AT decision making process. This has a profound effect on how AT services are delivered. It becomes a client-focused social and participatory service delivery model and should achieve the best results for people with disabilities and their carers (Craddock & McCormack 2002). Again this has major implications on training and education of all parties involved.

As stated earlier the Biopsychosocial Model sits somewhere between the Medical and Social Models. A Biopsychosocial Model sees disability as a complex phenomenon that is both at the level of a person's body and as a complex and primarily social phenomenon. Disability is always an interaction between features of the person and features of the overall context in which the person lives (KPT 2007). The principle Biopsychosocial Model in terms of disability is the World Health Organisation's International Classification of Functioning, Disability and Health or ICF (WHO-ICF, 2002).

2.3.1 ICF - International Classification of Functioning, Disability and Health

The ICF is made up of two parts, each with two components. The first part is entitled Functioning and Disability and includes body functions and structures and activities and participation. The second part is entitled Contextual Factors, which includes environmental factors and personal factors (APPENDIX A). The ICF can be expressed in both positive and negative terminology. Each component consists of various domains and, within each domain, categories that are the units of classification. *“The ICF puts the notions of ‘health’ and ‘disability’ in a new light. It acknowledges that every human being can experience a decrement in health and thereby experience some degree of disability. Disability is not something that only happens to a minority of humanity. The ICF thus ‘mainstreams’ the experience of disability and recognises it as a universal human experience. By shifting the focus from cause to impact it places all*

health conditions on an equal footing allowing them to be compared using a common metric – the ruler of health and disability. Furthermore ICF takes into account the social aspects of disability and does not see disability only as a 'medical' or 'biological' dysfunction. By including Contextual Factors, in which environmental factors are listed ICF allows to records the impact of the environment on the person's functioning.” (WHO- ICF 2002) Environmental factors are defined in the framework as the physical, social, and attitudinal environment in which people live and conduct their lives. Personal factors are the particular background of an individual's life and living, and are composed of features of the individual that are not part of a health condition or health states. Personal factors can include gender, race, age, or other health conditions, fitness, lifestyle, habits, upbringing, coping styles, social background, past and current experience, character style, as well as other psychological assets. (Jette & Keysor 2003). It is within the “Products and Technology” chapter of the “Environmental Factors” domain that AT resides and it can be seen as a key component of this domain that can improve the functioning of individuals with disabilities in community environments (Scherer & Glueckauf 2005).

2.3.2 ICF in Education

In the introduction of this chapter it was stated that the ICF can be considered a boundary object in the way it facilitates communication between different social and professional groups. *“If widely adopted, the ICF framework could provide the rehabilitation field with a common, international language with the potential to facilitate communication and scholarly discourse across disciplines and national boundaries, to stimulate interdisciplinary research, to improve clinical care, and ultimately to better inform health policy and management”* (Jette 2006). Seelman proposed the ICF as a useful framework on which to base coursework for individuals across a wide number of fields, including the health professions, social work, psychology, and disability studies. At the time of writing she had identified 30 ICF-related courses in universities in the US and Canada. One example she gives is the University of Pittsburgh Department of Occupational Therapy that uses the ICF as the foundation for curriculum design. (Seelman 2004). In Chris Allan’s paper on interprofessional education he tells of how a shared language and conceptual framework is essential to successful interprofessional collaboration. There are many

comparisons between AT education and interprofessional education in the purely medical domain that will be examined in more detail in the next chapter. He proposes that the ICF provides this shared language and conceptual framework that will help to transcend traditional disciplinary boundaries. He sees it enhancing interprofessional learning by promoting a multidimensional perspective of an individual's health concerns. In highlighting the value of the ICF he argues that a strong foundation based on the ICF could enhance communication and encourage collaboration between multiple disciplines (Allan et al 2006). In AT education as well as this potential use as a common international language to facilitate communication between the different disciplines associated with AT it could also be used as a means of classification of reusable learning objects. Finally its use as a broad conceptual model of AT could also inform how AT should be approached as a subject. This will be explored further in the following section.

2.4 AT Education, Information and Services milestones in Europe

If one considers low tech tools AT has been used since prehistory. This work is primarily concerned with Electronic AT and as such will take the starting point as the TIDE (Technology Initiative for Disabled and Elderly People): Heart project which was a report published in 1994. This was the result of a survey of existing training programmes in the fields of AT and Rehabilitation Technology and identified training requirements for the various professionals and critical components for a European curriculum (Whitney et al., 2011). The Heart recommendations concerning education will be looked at later in the AT Education chapter. 1995 saw the Strategy For Equality, published by the Commission for the Status of People With Disabilities. It made several recommendations regarding AT. In 1996 the Association for the Advancement of Assistive Technology in Europe was formed (AAATE). AAATE is the interdisciplinary pan-European association devoted to all aspects of AT, such as use, research, development, manufacture, supply, provision and policy (AAATE, 2012). Although no literature directly attributing the inauguration of AAATE in Lisbon in 1996 to the Heart report has been found its first four presidents were associated with the Heart study and AAATE filled one of the primary needs identified by the report, that of a pan European AT professional network. Since its existence

AAATE has established itself as the representative of the AT field in Europe and is an important facilitator of knowledge exchange and dissemination (Fagerberg, 2011). In 1998 the Certificate in Assistive Technology Application (CATA) ran in University College Dublin (UCD) for the first year. This course was run in partnership with the Central Remedial Clinic and has the honour of being the first accredited AT course in Ireland. Also in 1998 two major projects were initiated as a direct response to the training needs highlighted by the Heart report. TELEMATE (Turner-Smith & Devlin, 2005) which is of particular interest to this work as it concerned AT distance education and so will be examined in more detail in the AT Distance Education Chapter and the Empowering Users Through Assistive Technology (EUSTAT). EUSTAT focussed on user education and identified critical factors to be considered in user centred service delivery (Steel and Witte, 2011). In 2002 Enable Ireland and Dublin Institute of Technology began their Certified Assistive Technology Training Course aimed at professionals and AT service users. Also in 2002 EDeAN the European Design for All e-Accessibility Network began operating. In 2003 Deloitte and Touche issued their report on “Access to Assistive Technology in Europe” which found that despite the work done since the Heart Report that information was still lacking at all levels. A strong recommendation was made to make information accessible for all stakeholders, professionals and users, within Europe (Fagerberg, 2011). In 2004 the EASTIN project launched. The EASTIN network provides detailed and comprehensive information on existing AT products, their availability in the European market, and guidance for their appropriate choice and application to solve people's individual needs (EIS, 2012). In 2005 the Keeping Pace with Assistive Technology (KPT) questionnaire was circulated in four European Countries (Ireland, UK, Italy and Belgium). This questionnaire was directly building on the Heart Report and the subsequent TELEMATE project. In 2006 the KPT WP3 Final report on the findings of the questionnaire was published which was followed in 2007 by the “Guidelines for Lifelong Learning in Assistive Technology” booklet which was Published in English, Italian and Dutch with financial support from the European Commission – Leonardo da Vinci Programme. Finally in 2008 Dublin Institute of Technology began offering a Masters in Computing and Assistive Technology.

2.5 Conceptual Models of AT

In order to understand the complex system that is AT many conceptual models have been developed. Conceptual models provide a theoretical basis for advancing scientific knowledge and improving professional practice (Lenker & Paquet, 2003). In the field of AT there are a large number of conceptual models which perhaps indicates the complexity of AT usage. The premise behind all these models is to help service providers understand the factors that relate to the components of AT and how they influence each other. This will allow them to more provide successful solutions. This therefore should also be an important consideration in terms of AT education. Two conceptual models will be briefly examined. This work isn't concerned with the theory behind the models rather more interested in their common components and how they relate to the previously examined ICF which is itself of course a conceptual model of disability. The HAAT Model (Cook and Hussey, 2002) has three components; Human, Activity and AT within a forth, Context. In this model the context refers to anything outside the triumvirate of Human, Activity and AT, where the activity is preformed. This could be a physical environment, social context or cultural context (Gilligan, 2011). The SETT Model (Zabala, 2005) is an AT model that has been applied to an educational context. Its components are; Student, Environment, Tasks and Tools. Both these frameworks have been aligned below under the ICF to demonstrate their common components.

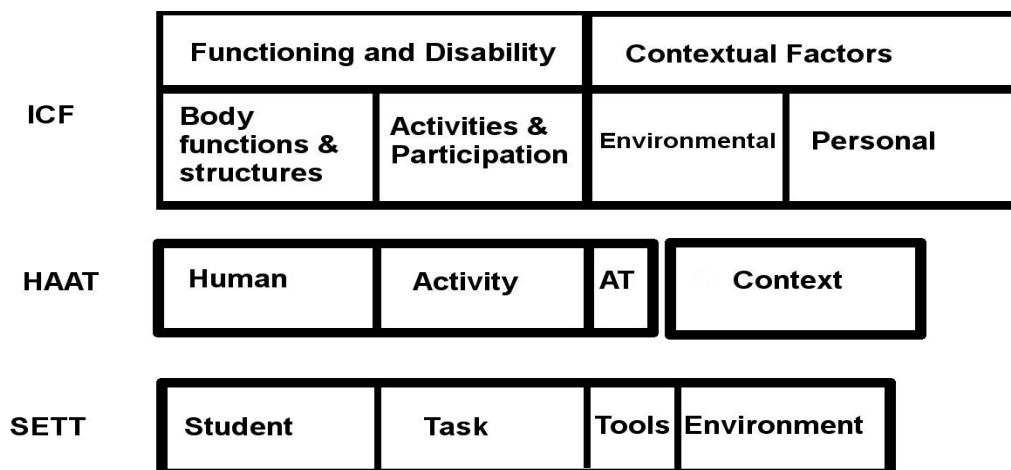


Figure 1: The components of the HAAT and the SETT Models aligned under the ICF.

The relevance to this to an AT course is that each of these components must be considered in any modules be they coming from the technology perspective, the task/activity perspective, the person or the environment.

2.6 Who? People involved in AT

There are three categories of people who use AT. The first mentioned above is the person who uses it as a tool to enable them accomplish any task or activity that they might otherwise find difficult or impossible. The second category is the people who support them in a professional capacity either by helping them select or acquire the AT or by providing training or technical support. The third category fulfil the same role as the second category except not in a professional capacity, they may be a friend or family member. This represents a very diverse group of people. How this might affect training will be discussed later, at this time however it is suffice to say that a broad range of people with various levels of ability (functional and cognitive) with different educational backgrounds and levels use AT. Another characteristic of all three categories of AT users are that they are often widely dispersed geographically. Professionals who work in AT usually so as part of a multidisciplinary team but only those in large towns or cities probably work under the same roof as other members of their AT team. Opportunities of knowledge sharing are restricted to online contact or the occasional conference. The Heart Report (1994) and later TELEMATE and KPT previously mentioned identified three broad groups of professionals who work in AT.

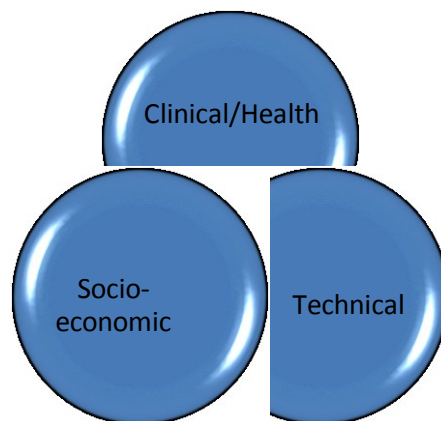


Figure 2: Range of professionals working in AT

More recently Elsaesser and Bauer classified four types of AT professional which they locate in different domains of the ICF; Health Professional in Body Functions and Structures (Doctors, Nurses, Therapists), Health Related Professionals in Activity and Participation (AT Specialists, Rehab Councillors), Product and technology professions in environmental factors domains (Research and Development, Manufacturers) and Resource Professionals who are also in the Environmental Domain (Administration, Employers) (Elsaesser & Bauer 2011). Although this approach is interesting it is too

US centric and this project will stay with the European approach origination in the Heart Report.

2.7 Conclusion

The research question this chapter was attempting to answer was; “*What are the characteristics of AT that will influence how training in the area should be delivered?*” What has been discovered is that AT can be considered a system with four components, Person Task/Activity AT and Environment are all integral to the AT process. These components are interrelated but can be individually identified using a combination of classification systems, ICF and the ISO 9999. The strength of both the ICF, as an increasingly used model in the rehabilitation field, and of the ISO 9999, as a useful tool and popular database in the field on AT can be a helpful resource for the best person technology match within an AT selection process (Bernd et al., 2009). What is being proposed here is that it could also be an efficient way of identifying small independent chunks of learning content. The brief history of AT information provision and education in Europe within the last 20 years has shown that although failings were successfully identified repeatedly and many innovative attempts at solutions were provided these issues have yet to be addressed fully. It also however uncovered a wealth of excellent research that has been left in the wake of multiple EU projects that will provide an excellent foundation upon which to build (Heart, TELEMATE, KPT). The audience will be a broad range of people with different intellectual abilities, educational levels and backgrounds, personalities and learning styles and many of them may have physical and sensory disabilities. At Education should be approached from the perspective of the Social Model of Disability and this will obviously impact on the way a course will be constructed (Seelman, 2004) but a lot can also be learned from the ICF approach which is rooted more in hard science. The ability of the ICF to act as a common language and structure through which professionals from different disciplines can understand AT should also be considered. In the next chapter how previous AT Educational projects dealt with these challenges will be examined.

3 AT EDUCATION

3.1 Introduction

The Heart Study (1994) identified that the training of professionals was a key area for the improvement and development of AT within Europe. It highlighted adequate training as being crucial for the introduction of more advanced AT devices. (Fagerberg, 2011). It also suggested; *“long distance education courses in assistive technology. It is probably necessary to use distance learning in order to cover all of Europe in a new, relatively small and multidisciplinary subject such as assistive technology. This is essential for the updating of in-service training of professionals and other actors actively involved in the field.”* (Azevedo et al, 1994).

Almost 10 years later in 2003 a study prepared by Deloitte & Touche titled “Access to Assistive Technology in the European Union”. It proposed six main areas of action, one of which was Education and Training. Its general recommendation in that area was; *“Take action to improve the theoretical and practical knowledge of functional problems, and the solutions that the use of Assistive Technology can offer. Professionals, in particular prescribers and assessors, must have sufficient expertise of assessment procedures and products.”*(Deloitte & Touche, 2003). It goes on to say how all parties involved in the field of Assistive Technology would benefit from a broader provision of basic education and continuing training. It particularly singles out Occupational Therapists saying that their training should focus on medical aspects of the disability and on the technical capabilities of the appropriate Assistive Technology products, both from a theoretical and a practical perspective. It then observes that Social workers technical experts and general practitioners would also benefit from targeted training. Finally like the Heart report it also recommends the promotion of AT e-learning and specifies including the development of learning materials that can be used across borders.

In the subsequent almost 10 years since that report the situation has degraded rather than improving. This is not to say that a lot of very good work hasn't been done in the area, it certainly has and will be outlined throughout this chapter. The AT landscape

itself has changed and it seems that by the time these reports are acted on the situation has yet again progressed. Rapid advances in the availability, diversity and complexity of AT devices and software solutions have outstripped the capacity of providers to *'learn, unlearn and relearn'* knowledge (Toffler & Toffler in Elsaesser & Bauer 2011).

The need for AT education has been documented in many professions. Physical and Occupational Therapists were two of the professions critical to AT as highlighted by the KPT findings and identified as prime recipients of training. Findings from a sizable sample (380) of Paediatric Physical Therapists' in the US found that overall almost half of them reported less than adequate training in AT and AT Services in all five areas surveyed (Long and Perry 2008). Those surveyed reported that they recognised the benefits of AT and AT Services and that they were confident both with working with low-tech devices and in assessment and evaluation however they reported low confidence for identifying sources of funding, suppliers of AT and AT Services and with high-tech devices. Closer to home a study on Irish community Occupational Therapists' (OT) views of electronic AT (Verdonck 2011) revealed that although 84% of those surveyed thought an OT should be able to assess for and prescribe electronic AT only 34% stated that they were able to do so. In fact 48% said that they had been asked to assess for and prescribe electronic AT and had been unable to do so. Although this was a relatively small sample (56) of a possibly particularly isolated section of the profession it points to a clear need for AT education within the field.

This chapter will open by looking at the original aims of Enable Ireland's Certified Assistive Technology Training Course. In its tenth year this year it is enjoying a longevity that seems to be somewhat rare in the world of AT education and as the basis of this paper deserves closer scrutiny. The chapter will then continue by examining the direct line of succession in European AT education from Heart through to KPT *“Guidelines for Lifelong Learning in Assistive Technology”*. Other significant efforts at addressing the need for AT education, both distance and face to face, from throughout Europe and the US will then be examined to identify requirements and methods of delivery. A review of literature on the multidisciplinary nature of AT education and how techniques used in Interprofessional Education e-learning like Problem Based Learning, Reflective practice and Case Studies can be borrowed and

utilised will follow. Finally a Case Study of how an organisation called IPAT are making use of Videoconferencing and an AT loan library to provide “hands on” practical training on AT equipment. The chapter will conclude with a list of requirements and methods of delivery derived from what has been learned.

3.2 Ten years of Certified AT Training - Enable Ireland

3.2.1 Introduction

Enable Ireland started its Certified Assistive Technology Training Course in 2002 with the support of Dublin Institute of Technology. The original course aim was to provide Enable Ireland Staff and Service Users with a comprehensive overview of the core issues pertaining to the delivery of effective high tech assistive technology service to people with physical disabilities. The three key parts of this original aim are that the audience is restricted to Enable Ireland Staff and Service Users. It was specifically concerned with training in “*high tech*” AT and the “*high tech*” AT was narrowed further by specifying AT for people with “*physical*” disabilities. After only one year however both the audience and the area of AT being covered had broadened considerably. Although still concerned primarily with Electronic AT, course content about technology for those with sensory disabilities, and specific learning disabilities was also covered and many course participants came from outside the organisation. Since 2005 the course has been annually be hosted by Microsoft in their Head Quarters in Dublin. This is an important aspect of the course. AT being recognised by a main stream tech giant goes with the ethos of the course which is very much about the mainstreaming of AT.

3.2.2 Rationale

The key objective was to facilitate course participants to acquire the knowledge, skills and attitudes which will enable them support users and potential users of Assistive Technology to optimise their personal independence, and achieve their goals in the areas of independent living, education, communication and employment. The “knowledge, skills and attitudes” mentioned in the course objectives reflect Bloom’s cognitive, psychomotor and affective learning (Bloom, 1956). They also align with the Recognition, Strategic and Affective networks of Universal Design for Learning

(CAST, 2011). The use of the word “*facilitate*” suggests social constructivism is the intended pedagogical strategy. Goals in the area of “*personal independence*” “*independent living, education, communication and employment*” all suggest that the course is taking the social model of disability view of AT. This of course would be expected from a disability advocacy organisation and is backed up by the fact that the intended audience it made up of professionals and AT users.

3.2.3 Course Content

In the original course documents the core subjects to be covered are listed below.

1. Augmentative and Alternative Communication
2. Computer Access
3. Power Mobility
4. Environmental Control Technology
5. Funding
6. Legislation (Disability)
7. Service Delivery Models
8. Teamwork and Problem Solving
9. Educational Software
10. Social Model of Disability
11. AT Portfolio (post course)

As the course has evolved Funding, Legislation and the Social Model of Disability have come together as one area under the general term Funding. Teamwork and problem solving have rather than staying as a core subject in themselves become a strategy that is used throughout all modules. All the other modules have remained although completely transformed over the last 10 years. Computer access has been split into three separate modules; Inbuilt Accessibility Features, Alternative Keyboards and Mice and Alternative Access. This reflects the growing importance of computers for AT and people with disabilities in general. Mobility has become Integrating Technologies which reflects feedback that power mobility is really an area in its own right with its own range of professionals. An AT course is really only concerned with how AT can integrate with the chair rather than the chair itself. New modules include; Accessible Design (Universal Design, Web/Document Accessibility), Dyslexia, Vision and Hearing, Mobile Technologies, Leisure, Future Technologies.

3.2.4 Teaching Methods

The teaching methods outlined in the original course proposal are “Introduction, theoretical framework, practical hands-on workshops and plenary sessions”. The introduction and theoretical framework would take the form of a PowerPoint supported didactic style lecture with a question and answer session. The practical hands on workshop would involve work with either the software or hardware being discussed or demonstration (power mobility, environmental control). The plenary session would be how subjects like legislation and funding would be dealt with. As stated earlier Case Studies, Problem Solving and Team building was used throughout.

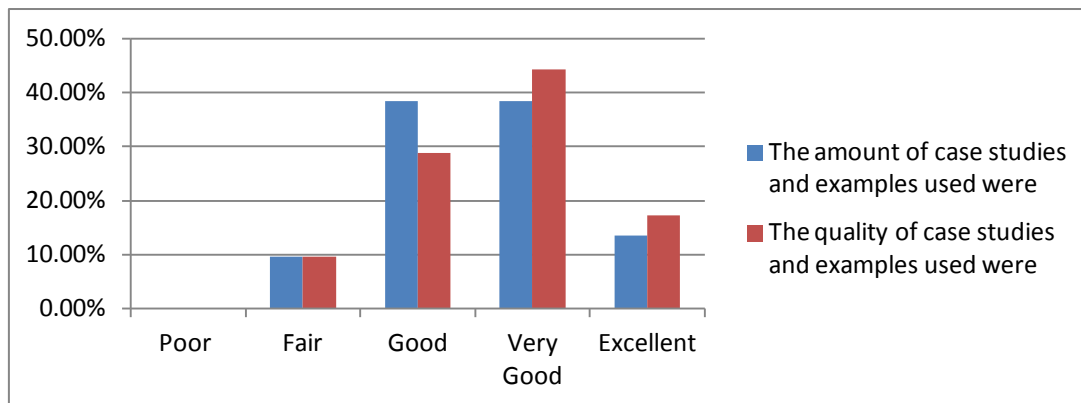


Figure 3: From the 2008 past participant survey

From the results of a survey carried out in 2008 (Figure: 3) this mix seemed to work well for people. The graph on the previous page shows how out of the 52 respondents there was a very positive view of the Case Studies used.

3.2.5 Participants

The graph below shows the range of course participants’ roles as they were when they took the course. The “Other” group included; Equipment & client Services Administrator, three IT Trainers (one of which was also Parent of an AT User), Librarian, Child and family support worker, Disability Officer, Managerial and a Job Coach. This illustrates the broad spectrum of people who might be interested in participating in an AT course. One surprising result is that only one AT user is listed as a course participant. This can be explained in two ways. Either the AT user was attending the course in another capacity (which is normally the case, as stated earlier very few people would identify themselves solely as an AT user) or they chose not participate in the survey. The same is true of the AT users friend or family. As can be

seen from the other section one person identified themselves as an IT Trainer and parent of an AT user. Had their actual professional role been one of the choices they probably would not have included that extra information.

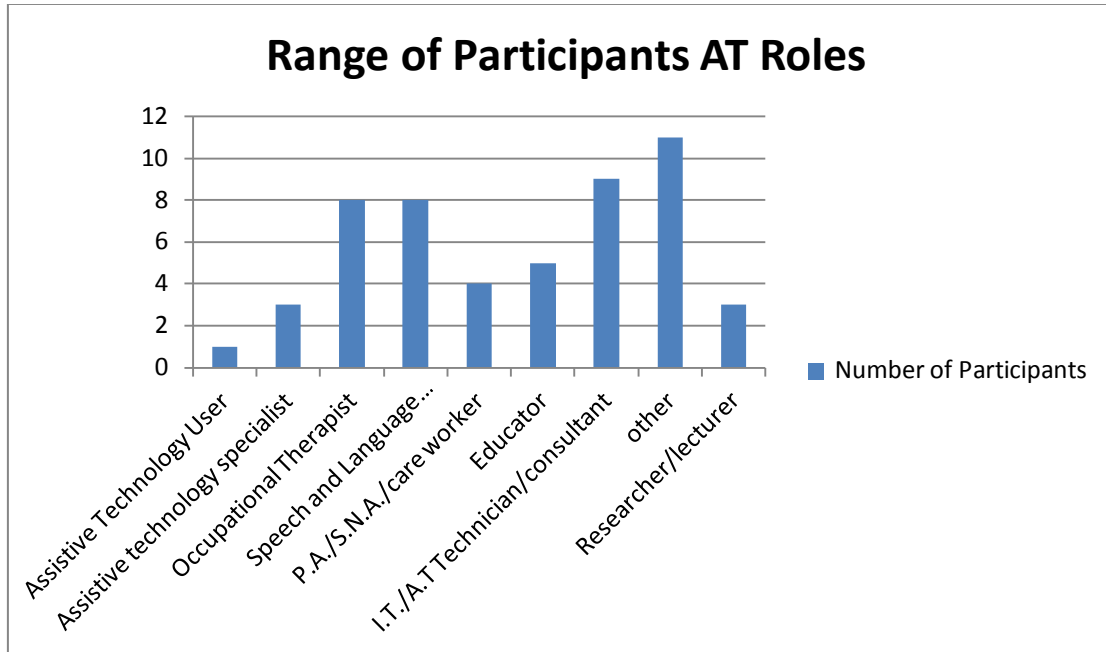


Figure 4: Past participants of AT course from the 2008 survey.

3.2.6 General Response and Developments

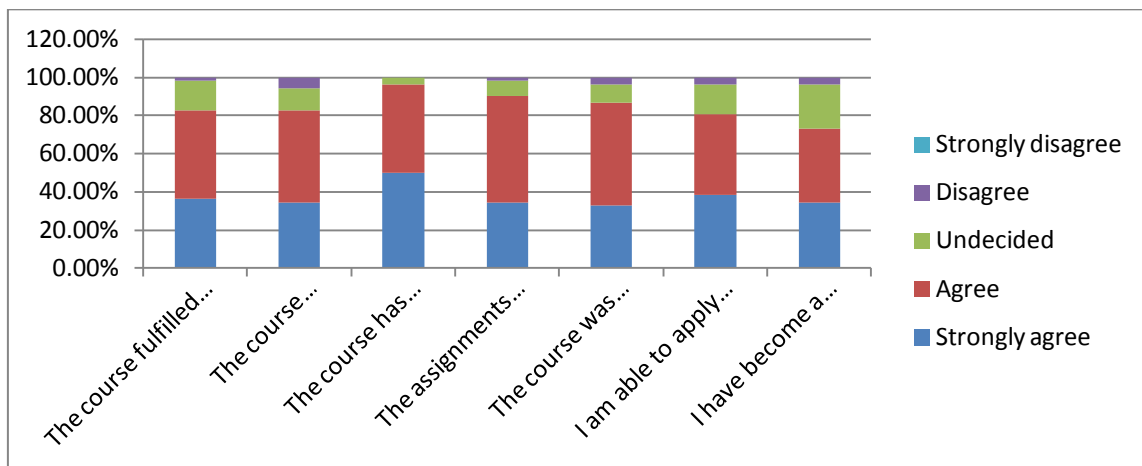


Figure 5: Past participants' opinions of AT course from the 2008 survey.

As can be seen from the results on the previous page (Figure: 5) there was an overwhelmingly positive response from past participants of the course. This obviously presents a challenge when it comes to replicating the success with e-learning. The preferences for future training however present some hope in this regard.

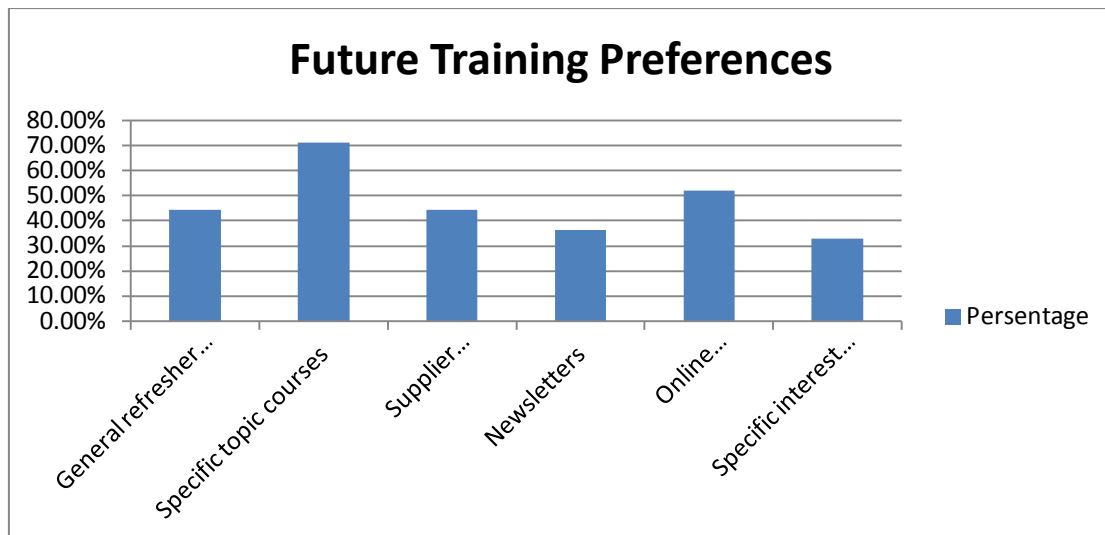


Figure 6: Past participant preferences for future training

As can be seen from the results above over 50% identify online learning as a preference for future training. The other interesting result here is the preference for specific topic courses which could be delivered through e-learning.

3.2.7 The Way forward

As was outlined in the course content section the Certified Assistive Technology Training Course has evolved significantly in its ten year existence. This has resulted in it keeping up to pace with technical developments but also social developments. The author was responsible for the complete redesign of the course materials DVD in 2010 as a result of the Accessible Web Design module of the Msc in Computing. This process was initiated after Enable Ireland was contracted to provide the course to Mada, Qatar Assistive Technology Centre. Mada is a non-profit organization that is empowering and enabling people with disabilities through the greater use of Information and Communication Technologies (Mada, 2012). This is obviously a very welcome additional revenue stream in current economic conditions. Between this new opportunity and the work done modernising and updating the course resources it became evident that a move to e-learning was inevitable. Participation numbers had been hit somewhat in recent years and people were reporting finding it difficult to be out of work on training for nine days. Travel expenses were also an issue for those not based in the Dublin area. It has been made clear by the training team in Enable Ireland that the Certified Assistive Technology Training Course is still very much a core part of the training programme. It has also been made clear that this particular course will

always have a face to face element. Two reasons for this are the importance of the continued presence in Microsoft which is seen as a mutually beneficial arrangement which raises the profile of AT while allowing Microsoft to make a valuable contribution to a long standing partner and express their corporate responsibility in an area where they have a commercial interest. The second is that the presentations by AT users have from the early days been an important aspect of the course and one that participants recognised as such. Although this could be done through synchronous technologies like video or web conferencing it is the general consensus among the team that much of the effectiveness of the presentation could be lost in this mode of delivery. It has been acknowledge however that for the reasons outlined above there must be a move to providing 60% to 70% of the course via e-learning in the coming year. This means that the approach planned is what is termed “Blended Learning”. Blended learning will be discussed later in the chapter.

3.3 Other Significant AT Education Projects

3.3.1 Tide: Heart Line E Study

The HEART Line E study published in 1994 grew out of two years of research into AT education throughout Europe and North America. Its purpose was to address the educational needs of Rehabilitation Technology and Assistive Technology (RT, AT) specialists and related professionals and their specific education needs. Although approaching twenty years old even though the area has changed radically in that time, Heart is still relevant for a couple of reasons. The Heart Line E report proposed a framework to represent AT. According to this framework the “handicap” represents the gap between the environmental demands and the individual’s abilities. This “handicap” as it is referred to, is a gap that could be diminished through changes in the individual and or the socio-economic environment and involves the introduction of a technical component. It proposed that AT education and training should reflect the three core components of this model; The human component, the environmental demands and the technical component (KPT, 2005). This model was based on the International Classification of Impairments, Disabilities and Handicaps, ICIDH (WHO, 1980) which was superseded by the ICF in 2001. Even though the way

disability is considered has progressed a great deal the basis for AT education reflecting Human, Technical and Socio-economic elements is still sound.

3.3.2 TELEMATE

TELEMATE was a pan European on-line AT education platform build on recommendation 5 of the aforementioned Heart Line E Study. *“We recommend long distance education courses in assistive technology.”* (Azevedo et al, 1994)

TELEMATE is of particular interest to this study in that it was the first serious attempt in Europe to create distance AT education. It was funded by European Commission through the Telematics Applications Programme for three years from 1998 to 2001 (Turner-Smith & Devlin, 2005). Aspects of note from the TELEMATE project are its use and expansion of the original proposal of the Heart report concerning the core elements of AT training; Human, Technical and Socio-economic. It mapped these components to the professional backgrounds of the people working in AT.

TELEMATE identified three particular issues in the field of AT education;

- different educational approaches are needed for members of a multidisciplinary teams depending on their professional background;
- the need for a common approach, language, and understanding between multidisciplinary team members;
- the extent of the knowledge required of service providers for holistic support of their clients. (Tiresias, 2009)

TELEMATE also introduced the idea of using Learning Objects within online AT education (TELEMATE, 1999) but that didn't seem to make the finished product. As can be seen above there was a significant emphasis on the multidisciplinary nature of the training within TELEMATE. This allows different but complementary approaches to similar problems to be explored because there were usually different professionals taking the same courses together (Turner-Smith & Devlin, 2005). It proposed an AT Fundamentals course that would be common to all participants and would provide a foundation for more detailed studies in specialist areas that could then be undertaken. This supported the multidisciplinary goals of the course by enabling professionals from diverse backgrounds to more effectively communicate and collaborate through the shared core knowledge of the fundamentals. In the Curriculum Framework Document (TELEMATE, 1999) many educational frameworks were examined.

TELEMATE didn't survive for long after its EU funding expired but its legacy is in the conceptual framework for multidisciplinary education in the field of AT it developed (Turner-Smith & Devlin, 2005).

3.3.3 KPT

In 2005 the Keeping Pace with Assistive Technology (KPT) programme created a training-needs analysis of 135 questions was circulated in four European Countries (Ireland, UK, Italy and Belgium). The range of professionals selected to take part in the study was built on the work done by the previous Heart Line E report and subsequent TELEMATE and EUSTAT projects. The report on the findings from the questionnaire was published in 2006. The key findings of the KPT-WP3 report included;

- Occupational therapists, physiotherapists, speech and language therapists and educationalists were identified as the professionals who would be the prime recipients of training.
- Professionals reported working in multiple settings with multi-professional teams.
- 80% of respondents had no pre-qualification AT training.
- Indications were that a focus on post-qualification education would be most effective.
- Respondents identified that keeping pace with new developments in AT and an increased demand for AT as being their biggest challenge.
- There was a preference for face to face training.

Guidelines to Lifelong Learning in Assistive Technology

As a result of the KPT questionnaire and report the “Guidelines to Lifelong Learning in Assistive Technology” booklet was produced. This book is an extremely valuable resource to any person or organisation planning to provide AT training. Below is a summary of some of the key recommendations and most useful aspects of the guide;

- It aligns the required AT knowledge to European Qualifications Framework (EQF) levels 1 to 7.
- It suggests recognition of prior learning.

- Proposes the use of case studies, especially with the use of photographs and video clips, can help highlight issues and can also be used for interactive problem-solving sessions.
- Suggests that as the assessment and support of AT is often very 'hands-on', especially regarding access issues, distance learning will in most cases need to be supplemented by face-to-face sessions allowing the possibility of handling and using equipment.
- Suggests experiential learning and associated reflection.
- Proposes the use of differentiated instruction.
- Suggests aligning training to the domains of the ICF.
- Suggests the promotion of Multi-professional working practices through multi-professional training.
- Provides a form to assisted in the planning of training sessions and courses (Appendix: A)

3.4 Previous Significant Distance AT Projects

Virtual Assistive Technology University (VATU) offered a Certificate in AT beginning in 2001 that was primarily aimed at educators. One of the most important goals of VATU course designers and instructors was to build an interactive component so that participants engage with one another; to the extent that the courses were designed around the social elements rather than the opposite approach (which would probably be considered the usual strategy). For this course peer discussion was the most important factor in the development of learning and real understanding and as such it was a major influence on the structural organisation of the VATU. The methods used were asynchronous discussion boards and email along with course content. In a paper laying out the strategies used to embed social learning and the rationale behind those strategies Kuech & Kimball provides what could be some very good techniques in the effective use of asynchronous learning. The importance of critical reflection is highlighted here once again. Critical reflection on participants “understanding of assistive technology concepts linked with peer feedback on these understandings, are processes reported in the research literature that may promote conceptual discussions leading to deeper understanding” (Kuech, 1999 in Kuech & Kimball, 2003). Rather than keeping a private learning journal peer feedback is also mentioned here. This

concept is certainly in keeping with current social media practices like blogging and e-portfolios. As mentioned in the introduction of this section the design of VATU encouraged participants to communicate and interact. What is most interesting here is the very specific requirements and guidelines provided to participants. They required each participant to start one discussion and to reply to all other student discussions. In order to ensure quality they issued guidelines in the form of a rubric. It is very comprehensive directing course participants to formulate “thoughtfully developed, carefully worded” questions. The rubric contains criteria such as; Relevance, Importance, Timeliness and Thought-Provoking. They conclude the guidelines with the statement; “Remember-You must lead one discussion and you must reply to other students who answer questions you submit. You are in control of the quality of the thread you create, so be sure to give feedback. If students post high quality responses, tell them.”(Kuech & Kimball, 2003.). It could be argued that such an authoritarian tone might be counterproductive but the practicality of the rubric and its obvious goal in ensuring the contribution of quality content from all participants would probably override the tone for most people.

Assistec was a blended learning AT course based in Austria launched in 2006. The course was offered by the Institute of Integrated Study, Linz, Austria who have a long and distinguished track record in innovative AT education. From 1994 they offered AT courses and had integrated AT into mainstream computer courses. Blended learning approach was decided upon for this course because of the "*high temporal and regional flexibility*" it offered to participants especially those in full time employment. However they also recognised the advantage of lectures from experts. Graduates of the course were awarded a degree called “*Experts on Assistive Technologies*” (Matausch et al., 2006).

3.5 Multidisciplinary AT Education

As can be seen the multidisciplinary nature of AT is one of the main complicating factors in regard to the provision of AT education. This challenge needs to be embraced because there seems to be an advantage in carrying out the selection and advisory process in an interdisciplinary team with clear allocated roles and regular staff training (Hoenig et al., 2005). Although these professions have diverse

educational backgrounds they have a common need for AT training. Elsaesser & Bauer observed that the service provider's ability to identify appropriate AT solutions and outcomes can be effected by their educational background and the era in which their experience was gained. It should be recognised and accepted that the solid foundation that could be provided by a broad AT course aimed at a multidisciplinary audience would be an effective way of filling these potential gaps in quality service provision (Elsaesser & Bauer 2011). This solid foundation was the approach of TELEMATE. There is common AT knowledge that is needed by the professions highlighted above and the others who also undoubtedly have literature documenting the need for AT training. Elsaesser and Bauer go on to suggest that the adoption of a common language for the provision of AT services will structure the relationship between areas leading to a higher quality AT service. (Elsaesser & Bauer 2011). In order to keep up with the acknowledged speed of developments in AT professionals must be prepared to share and exchange knowledge among each other about innovations and relevant mainstream technologies (Van Woerden 2006). The ability to keep up to date is a significant advantage that e-learning has over face to face training. A 1997 paper describing the development, implementation, and outcomes of an extended problem-based learning project imbedded in an interdisciplinary assistive technology course outlined the benefits but also the factors influencing success. It observed that participants need to be highly motivated and that they need to have previously covered the foundations of AT. This allows them to build on their knowledge and ability to access information from a variety of sources during the project. Attention needs to be paid to the correct mix of professionals in each group. Instructors act as facilitators guiding rather than instruction. It is recommended that care is taken in the introduction of Problem Based learning to participants and they should be guided through the process because of the significant differences to more traditional education. Overall the findings were that with if approached in this manner it proved very successful (Stern & Trefler, 1997)

3.6 Interprofessional Education

The generally accepted definition of IPE as put forward by the Centre for the Advancement of Interprofessional Education is "Interprofessional Education occurs when two or more professions learn with, from and about each other to improve

collaboration and the quality of care" (CAIPE 2002) or as one of the leading academics in the field (Barr et al., 2005) explains, it is about forming professional identities in a way that is open to collaboration with others in the interest of providing care. As the field of AT is rather small (even when considered worldwide) looking outside the area is necessary to get fresh research and thinking regarding its delivery as eLearning as a multidisciplinary practice. The above description of IPE would seem to be a perfect fit for AT. There are also other similarities to the practices and goals of Interprofessional teams in medicine and those in the field of AT. Indeed many of the professionals concerned may be involved in both areas. In IPE the patient is central to the process just as the AT user is in AT. Due to the WHO formation of a Study Group on Interprofessional Education and Collaborative Practice in 2007 and the subsequent 2010 report which acknowledges the appropriateness of its delivery through ICT (e-learning) and as CPD there is a wealth of current research into the area. (WHO 2010) For this reason the next few pages will examine some of the recent literature on the delivery of IPE as e-Learning.

3.6.1 Blended Learning

While the use of e-Learning seems to be gaining considerable ground within IPE, it is most often used in conjunction with some kind of face to face learning. Casimiro et al. tell how eLearning does not have to be an "all or nothing" approach. Blended learning may be favourable in many learning contexts. (Casimiro et al., 2009). According to the Sloan Consortium a blended learning or hybrid course is one that blends online and face-to-face delivery. Substantial proportion of the content is delivered online, typically uses online discussions, and typically has some face-to face meetings (Allen & Seamen, 2007). Although sometimes criticized for the arbitrary nature of the figure they say that between 30 to 79% of the course should be delivered online to be considered blended learning. Although there are often many contradicting studies in this area blended learning is considered an effective approach. In fact a comprehensive meta-analysis of all studies undertaken in the last ten years by the US Department of Education found that blends of online and face-to-face instruction, on average, had stronger learning outcomes than did face-to-face instruction alone. This is in comparison to their findings that instruction conducted entirely online is as effective as classroom instruction but no better (US DoE, 2010). The blended approach offers a

number of advantages. For one it recognises the importance of face-to-face contact between the students, especially at the initial stages of the learning experience as described by Borthick and Jones, 2000 (Gordon et al., 2010). It is also often seen as offering a low-risk strategy, a compromise, which will allow organisations to advance with and take full advantage of developments in technology. In this way they can capitalise on how these developments will offer new ways for learners to acquire knowledge and communicate while also fully utilising the tried and tested methods. To do this however it may be necessary to rethink how education is approached and to redesign the whole process. (Garrison & Kanuka, 2004). The use of e-Learning to complement face to face learning also makes it possible to efficiently practice distributed learning (Luke et al., 2009) where rather than given a large concentrated amount of information in a short time frame learners have time to fully digest the information, in theory getting more from the experience.

3.6.2 Time and Geography

Another common trend among the IPE literature reviewed is the initial driving force behind the decision to pursue e-Learning (including Blended Learning). The decentralised nature of eLearning along with its ability to fit into busy schedules seems to be the predominant reason for its initial consideration. In Canada while organising online dementia care training for healthcare teams MacDonald (2006) found the large amount of clinics and their wide distribution posed a significant challenge but that eLearning provided the solution. Proving to be an effective way of delivering educational programs that allow post-qualification healthcare learners to come together in a virtual environment to discuss and share information and experiences about IPC (MacDonald et al., 2006). In Finland it enabled discussion and collaboration between students and professionals that were located in different parts of the country (Juntunen & Heikkinen, 2004). Other literature however while acknowledging these advantages offer additional reasons for adopting e-Learning. Casimiro et al. for example mentions time and geography but adds that e-Learning can also help mitigate problems caused by “assorted professional backgrounds and differing levels of educational aptitude, literacy, experience, and seniority” (Casimiro et al., 2009). Also related to the time geography driver is that training becomes less disruptive and it seems to create an easier transition between learning and work (Thompson, 2003 cited in Casimiro et al.,

2009). Gordon et al. also list it as “overwhelmingly” the prime driver, what they term in their paper as “From Logistics to Learner Autonomy” which includes the advantages already mentioned like time and geography but adds the ability of offering additional resources for students to use according to their own perceived needs and the ability to replay resources. However he goes on to report that once engaged in the process of creating content, the lecturers whom participated in the study, found e-Learning offered further learning opportunities (Gordon et al 2010). These opportunities will be discussed below in more detail.

3.6.3 Teamwork

Many of the subthemes mentioned by Thistlethwaite and Moran under the teamwork heading emphasise cooperation and collaboration. A 2010 study (Gordon et al) of lecturers who had been given time to develop IPE e-Learning resources with the assistance of learning technologists under secondment to the Centre for Interprofessional eLearning (CIPeL) also recognised the importance of these outcomes. The lecturers utilised the constructivist approach of online discussion and scenarios to enable students to develop new perspectives through the exchange of ideas and active learning to foster collaboration. Participants in the study spoke about developing collaborative skills in their students through the planning of interactive activities for multidisciplinary groups. They used techniques to encourage students to bring their own experiences from practice (Gordon et al. 2010). Luke et al outline the 5 elements underpinning their strategy of achieving Cooperative Learning.

- Positive Interdependence: The process of working in teams to build collective knowledge. They achieve this through online discussions.
- Face-to-Face promotive interaction: Activities such as discussions, debates and joint decision making. They use asynchronous discussion like forums for these activities. They also highlight the importance of the instructor as a facilitator to maintain focus and lead the discussion when necessary.
- Individual accountability: Each participant is accountable for being a full member of the Interprofessional team. Techniques they use to promote individual accountability include reflective practice, peer assessment and peer review as well as mentorship.

- Interpersonal and small group skills: They achieve this through the use of Case Studies that participants can work through with their colleagues.
- Group processing: Participants reflecting on their practice, learning and knowledge. This is done both individually and in groups through the use of learning portfolios. (Luke et al., 2009)

3.6.4 Roles/Responsibilities

Luke et al. take a number of approaches to the education of participants about roles and responsibilities. They observe encouraging learners to understand their own roles and the roles of others can best be achieved through critical reflection of their own prior knowledge, attitudes and skills. They have a novel way of helping participants to engage in this process which will be outlined in the Ethics and Attitudes section below. Their main focus is on Problem Based Learning (PBL) and Case Studies but they also make use of didactic methods either through text or video, learner to learner discussion (either using forums or face-to-face) and learner to mentor discussion. Participants also had to make interprofessional care plans. They were specifically instructed to incorporate other health professionals' points of view in these plans. (Luke et al., 2009). Barrett et al. (2003) recommend that IPE modules are planned by an interprofessional team. In this way the planning process includes the sharing of professional perspectives (Juntunen & Heikkinen 2004). Juntunen & Heikkinen also highlight the importance of the facilitator in creating an interactive, approving social and communicative atmosphere. In IPE open communication and a shared understanding of each others' roles is an important part of meeting the many challenges posed by the diverse needs of learners (Hoover et al., 2000 cited in Juntunen & Heikkinen 2004). The outcome of effective communication is achieved by incorporating it into every activity. Gordon et al. tells of how participants were expected to communicate with the group and share insights from their own experiences (Gordon et al. 2010). Particularly interesting from the perspective of this work is the Allan et al. proposal that the conceptual framework of the ICF makes a valuable contribution to education in healthcare through its use as a language to provide a common ground for interprofessional and international communication. Ultimately, a strong foundation in the principles exemplified by the ICF may serve to enhance interprofessional communication and learning, and in so doing, encourage involvement

in interprofessional care (Allan et al., 2006). Luke et al outline the advantages of communicating through asynchronous forums while engaging in Case studies and problem based learning activities as the students are left with a full record of all communication activity (Luke et al., 2009).

3.6.5 Learning and Reflection

Luke et al. propose the use of a portfolio or a journal throughout the learning process. This portfolio is then used by the participants to reflect on their practice, learning and knowledge and is done both individually and in groups (Luke et al., 2009). Casimiro et al. observe that the asynchronous components themselves can promote reflection and facilitate critical thinking (Casimiro et al., 2009).

3.6.6 Patient/Service User

Gordon et al. outline the ability of e-Learning to bring “the patient/service user into the classroom” or the learning environment. They talk about the importance of giving the service user a voice in the education and ensuring they are central to the learning. They talk about e-Learning’s ability to include “hard to reach” individuals due to health or social circumstances.

3.6.7 Conclusion

In conclusion to this review of what is a large and growing body of research a number of observations can be made from the approach to e-Learning by practitioners of IPE that could be of use to online AT education. The use of Scenarios, Case Studies, Problem Based and Experiential learning activities particularly as group work is certainly an approach that should be adopted. Gordon et al. observation about the need for authenticity in this kind of learning content was of great importance. In dealing with a broad range of professionals there can be occasions where people don’t see the relevance of the instructional content to their professional role. However there is also a danger that creating scenarios and learning materials that are relevant to a broad range of professionals could result in materials that seem contrived and lack authenticity. (Gordon et al 2010). Other points made by Gordon et al were the importance of learner autonomy and collaboration, the use of constructivist and adult learning theories. Luke et al use of a portfolio or journal to aid reflection on learning should also be

incorporated. They also highlight the importance of the instructor as a facilitator to maintain focus and lead the discussion when necessary (Luke et al, 2009). In all studies there seemed to be a preference for a blended learning approach rather than pure e-Learning. Didactic online content was often used as preparation to supply students with background knowledge to prepare them for interactive discussion that would take place either online also or in the classroom (Gordon et al 2010). Although the term isn't mentioned here this practice has come to be called "Flipped Learning" and is rapidly gaining popularity. Finally the suggestion of using the ICF as a common language to enhance interprofessional communication and learning (Allan et al, 2006) is of particular relevance to AT.

3.7 IPAT Case Study

Synchronous distance AT training and hardware demonstration using Videoconferencing and Web Conferencing.

3.7.1 Background

The Interagency Program for Assistive Technology (IPAT) programme has been in operation in the state of North Dakota since March of 1993. The aims of this programme are to *"increases access to assistive technology in North Dakota by engaging in activities that raise awareness, disseminate information, provide training and assessments, work with policy makers, loan equipment for trial-use, and demonstrate assistive technology (AT) devices to individuals of all ages with disabilities and those experiencing the effects of aging throughout the state."* (IPAT, 2012). What is of particular interest to this paper is how they conduct distance training on the operation of dedicated AT hardware devices. As has been highlighted earlier in the paper, this is one area of potential difficulty for an online AT courses.

IPAT utilise videoconferencing technology to provide a comprehensive training service to a large and sparsely populated geographical area by a small team of 7 people. In a recent Rehabilitation Engineering and Assistive Technology Society of North America (RESNA) Webinar Ms Peggy Shireley of IPAT outlined how they provide quality AT services with the aid of ICT. Their reasons for taking this approach to service delivery were outlined and are some of the usual drivers.

Table 1: IPAT drivers for distance training.

Cost Effective	Enhances Efficiency
Eliminates travel time.	What took a day onsite takes 1-2 hours.
Eliminates mileage costs.	Provides an introduction of needs beyond paper reports.
Eliminates mailing costs of inappropriate equipment choices.	Makes device feature match more accurate.

The focus of the webinar was on the use of synchronous tools for distance assistive technology demonstrations and it was titled Conducting Distance Assistive Technology Services. All direct quotes used are either from the webinar or follow up emails with Ms Shireley. Transcript and emails are in APPENDIX B. The two most interesting aspects to what IPAT are doing in terms of this dissertation are;

- The use of videoconferencing and web conferencing to deliver training and demonstrations on specialist AT hardware
- How the loan library service is utilized for this training.

3.7.2 Videoconferencing and web conferencing

IPAT have two main centres with approximately 300km separating them. Both of these centres are equipped with dedicated videoconferencing facilities. The Video Conferencing system they use provides high definition sound and picture quality. It can either be “one to one”, “one to many” or “many to many”. They also have some specialized equipment that can bridge home users and conferencing sites together Ms Peggy Shireley went on to outline the main positive points of the system.

- Ease of use: Plug-and-play and requires little technical support.
- Flexibility: Plenty of options for different groups.
- Clarity: *“Picture quality is good, clear, especially when you're doing some screen sharing or demonstrating devices, it's wonderful.”* (Shireley, 2012).
- Reliable: Problems are infrequent and quality is generally consistent.

For balance she went on to mention some issues they had experienced like voice and video not being synchronised or video freezing but these were generally resolved by hanging up and restarting the call. In comparison she went on to discuss web

conferencing, in this particular case she was talking about Skype. She listed the advantages and disadvantages as being:

Table 2: Advantages and disadvantages of web conferencing.

Advantages	Disadvantages
Affordable	Reliability
Intuitive	Quality
Convenient	Internet speeds

She concluded by saying that even though there was no comparison between Skype and videoconferencing in terms of picture quality they frequently used both tools. It was just a matter of judging the requirements of the particular training. *“you need to filter through what is the real purpose of my connection here? If it is demonstrating a device that has a lot of components and small details or sharing -- teaching someone a software program, Skype would not be my preference.”* (Shireley, 2012)

3.7.3 The use of an AT loan library for delivery of distance training with specialist AT hardware.

IPAT make extensive use of an AT equipment loan library. This is the second interesting aspect of their training that could be a model worth replicating. Ms Shireley didn't talk much about this aspect during the webinar but when contacted with a few questions she was very helpful and forthcoming with information. When asked how the loan library facilitated training she replied;

“..when we are training someone to use augmentative communication devices (LightWriter; Dynavox products etc). We typically send the device(s) they are most interested in learning to the remote site so that both IPAT staff and the recipient of distance training, plus their speech language pathologist are actually touching and manipulating the same device. Sending a device to the remote site is also becoming standard when we do distance training for someone new to the use of the iPad and specific applications; there is nothing to replace the guided instruction with a device in hand, and videoconferencing allows us to do that effectively and efficiently.”

Universal Design for Learning is about using all the senses and it is quite obvious that the sense of touch is being neglected when using distance education. Obviously when dealing with software applications this can be less important. There are also the

possibilities offered by providing virtual desktops or screen sharing for software, hardware on the other hand is a much more difficult task. The solution offered by IPAT could be a cost-effective way of offering quality hands on training with dedicated AT hardware thus compensating for this deficit of e-learning.

3.7.4 Conclusion – What was learned from IPAT?

The IPAT service had much in common with Enable Ireland AT Training Service and it can be assumed many other small AT services around the world. They are all being forced into moving their training online for similar reasons, namely small teams with a large geographical area to cover on ever decreasing budgets. Videoconferencing is a service that is available in many medium sized organisations and one that is often underutilized (Misra, 2005, Robinson, 2002). The increased detail and resulting greater sense of the equipment being demonstrated would compensate for the reduced convenience of having to travel to a videoconferencing site. From Ms Peggy Shireley experiences it would appear that web conferencing is probably not reliable enough or of sufficient quality to conduct equipment demonstrations and should only be used for certain equipment and then only if there is no other option available. Their use of the AT loan library is also very interesting as it parallels Enable Ireland somewhat. It also opens the opportunity to use lower fidelity web conferencing by enabling both parties to have the physical equipment in the presence. While Enable Ireland is not currently operating a loan library it has done so in the recent past and much of the infrastructure still remains. This could be a particularly useful strategy for dedicated AAC devices that are expensive, complex and quite specialised. There are also the advantages that “hands-on” learning offer in terms of effectiveness and retention of information. This is an area of UDL that e-learning has obvious shortcomings in. It has been shown that hands-on activities enhance cognitive learning. Technology education has a strong basis in learning theory in the use of hands-on activities to relate technological concepts. Actually using the device will improve short and long term memory retention of information through greater use of visual, auditory, tactile, and motor memory storage areas of the brain (Korwin & Jones 1990).

3.8 Conclusion

From this lengthy chapter the requirements and methods of delivery of an AT course have been identified.

An AT course should provide;

- A common foundation in all areas of AT to all participants with the option of pursuing additional areas of personal or professional interest. This idea originated with TELEMATE and was progressed by KPT “Guide for Lifelong Learning in Assistive Technology”.
- Multidisciplinary problem based learning, different professionals learning with and about each other through Scenarios, Case Studies, Problem Based and Experiential learning. In all these cases the authenticity of the content is important. These techniques should follow the common foundation.
- Training on the roles and responsibilities within an AT team. This was highlighted by Boyle et al. and came up as a significant theme within IPE.
- A blended approach, some face to face elements are recommended. This was confirmed by the KPT study and by findings of best practice in IPE.
- Hands-on experience with technology but as was demonstrated by the practices of IPAT this too can be achieved through distance education.
- A strategy for recognition of prior learning should be adopted as suggested by the KPT. This could be incorporated into an e-portfolio. The Mozilla “OpenBadges” project could be one way of achieving this (Mozilla 2012)
- A learning journal or portfolio to be maintained by each participant to promote reflective practice. As suggested by KPT. A progression of this technique is the social peer review aspect suggested by VATU. In effect an e-portfolio.
- Differentiated instruction to accommodate different learning styles. Suggested in the KPT “Guide for Lifelong Learning in Assistive Technology”.

The following chapter will explore the technology that can be used to achieve these goals. First an appropriate design mythology will be selected, followed by an LMS. Following that the remainder of the chapter will investigate strategies for dealing with the biggest potential difficulty for AT e-Learning, ensuring accessibility for all course participants.

4 DISTANCE EDUCATION – E-LEARNING

4.1 Introduction

The Web-based nature of the courses also allows the instructor to bring together a “critical mass” of participants without the need for extended travel, which is a concern for the educators located in the rural areas of the country (Kuech & Kimball, 2003). The decentralised nature of e-Learning along with its ability to fit into busy schedules seems to be the predominant reason for its initial consideration. Although these are the prim drivers for organisations to start into e-learning the soon appreciate how it offers further learning opportunities. This journey from “Logistics to Learner Autonomy” and continues beyond what had originally been considered. (Gordon et al 2010). Developing an online course requires instructors to think about teaching and learning in a new way because this new medium has different strengths and weaknesses (Fish & Wickersham, 2009). Some of the differences between e-learning and class based learning are e-Learning is predominantly asynchronous (but not always). Participants enjoy greater flexibility as a result. Online discussions are generally non-linear, requiring students to juggle several conversations at once (Picciano, 2002 in Cashman, 2012). Online discussion forums people participate in multiple conversations simultaneously also when working online people have vast resources of information instantly available to them. The biggest challenge when coming to on-line instruction from classroom instruction is learning to think differently to take full advantage of the new medium. In this chapter a design methodology and a Learning Management System (LMS) will be selected. The potential difficulty of accessibility will be examine, first in terms of the specific LMS chosen but also for e-Learning in general through a case study of the creation of an accessible e-Learning module in an Irish context. Finally Universal Design for Learning will be investigated as a potential solution to the accessibility problem and as a potential pedagogical strategy.

4.2 The ADDIE Model

The ADDIE (Analyse, Design, Develop, Implement and Evaluate) Model is a generic and simplified design methodology that provides a foundation upon which most recent instructional design models associated with the design of e-learning are built (Irlbeck

et al 2006). According to Michael Molenda of the University of Indiana it “*is merely a colloquial term used to describe a systematic approach to instructional development, virtually synonymous with instructional systems development (ISD).*” (Molenda 2003). Both the broad and iterative qualities of the ADDIE model proved suitable for this particular project.

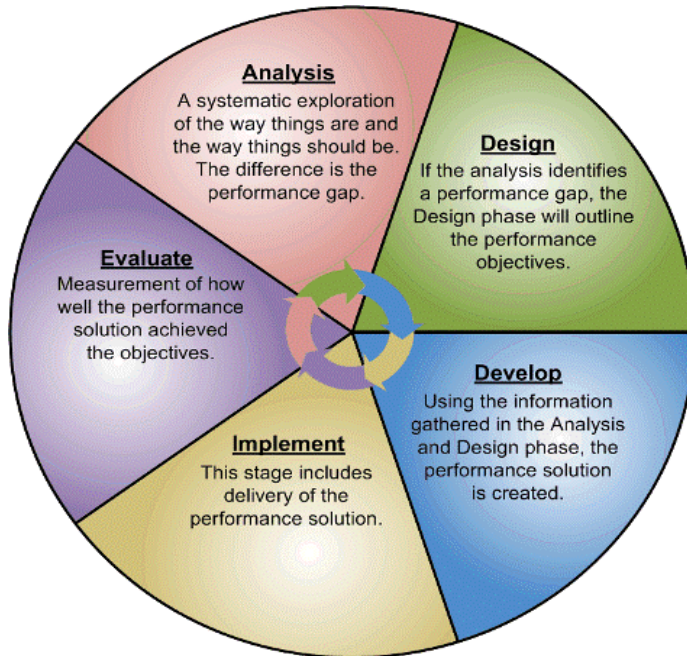


Figure 7 Diagram illustrating the stages of the ADDIE Model and illustrating its iterative nature

4.3 Learning Management System – Why Moodle?

One of the most important decisions to be made before embarking on the development of a framework for providing Assistive Technology training as e-learning regards choosing the most appropriate vehicle with which to deliver that training. The combination of software and hardware used to host courses online is often referred to as a Learning Management System (LMS) although the terms Course Management System, Collaboration and Learning Environment and Virtual Learning Environment (VLE) are also used interchangeably. There are a host of such systems available both Open Source Software (OSS) and proprietary and when choosing a LMS this may be the first of many decisions to be made. In general, obviously the big advantage of OSS is that there is no financial outlay for licensing. It also tends to require more technical expertise and can be poorly supported. Proprietary software on the other hand is often easier to use and better supported but at a price. This generality however does not seem

to hold true when it comes to LMS, at least in a couple of cases. Two studies have been identified that compare user experience of OSS Moodle to proprietary Blackboard; Bremer & Bryant (2005), Machado & Tao (2007) with Moodle come out on top each time. With this said it is not the purpose of this paper to extol the benefits open source over proprietary software it has however been decided for two reasons that only OSS LMS will be considered further;

1. Insufficient conclusive comparison studies of proprietary LMS within literature were located (with the exception of BlackBoard).
2. It was deemed inappropriate that a proprietary platform be used as it may exclude those organisations with insufficient funds to pay for licensing.

As sufficient resources or time are not available for the thorough testing needed to perform a proper comparison of LMS and it is somewhat beyond the scope of this paper a number of papers have been reviewed to identify comparisons that have been made. Only those conducted within the last four years (since 2008) have been considered and results are weighted in favour of recent comparisons. Three detailed comparison studies between OSS LMS were identified. A study in to virtual learning platforms used in Spanish universities showed that Moodle was both the most popular and the one that preformed best in tests (Bri et al., 2009). Al Ajlan made a comparative study between Moodle and other VLE systems based on two kinds of comparison. The first phase was based on the features and capabilities of VLE tools, and the second one was based on the technical aspects of VLE systems. He concluded that optimal VLE platform was Moodle (Al-Ajlan, 2009). These findings were supported by a similar Indian study (Kumar et al., 2011).

More reasons for choosing Moodle

1. Features/Interactivity – Moodle is built on a social constructionist approach and facilitates interaction between course participants, between participants and instructors and allows differentiated learning. This pedagogical style and features have previously been highlighted as appropriate for delivering AT education.
2. Popularity/Reach – Moodle at the time of writing is powering 66, 356 registered sites in 215 countries and available in 75 languages. It has 1, 180, 564 registered users (Moodle.org, 2012)

Due to the favourable comparisons and the two reasons outlined above Moodle has been chosen as the most appropriate LMS.

4.4 Potential Difficulties – Accessibility

There are two distinct aspects to accessibility when it comes to a Learning Management System. An LMS is content management system specifically for learning content so these two aspects to accessibility must be dealt with differently. First of all there is the site itself, in this case Moodle 2.2. The first part of this section will examine the accessibility of Moodle 2. A detailed accessibility evaluation was conducted by Greg Kraus of North Carolina State University in late 2011 (Kraus, 2011) where he identified and rated in terms of priority to fix a total of 72 accessibility issues both major and minor. That accessibility evaluation was accepted by Moodle HQ and the development community and a total of 62 Sub-tasks have been created in the Moodle Bug Tracker MDL-27843. Where issues have been identified possible workarounds will be suggested. The VLE site itself consists of various components. The main components of Moodle are Navigation, Resources, Activities and Blocks. The purpose of Navigation is self explanatory. The other three components are tools that are used to either create and present content or consume content depending on the user's role within the VLE. Although there are many possible roles within Moodle for the purposes of this paper only two will be considered, the teacher role and the student role. A teacher is a user with the rights and permissions to create courses and topics. This is the second aspect to an LMS. As far as accessibility is concerned an LMS is only as accessible as the content it contains. If the site itself is accessible but non-accessible content is added the LMS will not be accessible. A LMS is a unique environment when it comes to content in that all participants are content creators whether they are students or teachers. Teachers however have much more power in this respect and will be responsible for creating the majority of the material. Having said that the student will also be responsible for contributing content to the LMS and we must ensure that this content is also accessible. This creates a number of challenges when ensuring accessibility. An online Assistive Technology course must be a best practice example of accessibility. Insuring the accessibility of content created by course participants however is outside the scope of this paper although it has been highlighted as an area of further work.

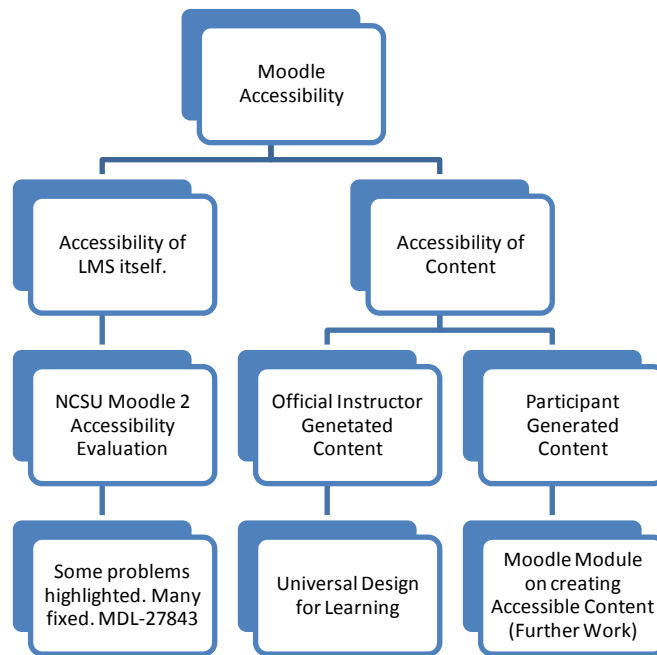


Figure 8: Illustration of the complexities of accessibility in an LMS

Some of the requirements might seem to be contradictory. In this regard an example often given is the need of someone with dyslexia for visual type content and the need for more text based content for someone who is visually impaired. Well coded web sites and applications will provide the flexibility to accommodate both individuals easily however. In order to understand the accessibility requirements of e-learning in practice in an Irish context a Case Study on the National Disability Authority recently completed e-learning module on Disability Equality was carried out.

4.5 Case Study – NDA, Creating an Accessible E-learning Module.

The National Disability Authority (NDA) recently created an e-learning module designed to provide Disability Equality training to public sector staff in Ireland. This module was officially launched on December 2nd 2011 and is being made available to the public through the eLearning section of the NDA website at <http://elearning.nda.ie/>. It is also available as a standalone module that has the capability of being incorporated into organisations existing Learning Management System (LMS). This is achieved through compliance with the Sharable Content Object Reference Model (SCORM) standard that allows interoperability of learning content between different LMS. This case study will examine the process used by the NDA in creating this

eLearning module. It is not intended to be a critical analysis of the pedagogical style used, quality or accuracy of the information contained. Rather it is concerned with the method used by the NDA throughout each stage of the design process to ensure that the finished product is universally designed and therefore as accessible and usable as practicably possible. This could be considered an ideal eLearning project to study from the context of accessibility and Universal Design for a number of reasons. First and foremost it is all created within an Irish context and obviously because of who the NDA are and who they represent one can safely assume that accessibility is very high on their agenda and therefore when producing these eLearning materials it was considering through all stages of the design process. This has been proposed as being the most effective and economical way of ensuring accessibility (Asakawa, 2005). The considerable resources available to the NDA should also be taken in to account. These could include their status as an independent state body with the financial backing of the government and their close links with disability advocacy organisations. Also within their own organisation they have significant resources in terms of experience and technical expertise as well as their association with the Centre for Excellence in Universal Design. For all these reasons their approach to the creation of accessible eLearning materials could be considered an example of best practice and as such that will be the focus of this Case study.

4.5.1 Production Process

This section will look at the key elements of the process used the NDA to produce an accessible eLearning resource that are relevant to this study. Therefore there is a focus on the initial Specification Document, Accessibility and User Testing. As it will be seen below that it is in their success in these key areas that the NDA ensured the overall realisation of their goals.

4.5.2 Tendering and the e-Learning Specification Document

The detailed tender document (APPENDIX C) gives a weighting of 50% in favour of the bidder who can demonstrate either through previous experience or through a clearly outlined technical strategy and inclusive design process that they can deliver the required results. In order to clarify these requirements accompanying the Tender document was an eLearning Specification document (Appendix D) and they also made

the ISO/IEC 24751:2008 "*Information technology- Individualized adaptability and accessibility in e-learning, education and training*" document available to interested parties. The ISO/IEC 24751 standard offers a framework and reference model, plus “*access for all*” criteria on personal needs and preferences, and a digital resource description. It is split into three parts. The first part provides a common framework that facilitates the matching of learner needs and preferences and with the corresponding the digital learning resources. In effect a guide to help developers make the correct decisions when choosing interface tools and digital learning resources and ensuring they are appropriate for their users. The second part provides a common information model to describe how a user desires to access online learning content and related applications. It includes how needs and preferences can be ranked with respect to priority, and the use of generic and application-specific needs and preference specifications. The final part provides a common language for describing aspects of a computer system (including networked systems) to facilitate their being matched to learners' accessibility needs and preferences. This part also describes application information scenarios and gives informative implementation examples (ISO, 2009). In many ways the eLearning Specification document is the key to the NDAs successful realisation of their goals respect to accessibility and usability.

The eLearning Specifications document clearly lays out what the NDA wanted in terms of functionality, usability, compatibility, adaptability and accessibility. If followed these specifications would ensure the finished product closely adhered to the Principles of Universal Design and the WAI WCAG 2.0 guidelines on accessibility. Although unlike the WAI WCAG 2.0 Guidelines the Principles of Universal Design or UDL are not specifically referred to, it is clear that that they informed the content of this document. Below is a synopsis of the document with analysis where relevant only areas of particular interest to this dissertation are examined.

General Functions

Here the general outline of functionality that is expected is laid out.

- Self-paced, allow the user to stop and resume from their previous location, allow the user control over all media clips used (stop, start, rewind etc.), allow the user choose their own personal navigation path through the

module. (UDL Guideline 4; Checkpoint 1), (UDL Guideline 7; Checkpoint 7).

- Provide Help facility (UDL Guideline 5; Checkpoint 3).
- Provide a progress indicator so a user can judge what chapters have been completed and what chapters are outstanding. (UDL Guideline 6; Checkpoint 1, 2, 3, 4)
- Include a 'companion handbook' to provide guidance (pdf and XHTML) (UDL Guideline 1; Checkpoint 2, 3)
- Customisable - ability to choose text size and it offered high contrast and a blue background as well, text only and default. (UDL Guideline 1; Checkpoint 1)
- Glossary, with entries linked from the main text (UDL Guideline 2; Checkpoint 1, 2, 3, 4)
- No restriction the time taken for any user to complete the module.
- Capable of being localised into other languages. (UDL Guideline 2; Checkpoint 4).

E-Learning approach (front end specifications)

This section outlines some of the requirements for the user facing front end (relevant to this dissertation).

- Module must be self contained
- Use a 'Case Study' approach.
- Use embedded continuous assessment. When questions are answered incorrectly trainee must be directed to review relevant section and repeat the questions. (UDL Guideline 8; Checkpoint 4) (UDL Guideline 3; Checkpoint 2, 3, 4)
- A range of techniques to assess the trainee's knowledge and understanding should be used. (UDL Guideline 4; Checkpoint 1) (UDL Guideline 5; Checkpoint 2)

Video/Animation

There should be use of video or animation in order to help engage the user and facilitate different learning styles (UDL Guideline 2; Checkpoint 5). All video or

animation clips must have text descriptions available electronically (WCAG 2.0, Success Criteria 1.2.8, UDL Guideline 1; Checkpoint 2, 3). Video and animation pieces should in no way be considered stereotypical or cause offence.

Access and authentication model

- Authentication model must be secure yet simple and not prove to be a barrier for use by non-technical user.
- The authentication model must allow for self-paced learning.

Accessibility

The e-Learning specification document also gave a brief outline of the importance of accessibility to people with various disabilities but also to the general target audience at large. They then point to two resources that are available to aid the bidders in their efforts in this regard. They again mention the standard ISO/IEC 24751 on Information technology - Individualized adaptability and accessibility in e-learning, education and training discussed earlier. Finally they specify “*The system must meet WAIWCAG 2.0 guidelines for web accessibility.*” And list some of the key guidelines (WCAG, 2008); They then emphasise the point through the following passage. “*This list is not comprehensive. Suppliers are advised not to underestimate the effort involved in ensuring a high standard of accessibility is achieved....*”

Technology

The final section of the specifications document deals with the technology used for delivery. Rather than providing hard and fast guides this is left more open. It does specify browsers the module should effectively run in and that it should operate successfully in managed Terminal Server' environments, such as Citrix. It also highlights the potentially closed IT environments that the module will be expected to run in and although not openly prohibiting the use of technologies like Flash and Active x strongly hints that alternatives should be sought.

4.5.3 Accessibility

It can be seen how the NDA used the eLearning Specification document to clearly lay out their stall in terms of what they expected from the eLearning provider. (This

document could be considered a good specification for the production of any accessible e-Learning). In this section some of the difficulties that were encountered, decisions taken and compromises made by the NDA in partnership with the eLearning providers in order to achieve the highest level of accessibility possible will be examined.

Probably the first and most important decision taken was on the technology to be used for the delivery of the eLearning module. Choices include html, flash, java, and java-script or combinations of each and may also include elements of audio, video, PowerPoint (Smith Nash, 2005). There are of course other options but they would involve the use of some manner of “player” application and this was ruled out in the specifications document. HTML was decided on as being the most accessible method of delivery or rather a combination of HTML and java-script. This is in line with the technology specifications and also in line with WAI WCAG 2.0 Guidelines. One of the more challenging aspects of this project was the balancing of interactivity with accessibility. Many activities frequently used to engage learners such as “*click to reveal*” exercises were not possible to replicate to users experiencing the module using a screen reader. In order to create a finished product of equitable use (Principle: 1) some compromised had to be made in this regard. The use of embedded video always caused difficulty in regard to accessibility. Firstly the controls are not always keyboard accessible. They chose to use Windows Media Player (WMP) to embed the videos in this module. This player is keyboard accessible when used in Internet Explorer but not in any other browser. To overcome this difficulty a link (Figure: 9) is provided allowing the user to download the video and play it in a standalone media player.

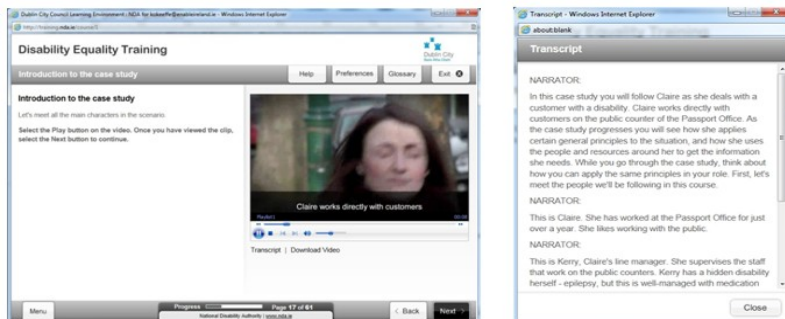


Figure 9: User is provided with a link to the video file and play it in a standalone media player (left) and the window that pops up containing transcript of audio in the video (right).

Most standalone players support keyboard accessibility and since this course was designed to be used through Microsoft Windows OS it could be assumed that the system had the WMP installed as it comes with the OS. Another difficulty caused by the use of video are the added requirements of text description, audio description, subtitling and Irish Sign Language (ISL) translation. To achieve full AAA compliance all these accommodations must be made. For AA compliance there should be Audio description, subtitling and a Text description and A compliance just a text description and subtitling. In this case videos were scripted so as to avoid the need for audio description. While this has the result of making the video content accessible to a large extent it does not satisfy the guidelines. The decision not to use ISL may have been down to cost. The end result is that the video content in this module would have an A rating as it contains subtitles and a text description (the transcript of the script was used as a text description and might require additional context information to fully satisfy the guidelines). This demonstrates how difficult it to achieve a full AAA. Although this full level of accessibility is an aspiration it is acceptable to have AAA where possible and state the areas where is hasn't be fully achieved. For example *“This e-Learning module has Triple-A Conformance to Web Content Accessibility Guidelines 2.0 except page 5, 10 and 15”*. Other accessibility features contained in this module are the Display preferences (Figure: 10) which include a text only option as well as High Contrast and Low Contrast.

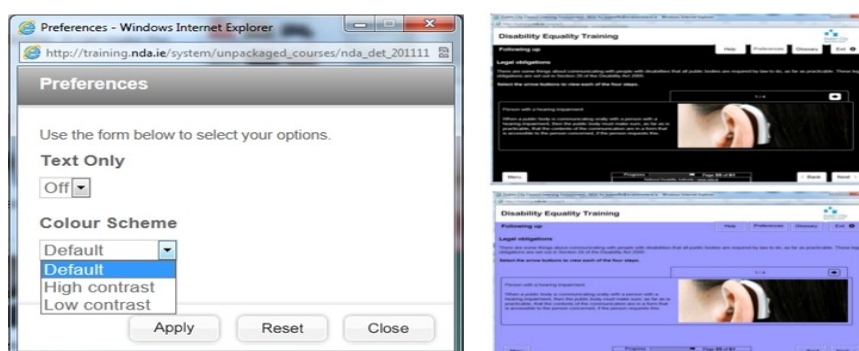


Figure 10: Dropdown menu of display preferences (left) offering default, high contrast (top right) and low contrast (bottom right).

4.5.4 User Testing

User testing was made available to tender (Appendix E) to third parties. There were only two bids and the contract was won by the Centre for Inclusive Technology

(CFIT). There are obvious advantages to having an independent organisation conduct user testing over allowing the developer conduct their own user testing in house. CFIT being accessibility experts and also having no investment in the development process could be relied on to conduct stringent testing. They also have experienced testers with a wide range of expert AT users available to them. The disadvantage would be the extra load in terms of project management caused by bringing in a third party. CFIT arranged for 15 testers, a mix of target audience and people with various disabilities to conduct tests. As would be expected the tests threw up several issues relating to accessibility and usability and it was expressed that it would have been better if it had been possible to start testing earlier in the design process. Because testing was done so far into the development process there were issues identified that simply could not be fixed and compromises had to be reached.

4.5.5 Analyses and Reflection

In many ways process by which the NDA produced their eLearning module on Disability Equality could be considered best practice when developing an eLearning module with the aid of a third party developer. Below are the key actions in relation to this dissertation that ensured the successful delivery of this project.

- The detailed specifications document including accessibility guidelines that accompanied the tender was invaluable. Had they gone to a developer without this document the likelihood is that they would have had to settle for a finished product that did not satisfy their high accessibility standards. The NDA had the technical expertise in house so it was easier for them to draw up these specifications. If an organisation did not have the technical expertise it would be worth a considerable consultation fee to have a document like this prepared for them before undertaking a project of this kind.
- Using a specialist accessibility user testing like CFIT will ensure a higher level of accessibility. It comes at a monetary cost but also a cost in terms of managing relationships. One organisation testing another may cause an increased workload in terms of project management.

Parts of the process that they would have done differently were or features they will change in future modules;

- Conduct user testing earlier in the design process. There were two major usability issues regarding the question and answering process in this module that were highlighted by the user testing;
- They proposed creating questions first using a web service like SurveyMonkey and again to begin testing much earlier in the design process.
- They will stick to single answer multiple choice questions.
- They thought they should have possibly incorporated the ability to change the colour/style of the module (skinable).
- They should have used some kind of sound to signify the start and the end of the video pieces (useful for blind users).

Full conclusions as to what this case study means for the design of accessible AT e-Learning will be made at the end of this chapter. However what is becoming evident is that when it comes to creating accessible e-Learning a closer look at Universal Design or more specifically Universal design for Learning (UDL) is necessary.

4.6 Universal Design for Learning

As can be seen from the NDAs approach to e-Learning in the case study in the previous section accessibility goes hand in hand with a universal design approach if truly effective e-learning is to be created. The principles of Universal Design have come out of architecture, the term itself is attributed to architect Ronald L. Mace. Universal Design is the design and composition of an environment so that it can be accessed, understood and used to the greatest extent possible by all people regardless of their age, size, ability or disability (CEUD, 2012). Universal Design for Learning is an adaptation of the original 7 principles of Universal Design for use in education. The term is generally attributed to David Rose and Anne Meyer. In 1998 CAST (Center for Applied Special Technology) introduced the principles of UDL to the Council for Exceptional Children in the US which published a topical brief, Design Principles for Student Access, that is often cited as the first published paper specifically on UDL (CAST, 2012). In the following section there is a general introduction to UDL based version 2 of the guidelines (CAST, 2011) followed by a paragraph on each principle which will then be followed by a paragraph relating it to Moodle.

Universal Design for Learning (UDL) is a framework that seeks to address what is considered the primary barrier to fostering expert learners within instructional

environments. This barrier is identified as inflexible curricula, a “one size fits all” approach to designing learning content. UDL helps address learner variability by suggesting flexible goals, methods, materials, and assessments that empower educators to meet these varied needs. Curricula that is created using UDL is designed from the outset to meet the needs of all learners, making costly, time-consuming, and after-the-fact changes unnecessary. The UDL framework encourages creating flexible designs from the start that have customizable options, which allow all learners to progress from where they are and not where we would have imagined them to be. The options for accomplishing this are varied and robust enough to provide effective instruction to all learners. (CAST, 2011)

It has been discussed previously in this chapter how Moodle 2.2 as a LMS can (for the most part) be considered accessible in terms of the WCA Guidelines 2.0 or the USA’s Section 508. It was also discussed in that section that the nature of an LMS means that there are two distinct strands of accessibility. The LMS itself as an application and secondly the content that is added to that LMS. Making the content accessible is however the baseline and not nearly sufficient when it comes to educational content. As was learned from the NDA Case Study the implementation of the principles of UDL can elevate pure information to instructional content and in the process increases its accessibility. This is by no means to say that by implementing the principles of UDL one can ignore the WCA Guidelines. The two are in fact inextricably linked. The first step in implementing the principles of UDL is through good coding and observation of the WCA Guidelines. On occasion a conflict may arise between the WCA Guidelines and implementation of the principles of UDL. An example of this might be a course participant posting an audio recording to a forum. Giving the option of posting to a forum using audio satisfies UDL Checkpoint 4.1 (Vary the methods for response and navigation) and 5.1 (Use multiple media for communication) while at the same time making it inaccessible to a deaf course participant. One workaround to this situation might be to get other course participants to transcribe the audio, the advantage of this approach would be that it would also satisfy Checkpoint 8.3 (Foster Collaboration and Community). This is just one example of the many situations that may arise and it illustrates the need to take flexible and creative approach to the implementation of the principles of UDL and accessibility guidelines.

4.6.1 Principle I. Provide Multiple Means of Representation

Learners differ in the ways that they perceive and comprehend information that is presented to them. For example, those with sensory disabilities (e.g., blindness or deafness); learning disabilities (e.g., dyslexia); language or cultural differences, and so forth may all require different ways of approaching content. Others may simply grasp information quicker or more efficiently through visual or auditory means rather than printed text. Also learning, and transfer of learning, occurs when multiple representations are used, because it allows students to make connections within, as well as between, concepts. In short, there is not one means of representation that will be optimal for all learners; providing options for representation is essential. (CAST, 2011). Online education offers many options to provide multiple means of representation and Moodle as a LMS is one of the leaders when it comes to features and tools to support the implementation of UDL Principle 1. One means of representation that has proved useful in face to face AT education that even Moodle cannot offer however is touch (smell obviously would also be problematic but it is not a sense that is utilized to any great extent in AT training). Bespoke AT hardware is not as common as in the past due to an increase in the use of mainstream hardware with specialized software installed. It is however still used to some extent and there is no online alternative to a hands on session with specialized hardware. This is of course doubly true when it comes to users that are blind or have a significant visual impairment. In that case one minute holding the device and exploring it with their hands would probably tell them more than 10 minutes of audio or perhaps a couple of pages of text. Interviews with AT educators has indicated that they would all favour a blended approach to AT education so in that case there would be an opportunity to exploit the sense of touch in a classroom setting. A potential solution to this has been outlined in the AT education chapter through the IPAT Case Study. As said above Moodle offers many opportunities when it comes to representation of content so rather than dwelling on what can't be achieved below what can be achieved is outlined. Learning is obviously impossible if the information is imperceptible. As discussed above however where being perceptible might be sufficient for information like a timetable or a website a learning resource must be presented in a way that is also effective. If just perceiving the information requires an extraordinary effort then the additional effort required to actually develop an understanding may prove to be too

much of a barrier. This means that all information must be easily perceivable by all learners. As discussed the first step to this is valid well coded HTML. HTML can be easily converted by all assistive technologies and it can be easily adjusted by the user (magnification, high contrast alternative styles). The next step would be to provide the information through different modalities. Alongside the text could be an audio file that could be played with an embedded player or downloaded. A video (with subtitles or Irish Sign Language ISL), photographs and diagrams could be provided for more visual learners or those with literacy difficulties. Following this approach will not only make the content more accessible to those with sensory disabilities but also more effective as instruction for all. Information should also be understandable, by that it is meant that plain English should be used whenever possible. This is important for people with literacy problems but also non-native English speakers. The Glossary feature in Moodle is also a useful tool in this respect. The TextHelp and Point web apps that will be discussed in the next chapter are a great way of satisfying checkpoints in this area. Key points should be highlighted and reiterated to guide learning.

4.6.2 Principle II: Provide Multiple Means of Action and Expression.

Learners differ in the ways that they can navigate a learning environment and express what they know. For example, individuals with significant movement impairments (e.g., cerebral palsy), those who struggle with strategic and organizational abilities (executive function disorders), those who have language barriers, and so forth approach learning tasks very differently. Some may be able to express themselves well in written text but not speech, and vice versa. It should also be recognized that action and expression require a great deal of strategy, practice, and organization, and this is another area in which learners can differ. In reality, there is not one means of action and expression that will be optimal for all learners; providing options for action and expression is essential.(CAST, 2011). All Moodle actions are keyboard accessible. This allows other alternative input methods to be used. In the following chapter additional plugins will be investigated that will allow users to respond to forums and quizzes using audio. All deliverables required of participants do not necessarily have to be in written form. The idea of a web quest where participants are asked to find a video on YouTube on a particular subject or given the time maybe even create a video. Changing what is required of participants has been found to encourage the

involvement of different individuals who may not have participated so much in other tasks. Moodle's conditional activities and activity completion will be talked about in the coming chapter but it is mentioned here in terms of how it allows a Moodle course creator build fluencies with graduated levels of support for practice and performance. Depending on the tasks completed by an individual or the success with which they complete those tasks different activities can be offered to them. This allows their learning to be scaffolded. Mind mapping and concept mapping tools in Moodle will be appropriate for this section as are features like progress bars and checklists.

4.6.3 Principle III: Provide Multiple Means of Engagement.

Affect represents a crucial element to learning, and learners differ markedly in the ways in which they can be engaged or motivated to learn. There are a variety of sources that can influence individual variation in affect including neurology, culture, personal relevance, subjectivity, and background knowledge, along with a variety of other factors presented in these guidelines. Some learners are highly engaged by spontaneity and novelty while other are disengaged, even frightened, by those aspects, preferring strict routine. Some learners might like to work alone, while others prefer to work with their peers. In reality, there is not one means of engagement that will be optimal for all learners in all contexts; providing multiple options for engagement is essential (CAST, 2011). Principle III refers to the higher order of learning or the affective domain. Since Moodle is built around a social constructivist pedagogy it has many tools in its core build to satisfy this area of UDL. Learner autonomy is important in this section as are qualities like value and authenticity. The techniques from the literature review of IPE e-learning will all be part of this area of UDL. This is where the multidisciplinary teams learn about each other. This is where the Problem Based Learning occurs and this is where the reflection is done. Tools like the Forum and the Workshop can be used to cultivate collaborative practice through the development a common language and by promoting better understanding of the respective roles involved in the field of AT. The blog or a third party tool called exibis can be used to keep a reflective journal of ideas and learning experiences that can be shared with the group. The role of the instructor as a facilitator is very important in these activities. Timely and constructive feedback is most important.

4.7 Conclusion

In this chapter the ADDIE model has been identified as an appropriate instructional design model. Moodle has been selected as the LMS. The case study of the recent NDA e-learning project illustrated the importance of considering accessibility from the very start of a project. Although the NDA were dealing with external developers for their eLearning project their detailed specifications document clearly put accessibility and Universal Design as a top priority. Their use of the principles of Universal Design clearly elevated the end product beyond being purely accessible information into engaging instruction. Some of the strategies they used in their eLearning approach that will be of use in this project are;

- Learning should be Self-paced.
- The workaround for non-keyboard accessible embedded media player.
- Use a Case Study approach (where appropriate).
- Embedded continuous assessment. Assessment used correctly in this way is not only useful for evaluating the effectiveness of the learning content but is also a good way to highlight the salient points of the content covered. In UDL terms it is promoting two kinds of learning and satisfying numerous checkpoints.
- The recommendation to use different types of question is also in line with UDL guidelines and should be utilised.
- Authentication should not be a barrier. Moodle by default requires a password that contains a symbol, a number, a lower and upper case letter and be at least 9 characters long. This might be too complicated; it will need to be tested. The balance between security and accessibility however interesting is not within the scope of this dissertation.
- Technologies: As many public service institutions have restrictions on computers that don't allow the installation of external software technologies such as flash or active x may prove to be a barrier. HTML is a preference.

Finally the principles of UDL seem to offer a good fit for the Moodle LMS, they offer a strategy for accessibility and pedagogy that will be followed in the coming chapters.

5 STEP 1: TOWARDS UDL AT E-LEARNING

5.1 Introduction

In this chapter the ADDIE design methodology will be used to create a series of pilot modules. The complete cycle will be followed through and then in the following chapter the process itself will be adapted based on the outcomes of the evaluation. As the goal of this research is not to simply produce a finished instructional design but rather a toolkit to enable AT educators to do so in an effective and efficient manner, a more evolved and complex model would have been unsuitable. The ADDIE Model however provides enough structure to keep the design process on track while at the same time being loose enough for purpose. Although laid out in a linear chronological manner over the next number of pages in reality the ADDIE process as it was used here had a much closer resemblance to ADDIE as it is used in Rapid prototyping techniques. What is meant by this is that the design and development phases overlapped somewhat in order to save time (Stokes and Richey, 2000). The finished modules were in a sense Pilot (or Beta) Prototypes, while finished and working it was always the intention to redesign them according to findings of the evaluation. The design process itself was also part of the test. It is the intention to use the ADDIE Design methodology for future iterations but as a much more structured and formalised process. This structure will be informed by what is learned from this first iteration.

5.2 Analysis

In the first iteration the analysis phase was conducted in January 2012. The author met with Siobhan Long, Manager and Juliann Bergin, Lead Trainer of Enable Ireland's National Assistive Technology Training Service. During this meeting the reasons behind the proposed move of parts of the course online were discussed. Perhaps the biggest driver was that due to cutbacks there is increased time pressure on what would traditionally be the largest section of the course audience, therapists. An increased workload meant many of those who had expressed interest in attending the course found that they were unable to take leave for the 9 days required to complete the course. Additionally travel expenses proved problematic for some who were based outside of Dublin as budgets are being cut also. It was decided that making some of the

course available online would result in it being more accessible to busy professionals and also drive down costs for their employers. Another reason discussed was that the training service had recently been contracted to provide training to an outside organisation based in Qatar. It was felt that this additional revenue stream (which was very welcome in the current harsh economic climate) could be best exploited by the use of online content.

Already, before discussing the approach, three of the four reasons mentioned in the introduction for moving content online were present; Reach, Efficiency and Accessibility (here used in its broader meaning rather than referring to accessibility for users with disabilities). The remainder of the discussion revolved around the syllabus of the Certified Assistive Technology Training Course. It was agreed that 5 modules would be made available using the LMS Moodle to the participants of the 2012 course. The criteria for choosing the modules were twofold. Due to time constraints only content that lent itself to relatively easy conversion to online delivery was chosen however it was agreed that as many different methods of delivery as possible could be used as long as it didn't have a significant impact on the overall quality of the training. Although this resulted in a lack of consistency in the layout of each module and is contrary to the principles of UDL (Kumar 2006) it was decided that the impact could be mitigated through close monitoring and support. The potential benefits of following bad practice in this initial iteration were that it allowed for rapid progress to be made and provided the same amount of user feedback and data as four separate iterations had this principle of Universal Design been strictly adhered to. The implications of this will be discussed further in the later stages.

The modules chosen for the initial test were;

- Funding
- Assessment Models
- A Case Study
- Effective Use of Symbols
- Future Technologies

5.2.1 Who is the audience and what are their characteristics?

In the original “High Tech Assistive Technology Training Course” proposal which was made to DIT course participants would include “therapist, teachers, personal

assistants, technicians, engineers, IT Tutors and AT users/potential users.” and their prior learning experiences would range from “post graduate diploma level to secondary school level.” However it also clearly stated that “Academic achievement does not dictate course participation”. The course had been running a number of years since this proposal was made and in that time the audience has become even more diverse with the inclusion of third level disability officers, administration, managers, family members of AT users and community care workers. As would be expected from such a broad range of course participants the full spectrum of learning characteristics would inevitably be encountered. Teaching strategies must anticipate and accommodate the differing comprehension rates of learners because in general adults learn at different paces and in diverse ways according to their intellectual ability, educational level, personality and cognitive learning styles (Wynne, ASSET PROJECT). There being relatively high percentage of participants with physical and sensory disabilities on this particular course meant there was a need for additional support and accommodations. In the traditional face to face method this was achieved through the provision of additional staff that would be available to facilitate the class and assist the primary trainer. It was recognised at this early stage of analysis that there were a number of ways in which making content available online might in fact offer significant advantages to increase the effectiveness of teaching such a broad audience. For example what had previously been delivered in a lecture style in a one hour period would be available to the student for as long as they needed to properly process the information. Material could be made available to course participants in advance of face to face classes so that they could familiarise themselves with the basic principles of an unfamiliar subject. In addition to this, course materials made available in accordance to the principles of UDL would accommodate diverse learning styles of those who perhaps may not have felt comfortable acknowledging that they needed additional support in a classroom setting. The possibility of differentiated learning was also proposed at this early stage although it was acknowledged that this was not something that would be achieved in this initial test.

5.2.2 Instructional Goals and Learning Objectives of proposed Online Modules

Table 3: Outline of Module titles, Instructional Goals and Learning Outcomes

Module	Instructional Goal	Learning Objectives
Funding	Understanding of the central legislative and funding mechanisms which impact upon AT service delivery.	<ul style="list-style-type: none"> • Demonstrate an understanding of the Social Model of Disability and how informs the provision of funding in the context of AT. • Demonstrate an understanding of Government policy and the legislative context within which AT funding is situated. • The ability to identify sources of AT funding.
Assessment Models	Familiarity with assessment models that ensure that AT users and potential users are central to the AT decision-making process.	<ul style="list-style-type: none"> • Demonstrate an understanding of the HAAT Model. • Demonstrate an understanding of the SETT Model. • Demonstrate an understanding of the MPT. • Identify the context within which a particular model is best used or suggest ways in which a model could be adapted for use in different situations.
Case Study	Understanding of AT use in a real world situation.	<ul style="list-style-type: none"> • Apply knowledge of AT to a real life scenario.
Effective Use of Symbols	Understanding of the basic principles behind the use of symbols for communication.	<ul style="list-style-type: none"> • Demonstrate the ability to construct and decode a message communicated using symbols. • Demonstrate an understanding of the different levels of representation.
Future Technologies	Familiarity with emerging technological trends and how they could be used in future AT products.	<ul style="list-style-type: none"> • Demonstrate awareness of emerging technological trends. • Application of future technologies to current real world situations.

The instructional goals and learning objectives in the table above are those specific to those particular modules and should be considered as in addition to the goals of the course in general.

5.2.3 Module Content

It was the responsibility of the individual members of the training team to produce the content for each module. As each team member had previous experience in delivering the content for their particular module in a face to face setting they had strong ideas on how the topic should be structured. The structure of the online module however did not always reflect how it had been structured as a face to face session. More details on the design of the individual modules will be given below.

5.2.4 What are the delivery options?

Although it is not primarily considered an e-learning authoring application Moodle has a wide range of authoring options available. For reasons mentioned previously in particular regarding accessibility and a preference for open source alternatives (where available) only authoring tools that use HTML and that are available in the Moodle LMS were considered for primary content. The following resources were selected to be used on the initial test modules;

Table 4 Outline of Module title, Moodle Resource or Activity to be used and their features

Module	Resource/Activity	Features
Funding	<ul style="list-style-type: none"> • Web Page • Multiple Choice Quiz • Forum – Single simple discussion 	<ul style="list-style-type: none"> • The web page resource is self explanatory. The only modification made in this case was the addition of forward and back navigation buttons. • Single answer multiple choice questions were used to focus learning and provide feedback. Participants could retake the quiz as often as they wanted and their best score was recorded. • A single simple discussion type forum was selected where the trainer posted a question and participants answered.
Assessment Models	<ul style="list-style-type: none"> • Web Page • PDF files • Multiple Choice Quiz • Forum – Single simple discussion 	<ul style="list-style-type: none"> • Same as above. Simple webpage with navigation. • Extra content was provided on each subject in the form of accessible PDF files to allow participants to easily download the materials. • Single answer multiple choice questions (As above) • Single simple discussion type forum (As above)

Case Study	<ul style="list-style-type: none"> • Lesson Activity • Multiple Choice Quiz • Forum – Single simple discussion 	<ul style="list-style-type: none"> • The Lesson activity was chosen for the case study. The details of the lesson module will be discussed later. • Single answer multiple choice questions (As above) • Single simple discussion type forum (As above)
Effective Use of Symbols	<ul style="list-style-type: none"> • Lesson Activity • Multiple Choice Quiz • Forum – Single simple discussion 	<ul style="list-style-type: none"> • The lesson activity was chosen for the symbols module. • Single answer multiple choice questions (As above) • Single simple discussion type forum (As above)
Future Technologies	<ul style="list-style-type: none"> • Glossary • Book Module • Forum – Single simple discussion 	<ul style="list-style-type: none"> • Because of the nature of the future technologies module it was decided that it should have its own Glossary. • The book module, which is not core in Moodle 2.2 was selected, it will be discussed in more detail later. • As with the previous modules a single simple discussion forum was used.

5.2.5 What were the constraints?

The major constraint on the initial test modules was the time available to develop them. This was the main reason why the more complex but promising activities such as the Workbook and Wiki modules were not utilised and perhaps the Lesson and Glossary modules were not used to their full potential in the initial test. The tight deadline and steep learning curve meant they had to be left to the second iteration.

5.2.6 Requirements of course participants?

The two deliverables required of course participants were completion of all Multiple Choice Quizzes and participation in all forums. This will be discussed in more detail later.

5.2.7 Difference between classroom and web delivery

A lot of consideration was given during the analysis phase to the differences between how these particular topics would be delivered on the web as opposed to how they were delivered in class. As was mentioned previously these subjects were chosen because they had traditionally been delivered in a more didactic style. It was felt that

this would make them easier to translate to online delivery than for example a more hands on subject. In the case of the Assessment Models module the online content was very much supplemental to discussion and further exploration later in a face to face class. This was important as it was felt that it was a core area of the course. Most participants had no previous experience of the LMS Moodle and so a significant part of the face to face class time was given to walk them through the user interface.

In order to gain an objective view on the advantages and disadvantages of making training available online the PMI (Plus, Minus, Interesting) technique from the CoRT (Cognitive Research Trust) (De Bono 1985) was used. The results of this exercise are outlined in a table in APPENDIX G. What came out of this exercise was the realisation that most of the Minus points could be mitigated through good practice on the part of the training team and the use of the principles of UDL within the LMS. There were however outstanding negative aspects. The biggest concern to the training team was the fact that one of the most successful aspects of the Face to Face course was the presentations made by AT users. It was felt that although these could be replicated to some extent either by recording them on video or conducting a synchronous session using Skype or a similar service there would be a significant loss of impact. The second main difficulty envisaged was the hands on work with specialist hardware. Possibilities for resolving this second difficulty were explored in the IPAT case study in the previous section.

5.2.8 What are the online pedagogical considerations?

It was then discussed with the training team what pedagogical approaches were taken while delivering the selected modules in a classroom setting and whether they felt that similar approaches could be used for delivery online. As these particular modules were selected because they were primarily delivered with a didactic approach it was felt that a comparable approach could be adopted for the delivery of the main body of content online. More detail will be given in the following section on development. In all cases however the lecture was followed up with a group discussion and in some cases a problem based learning exercise, a case study or further reading. It was agreed by the team that the Forum activity if used correctly would be an ideal vehicle for the first two pedagogical approaches and links to web sites and documents would work for the latter.

5.3 Design

The putting together of the content was the responsibility of the individual trainers who had previously been involved with the delivery of classroom training. The instructional goals and learning objectives for each module were clear from the analysis phase. Previously these modules had been delivered verbally with the use of PowerPoint slides for key points and headings. The first task of the training staff was to transcribe this information. In three of the modules the PowerPoint slides were used as a guide in the completion of this task. Once this had been done the training team met with the original PowerPoint slides printed out and used them to create a storyboard of sorts to help plan the flow of the module.

5.3.1 Chunking

It was decided for a number of reasons that a reorganisation of two of the modules from how they had been presented in lecture format was necessary. The main strategy behind this reorganisation was to break them up into natural subsections. This process of chunking into meaningful parts both served a pedagogical purpose and a technical purpose. The pedagogical purpose was that it was felt that these modules were particularly wordy and that breaking them down into more manageable sections would increase their effectiveness. Also by doing this an ideal opportunity was provided to include a multiple choice quiz activity on the content which had just been learned. “Evaluation should be embedded in the materials with which students are working, so that ongoing monitoring and feedback can help them stay on track” (Hitchcock et al, 2002). This practice is in line with Checkpoint 6.4 “Enhance capacity for monitoring progress” of the UDL Guidelines (Cast, 2011). It was also one of the specifications laid out by the NDA as was seen in the previous Case Study on their experiences of creating accessible eLearning. The technical reason was that by breaking the information down into small self contained chunks they became in effect reusable Learning Objects. This was especially important for the content in these modules as it is critical information that comes up in other sections of the course.

5.3.2 Microsoft Word

The only authoring tool used by the team members when in the design phase of the content was Microsoft Word. A document with accompanying photos and video was

made available to the developer (the author). This word document would contain the text and its sequencing and references to any photos or video if specified. It had been decided to present as much content as possible in pure HTML for accessibility reasons. This resulted in many of the “look and feel” decisions that might usually be part of the design phase being pushed on to the development phase.

5.4 Development

The development phase was a relatively straight forward process. The Moodle resources and activities that were to be used had been decided in the Analysis phase and the content prepared in the Design phase. The development phase then consisted of the copying of the text that had been supplied into the resource that had been assigned for that module. Moodle being a content management system is designed to be used by non-developers and as such is quite non technical. It also has the advantage of having extensive documentation and a very active community at www.Moodle.org. All the main settings can be implemented by the Administrator through menus of check boxes and dropdowns but as will be seen below knowledge of HTML and CSS is a definite advantage when creating the content. Underneath, Moodle is php based but can be successfully used without ever editing a php file. If the user has even a basic knowledge of php however they can easily customize the look and feel of the LMS. Moodle needs to be run on a web server; the most common choice is Apache. It also needs a database, usually MySQL but PostgreSQL will work also and as mentioned php will need to be configured. All development that will be outlined in the following pages was done on a local install of Moodle using the XAMP. XAMPP is an easy to install Apache distribution containing MySQL and PHP. It just needs to be extracted and run saving a lot of time. It should be stressed though that such an install is not suitable for a production server. It is however an ideal environment for developing modules, playing around with settings and testing plugins. Once the user is happy with the modules they can be backed up and imported to the production environment. The following pages will outline the tools, processes and features that were used in all the modules.

5.4.1 TinyMCE

TinyMCE is the text editor that is used for authoring HTML content in Moodle. TinyMCE is a platform independent web based JavaScript HTML WYSIWYG (what you see is what you get) editor (<http://www.tinymce.com/>). It is open source, powerful and customisable yet simple to use. For these reasons it is often the editor of choice for many content management systems. The user does not need any HTML or CSS knowledge to author pages but that said it certainly helps if a more professional look to the content is require.

5.4.2 Moodle Page Resource

The Moodle resource “Page” is just a simple HTML page. It made up the majority of the content of the Funding and Assessment models modules and it was also used to create specific instruction pages like project details. Using the TinyMCE editor described above the content creator can position and style content in any way they wish. Images and videos can also be embedded as outlined above. The page resource is easy to use yet powerful. It is also completely accessible in terms of WCAG 2.0 Guidelines if properly formatted and alternative text is used. There were two minor design issues of using multiple pages as were done in the funding module. Firstly, it can lead to a rather intimidating module page. It looks like there is a lot of content there and some users might find that off putting. Although this wasn’t done in this module a way of avoiding this potentially distracting cluttered effect would be to make use of the conditional activity settings in Moodle. These settings would allow the course creator to make each group of pages conditional on the completion of the quiz preceding them. In this way the user would only see the first two pages and the first quiz when they log on . Once they complete the first quiz the next few pages and the next quiz will appear and so on. The second design issue was that although there was navigation available in the left hand side it was felt that forward and back arrows would be a nice feature and would make the module seem more of a cohesive unit rather than a bunch of pages. These were easily added using the HTML editor as can be seen in the screen shot (Figure: 12, right).

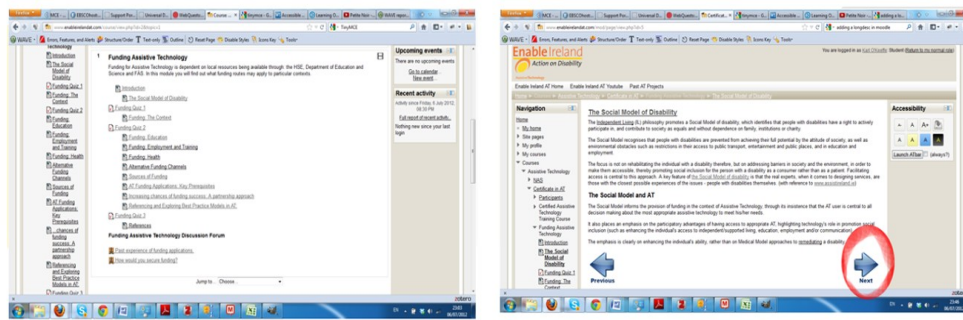


Figure 11: The course view of Funding Assistive Technology module (left) and additional navigation buttons added to the page resource (right).

5.4.3 Moodle Quiz Activity

The Quiz activity in Moodle is quite extensive and a little too complex to describe in detail here. Only the features used in these modules will be outlined. Only one type of Quiz question was used. Multiple choice single answer. The quizzes were embedded within the content after what was considered a unit or topic was covered. It was made clear to the participants that although they had to complete all quizzes to progress through the course they could reattempt the questions as often as necessary and only their highest score would be recorded. The settings in the quiz activity give you the option to leave different feedback depending on the answer received. This is a very useful feature. An example of the feedback can be seen on the screen shots below (Figure: 12).

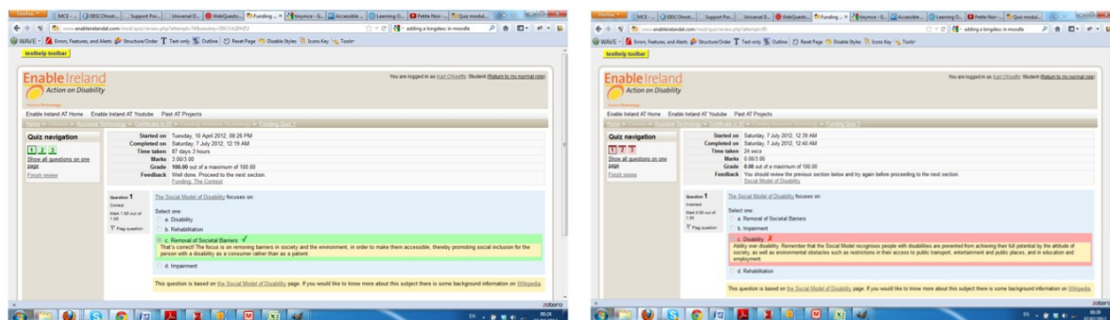


Figure 12: The answer was correct so the participant gets a little tick and the colour green (left) and if participants get the question wrong they get a hint as to the correct answer (right).

If a participant answers incorrectly they receive feedback pointing out why their answer was incorrect but they do not get told directly the correct answer as they are expected to reattempt the question (Figure: 13).

On completing the quiz if they have answered all questions correctly they will be congratulated and given a link to the next section (Figure: 13). If they get one or more questions wrong they will be directed back to the section just covered in order to review it before reattempting the quiz. (Figure:13). They are not prevented from continuing however if they so wish. The quiz activity was used in all modules.

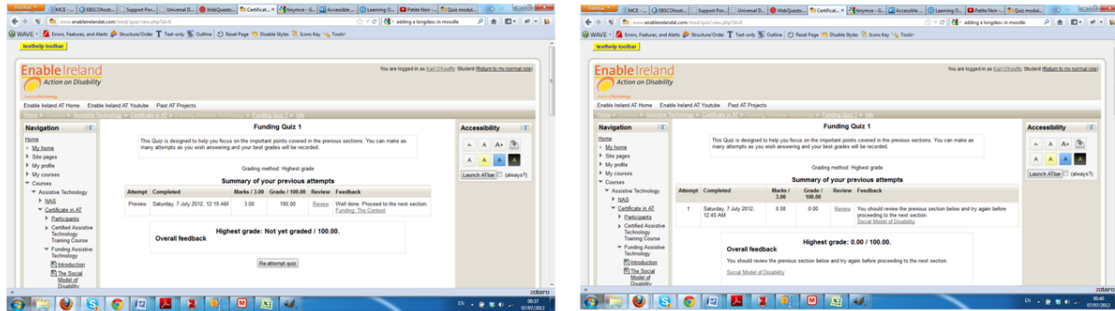


Figure 13: If all answers are correct the participant will be congratulated and directed to the next section (left) or if the participant gets one or more questions wrong they will be directed back to the section just covered (right).

5.4.4 The Forum

The third part of the Funding AT module is the forum. All participants were told that they were expected to make at least one post on every forum. A forum activity was used in every module and was deemed the most important aspect. It also involves very little work in the development stage once the topics have been decided upon. As will be seen in the subsequent stages it does involve ongoing work from the facilitators. There are five forum types in Moodle;

- A single simple discussion - A single topic discussion developed on one page, which is useful for short focused discussions
- Standard forum for general use - An open forum where anyone can start a new topic at any time.
- Each person posts one discussion - Each person can post exactly one new discussion topic (everyone can reply to them though).
- Q and A Forum - Instead of initiating discussions participants pose a question in the initial post of a discussion. Participants reply with an answer, but they will not see the replies of other participants until they submitted the reply.
- Standard forum displayed in a blog-like format. (Moodle.org)

Only one type of forum was used within the modules, the single simple discussion type, although the standard forum for general use was used in the main course area. The single simple discussion format allowed each forum to have a clear topic. The instructor of the course would pose two questions or statements about some aspect of the content covered. The participants were expected to submit answers or suggestions. One of the statements by the instructors usually required the participants to relate the content covered back to their own experiences. This was usually quite successful. Another strategy used was the creation of a hypothetical but realistic “real life” situation related to the content covered that the participants were expected to provide a solution to. The screen shot below shows one of the forums from the Funding AT module (Figure: 14). The forum was used in all modules.

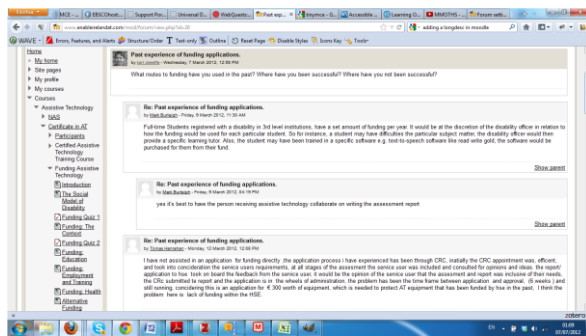


Figure 14: An example of a single simple discussion forum.

5.4.5 AT Assessment Models Module

The AT Assessment Module will be discussed separately because of the slightly different approach used. Although a similar strategy as the Funding AT module was employed in the AT Assessment Models module there was one significant difference. One page was created for each Assessment Model (3 were covered altogether). This page gave an introduction to and an outline of each model. Then rather than creating additional pages the more detailed information was uploaded in pdf form. The thinking here was that at this was additional information which in reality was more detail than many of the participants required making it available in this format was acceptable. It also meant it was in easily printable form (and was potentially the kind of information that a participant may want to print out). Other than the replacement of some pages with pdf files this module followed much the same format as the previous one. There was a quiz at the end of each section with multiple choice questions designed to

highlight the important facts covered in the material just covered. There were also the mandatory three discussion forums at the end of the module. This module also suffered from the sprawled effect of the previous module because of the number of separate files involved as can be seen from the screen shot below (Figure: 15)

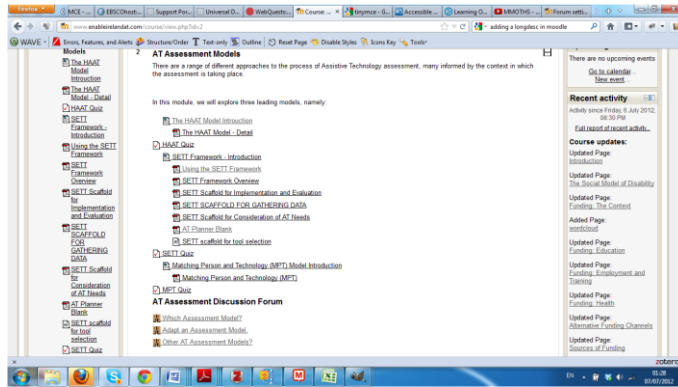


Figure 15: The course view of the AT Assessment Module.

5.4.6 Lesson Activity

The Lesson Activity is interesting and offers real potential for creating complex modules that allow participants to follow different path through the content. In this case it was used in quite a simple and straightforward manner as that was all that was required. The first effect of using the Lesson rather than the two previous methods is that it allows the course view of the module to be much neater (Figure: 16)

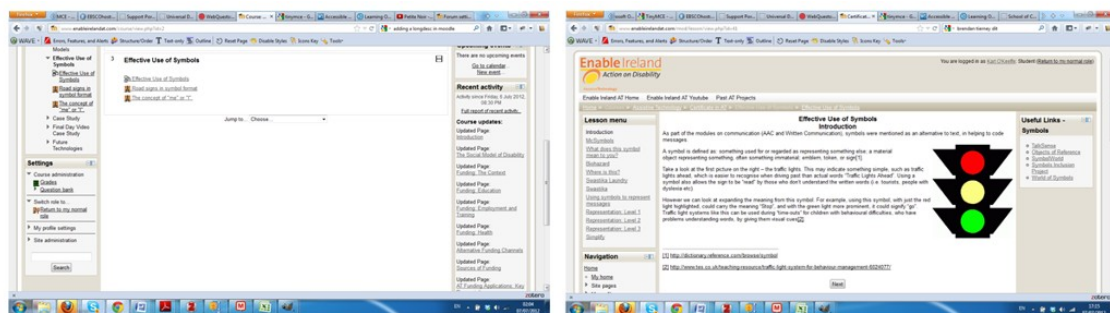


Figure 16: Course view of the effective use of symbols module (left) and the layout of the lesson module (right).

This may not seem a particularly big advantage when viewed in single screen shots as illustrated here but the default course view displays all modules in the course on one page. When each module is a screen in length by itself the user is soon faced with what is called in design circles “the scroll of death”, something that should be avoided for usability (and accessibility) reasons. Here within the course view only the two forum

questions and the Lesson Activity are visible. Once clicked on the lesson opens and the user can navigate through it using the side navigation on the left or the forward/back (in this example only forward and back are used but there could also be a range of choices for the user) buttons. From the screen shot (Figure: 16) the general layout of the Effective use of Symbols module can be seen. Once entered the lesson contents appear in the left side navigation window, this is not default but can be turned on in the settings. The button in the centre leads to the next page although the participant does have the option of skipping ahead using the menu if that is what they desire. A HTML block was included in the right section with links to further reading and resources. Rather than using the Quiz activity the Lesson module has this capability built in. This is quite convenient as if a participant answers a question wrong the instructor can set it up so that it directs them to the exact point in the content where the relevant information was contained. As this was a rather short module it was decided not to embed the questions throughout the content. Development wise the Lesson is a little more complex to set up but the payoff in terms of usability is certainly worth the extra effort. The Lesson activity was used in the Effective use of Symbols and Case Study Modules.

5.4.7 Book Resource

The Book resource is not currently part of the Moodle core and needs to be downloaded separately and installed. It will however be part of Moodle core from version 2.3 on. From a development point of view the Book combines the best aspects of the Page resource and the Lesson activity. It includes on page navigation buttons similar to those that were added to the page resource in the first module. It is simple to set up. One negative aspect that became apparent when conducting the automatic accessibility testing was that is the page title was ticked (in settings) to appear on the page, Moodle for some reason assigns it as a second level heading (<h2>) when it should in fact be first level. This can be overcome quite easily however by electing to not display the page title and adding it in as a first level heading on the page with the HTML editor. Figure: 17 is the course view of the Future Technologies Module.

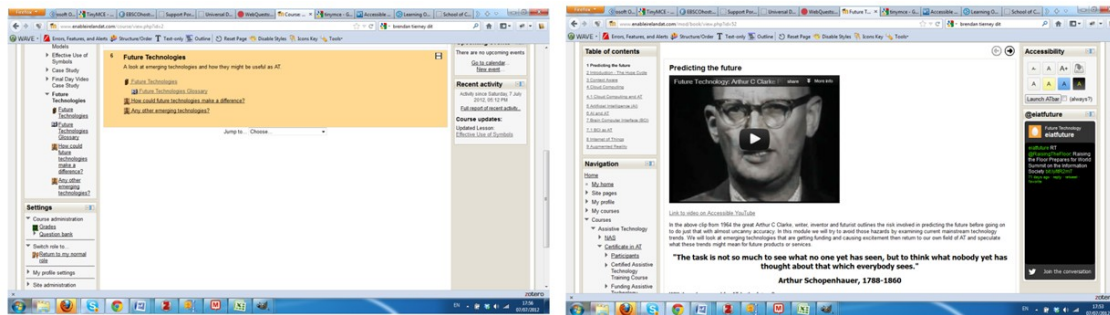


Figure 17: Course view of the Future Technologies Module (left) and the Future technologies module (right).

As can be seen from the screen shot above like the Lesson module the once entered the Book resource (once activated in settings) displays its table of contents on the top left of the navigation window. In this way it allows participants a nonlinear approach to the content if they so wish. On the top right forward and back navigation buttons can be seen. These are also found on the bottom right of each page. Another nice feature the Book resource offers which can't be seen in the screen shot above is the option to view the content on a single page, either by chapter or in total, in a print friendly format. An additional block was created for this module that can be seen on the bottom right. The HTML block was embedded with a twitter feed created for this module. This feature allowed the instructor to add new and up to date content without having to log on and alter the course. This was deemed important because due to the nature of the subject, if new developments aren't acknowledged it loses some relevance. One final feature of the Book module is that it can be downloaded as an IMS CP. IMS Global Learning Consortium to give the organisation its full name is a not for profit organization whose objective is to enable the growth and impact of all learning technology, particularly e-Learning. The Content Package (CP) is an interoperability standard that is part of the IMS Common Cartridge format. In essence it is similar to the SCORM standard, a zip file containing metadata (information about the contents) and files (usually HTML). The two big advantages it offers are interoperability and reusability. This will be discussed in more detail later. The Book was used for the Future Technologies module. The Future Technologies module contained the usual two forums and it also contained its own Glossary as there was quite a lot of new terminology used. The Glossary will be discussed underneath in the UDL section below.

5.4.8 Universal Design for Learning (UDL)

UDL had been identified as a pedagogical strategy that offered significant benefits in terms of accessibility in the Analysis stage of the design process. Three tools were implemented in the Development process in efforts to satisfy the principles of UDL. The first was the Glossary, a feature of Moodle core that will be explained below.

The Glossary

Using clear understandable language is obviously important when creating instructional materials but sometimes new words, terms or phrases are an unavoidable part of learning. A good example of this would be the Future Technologies module above. Many of the course participants would have been unfamiliar with the word “exoskeleton”, certainly within the context it was used in this module. In Moodle the instructor can create a Glossary for words such as this. A Glossary can be created for a specific module (as was done in Future Technologies) or a global one for the whole course (or indeed both). There is also an auto-linking feature in the Glossary (this feature needs to be turned on in settings by the administrator and then enabled for each entry required). This will automatically create a hyperlink out of all words entered in the Glossary where they appear within the main body of the text. The hyperlink distinguishes itself from ordinary hyperlinks by a question mark tool tip. Once clicked the link opens a popup window with an explanation of the word (Figure: 18). Photographs, graphic illustrations or a video link can also accompany the word definition in the glossary to further clarify its meaning. Use of the Glossary satisfy’s UDL Guideline 2.

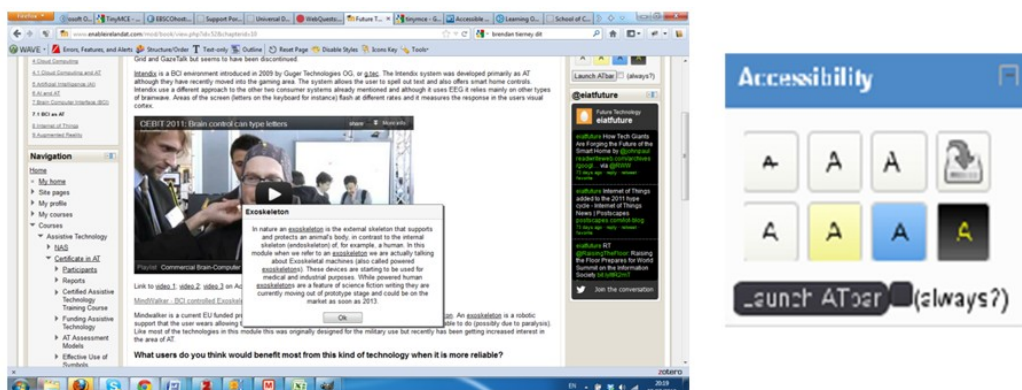


Figure 18: An example of the Glossary auto-linking feature (left) and the Accessibility Block plugin (right).

Accessibility block

The accessibility block (Figure: 18) is an external plugin available to download from Moodle that aims to provide an easy way for users to customise the LMS to their visual needs. “It supports changing of text sizes and colour schemes. Customisations save to the user's session, allowing them to persist between pages, and can also be saved to the database allowing them to apply permanently.” (Moodle.org). The block offers the functionality it promises but unfortunately it's a little unreliable (seem to be issues in Firefox) and the text resizing is limited. The block also integrates ATBar from Southampton University ECS. This provides extra tools and customisation options, including dictionary lookup and Text-to-speech TTS. The TTS requires additional installations and as will be discussed below, this was not possible on the production server. The visual customisations available using the ATBar allow the user much more control than the block does. A much wider range of colours for the text and background are available and the text resizing works very well. The downside is that all customisations made with the ATBar don't persist and must be redone for every page visited. On the plus side the Accessibility Block seems to be quite well supported so future versions with the bugs mentioned fixed, should be available soon. This additional block partially satisfies UDL Guideline 1.

TextHelp SpeechStream Toolbar

The SpeechStream Toolbar (Figure: 19) is a web application available from TextHelp Ltd, one of the leaders in literacy support software. It is a JavaScript application that offers high quality TTS with highlighting, colour highlight annotations, translation (Spanish and Italian), factfinder (Google), dictionary (with TTS) and calculator. The most useful features are briefly outlined below.



Figure 19: The SpeechStream toolbar from TextHelp Ltd.

- **Text to Speech** - As well as a high quality synthesised voice the text is highlighted while being spoken (Figure: 20).

- **Colour Highlighter** - This feature allows the participant to highlight important parts of the text in up to five different colours. When the Highlight collector icon is clicked these notes are gathered together for easy copying.
- **Dictionary**- This feature allows the participant to check the meaning of a word without leaving the page.

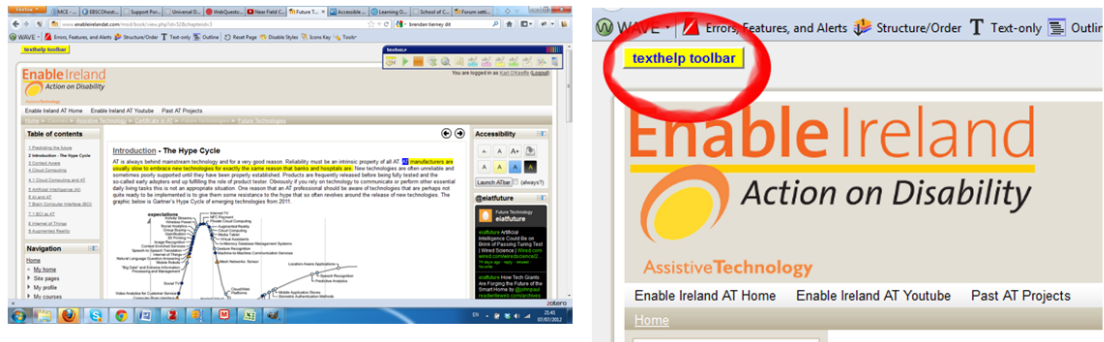


Figure 20: SpeechStream TTS with highlighting (left) and the TextHelp toolbar button that was created to resolve an issue with IE8 but also resulted in a much better implementation of the application (right).

The SpeechStream Toolbar is relatively easy to implement in Moodle and best of all it can be done without access to the root of the server. TextHelp supply the basic code that only needs minor modification. Within Moodle, the Administrator needs to open Site Administration > Appearance > Additional HTML and paste the appropriate code into the Head and Body sections. With this done the toolbar will load automatically with the page. Initial testing revealed that in Internet Explorer 8 if the toolbar was loaded in this way it somehow knocked out the navigation. The solution arrived at was to create a button to load the toolbar (Figure: 20). If the toolbar loaded after the page, the navigation was not affected. Even if this problem had not arisen with IE8 this was a much better way of implementing the toolbar. It makes it available for those who want to use it without unnecessarily using up screen space for those who don't.

5.5 Implementation

Once the development was complete each module was user tested by team members who had previously not used Moodle. All question/answers were double checked, content was proof read and an automatic accessibility test was completed. This obviously isn't sufficient testing but these modules themselves were a first iteration and as such were going to be user tested in the field.

In order to implement the modules a decision needed to be made regarding hosting. A domain name was first purchased www.enableirelandat.com and three options for hosting were considered, all with advantages and disadvantages.

Web Host (Cloud Hosting)	In House Hosting (On Enable Ireland WAN)	Moodle Partner (managed/maintained service)
Cheap	Cheap (if spare server can be sources)	Reliable
Root access to server – Full Control	Root access to server – Full Control	Support - Experience & Technical expertise
No Support (self supported – drain on limited resources)	No Support (self supported – drain on limited resources,)	More expensive
Limited experience	Only available on Company Network	Limited Control

Figure 21: Comparison of hosting options.

The decision was down to time and reliability in the end. As this was going to be a live course an experienced specialist Moodle Hosting Company called Synergy was chosen. This could be considered money well invested. They are responsible for all upgrades and backups and have proved very reliable. Because it is a managed hosting package access to the root of the server is not available. This means that if additional plugins are required or the theme needs to be modified it has to be done by the hosting company. They have been very obliging in this regard but what can be asked of them (for no money) is limited. Although this causes problems in terms of the latter part of this dissertation it is for the best as a production site is not an appropriate place for testing software. For this reason a new Moodle install using Cloud Hosting and Cpanel was set up for the sole purpose of testing plugins and themes. This site is available at <http://www.electroat.com/moodle>. The modules built on the local Moodle install were backed up and uploaded to the new hosted Moodle site. There were 15 participants in the Certified Assistive Technology Training Course 2012 so 15 accounts were created with standard passwords. As the course was being delivered as blended learning half an hour was put aside of class time in order for the participants to be introduced to the LMS and walked through the navigation and features. They were first directed to change their standard passwords and then asked to fill in some personal information in

their profile. They were also shown how the navigation and blocks could be docked and expanded as these had been identified as potential usability issues. The course was scheduled for 3 days in March, 2 days in April and 2 days in May. It had previously been decided to release 2 modules (Funding AT and Assessment Models) during the first face to face session for the participants to complete over the month between that and the second face to face session. During the second face to face session in April participants were asked for feedback on the first two modules and whether they had experienced any difficulties with the LMS. There was also a follow up session on the Assessment Models. This seemed to work well as it is a potentially difficult area and most probably new to anyone outside of the disability sector. As they had previously completed the online module it was the facilitator's opinion that the class was much more engaged than had been the case in previous years. Over the three months of the course very little technical support was required; only two password resets were requested.

5.6 Evaluation

There are two aspects to the evaluation of the modules that were the end product of the design process outlined over the previous pages. First is the evaluation of how the modules preformed in terms of user experience and effectiveness. This was done using both qualitative and quantitative methods. Although questionnaires were used they were very detailed and the results were not examined in terms of pure data (although they are represented as graphs below) but they allowed themes to emerge that might not have been apparent through pure statistical analysis. This is why it can be considered qualitative. These questionnaires were issued to participants on completion of the course (APPENDIX H). This questionnaire was divided into three basic parts. The first part related to their overall satisfaction with the e-Learning aspect of the course, the second was based on the principles of UDL and how they were applies (or should have been applied) and the final part was about the usability of Moodle. Alongside these results the LMS logs were also examined to learn about participant use in a more objective quantitative research method. The second evaluation was of the modules themselves and how they stood up to the UDL Checklist. Had UDL e-learning been created?

5.6.1 Overall Satisfaction

The two questions were designed to gauge the participants' previous experience and attitudes towards e-Learning.

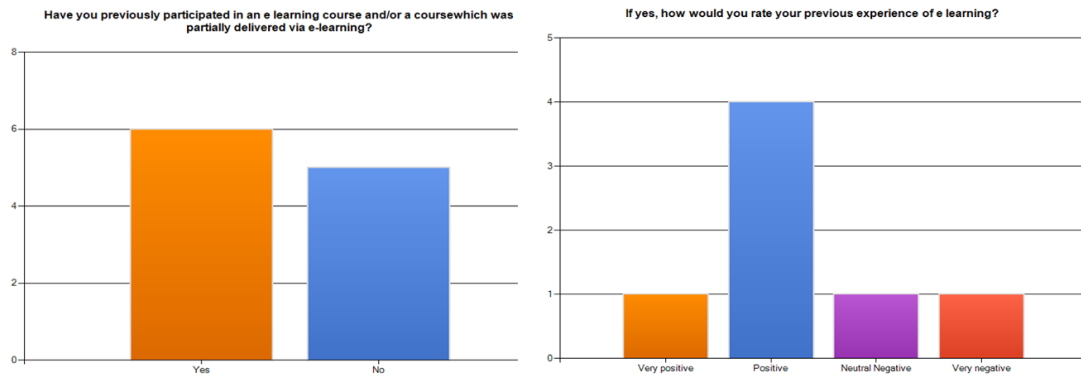


Figure 22: Results of survey question 1 (left) and question 2 (right).

Just over half of the course participants had previous experience of e-Learning (question 1) and of them 80% had a good experience of previous e-Learning (question 2).

In the relation to the overall satisfaction of the e-Learning content of the course the result was over 90% positive (Figure: 23). The most interesting aspect of this result is that the two participants who previously had a negative experience with e-Learning reported having a positive experience with this content. The negative response will be returned to in relation to support and general usability; it is however worth noting at this stage that the negative response had no previous experience of e-Learning.

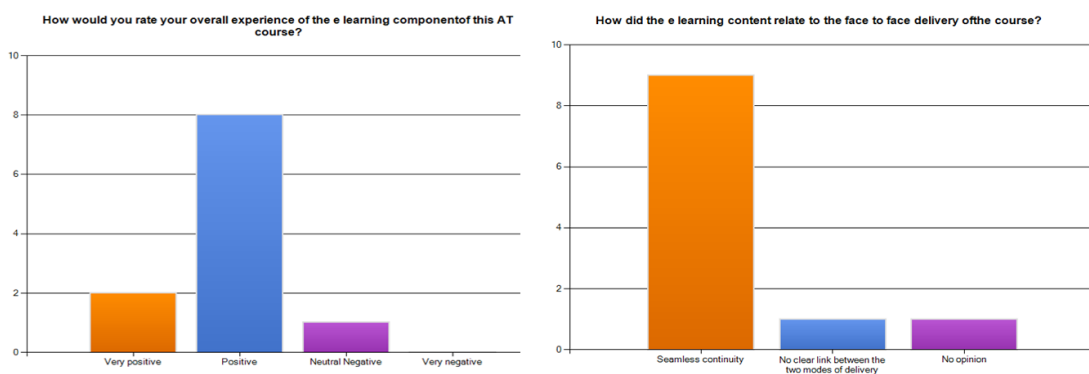


Figure 23: Results of survey question 3 (left) and question 4 (right).

In relation to question 4, “How did the e-learning content relate to the face to face delivery of the course?” it was important to the instructors that the e-Learning aspect of the course did not appear to participants as being “bolted on” to the original course.

Many of the ideas introduced in the e-learning part of the course were revisited in class time or first introduced in class and reinforced through the e-learning materials.

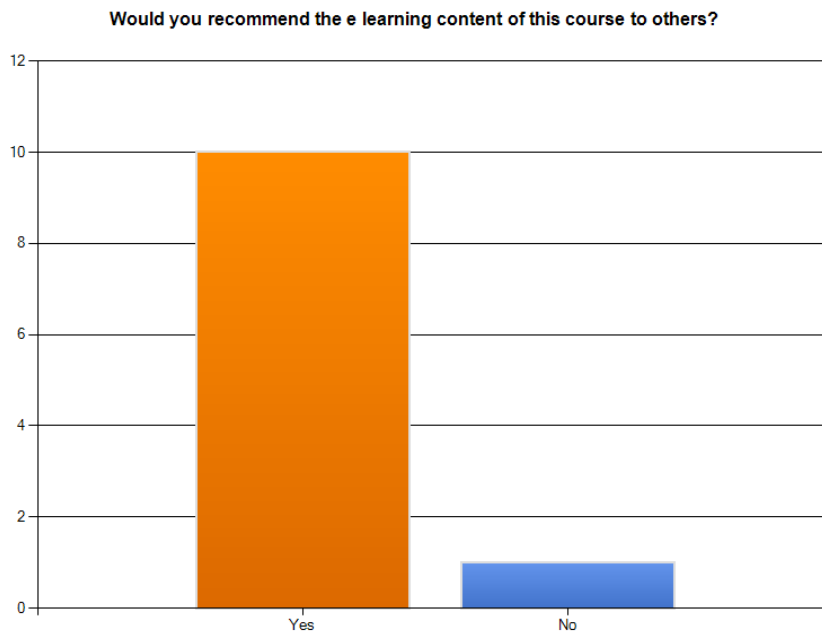


Figure 24: Results of survey question 5.

The above question (Figure: 24) was included to identify whether the participants were confident with their previous estimations of the positive nature of their experience on the course. For many people recommending a course would constitute a greater value than just indicating a positive experience. While a negative experience may be recognized as being down to more personal reasons or unfortunate events that may not be transferable to others and as a result the participant might recommend the content. In this case however it reinforced the results of question 3.

5.6.2 Universal Design for Learning

The second section of the questionnaire consisted of 26 questions. Of the 26 questions 22 were based on the principles of UDL and the final four on the Blended learning approach taken. The questionnaire consisted of statements with a Likert scale to allow participants express their level of agreement or disagreement with the statement. The results are provided in a graphical format over the next few pages along with a brief analysis. They have been organised under the principle of UDL to which they apply.

Principle I: Provide multiple means of representation

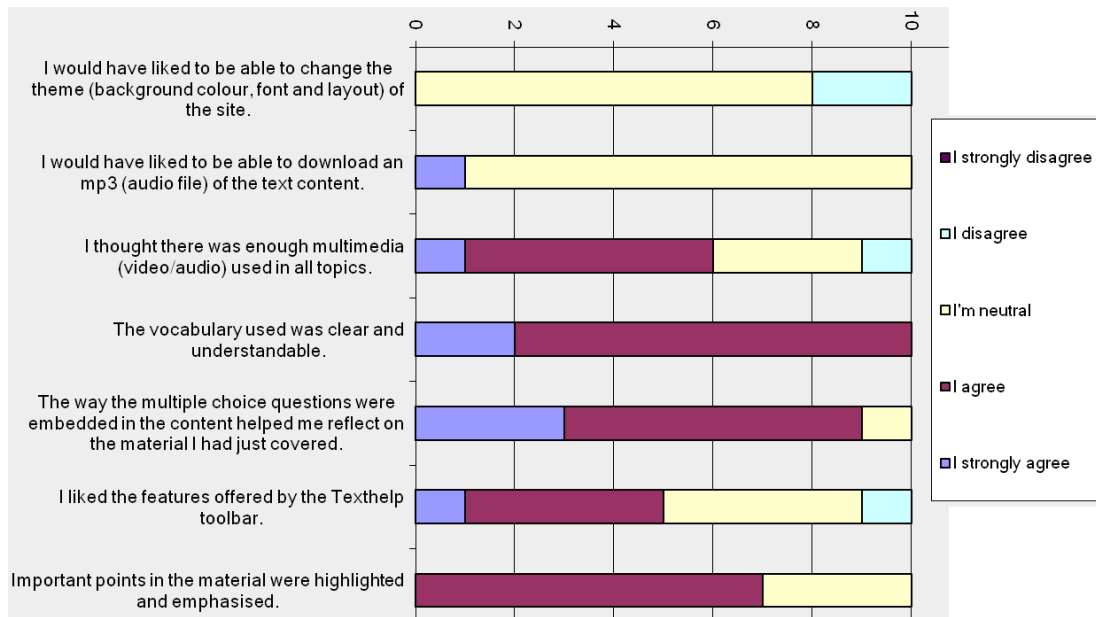


Figure 25: Results of Likert scale questions relating to UDL principle 1.

Interpreting the results of this data can be problematic and the temptation is to disregard some questions entirely as it seems evident that the wording of the statement may have lead to some misinterpretation. An example of this is the first response. 80% of respondents were neutral about being offered the ability to change the theme (background colour, font and layout) of the e-learning site. This could be expected as this feature would significantly benefit only those who have some kind print disability or low vision. However it can only be assumed that the statement was misinterpreted by the 20% who disagreed. The second response is interesting in that it demonstrates how universal design can accommodate those who may often be excluded by traditional approaches. While 90% were neutral about being able to download an mp3 of the text content, 10% strongly agreed that they would like the facility. 60% agreed that enough multimedia was used in “all” topics where as 10% disagreed (not surprisingly the same respondent who would have liked the mp3 download). There was general consensus on the vocabulary being easy to understand and the effectiveness of the embedded multiple choice questions. 50% liked the features offered by the TextHelp toolbar (10% strongly agreed, same respondent who favoured audio in the previous questions), 40% were neutral and (inexplicably in the author’s opinion) 10% didn’t like the features offered. Finally 70% felt that important features were highlighted and emphasised, 30% were neutral in this regard. Although overall efforts at implementing UDL Principle 1 “Provide multiple means of representation”

seem to have been well received it is also evident that there is room for improvement. The 10% who from their answers had a preference to audio and audio/visual content could be accommodated much more successfully. Some work also needs to be done on clarifying learning goals. It also has to be remembered that this small sample did not include anyone hard of hearing or with a visual impairment.

Principle II: Provide Multiple Means of Action and Expression

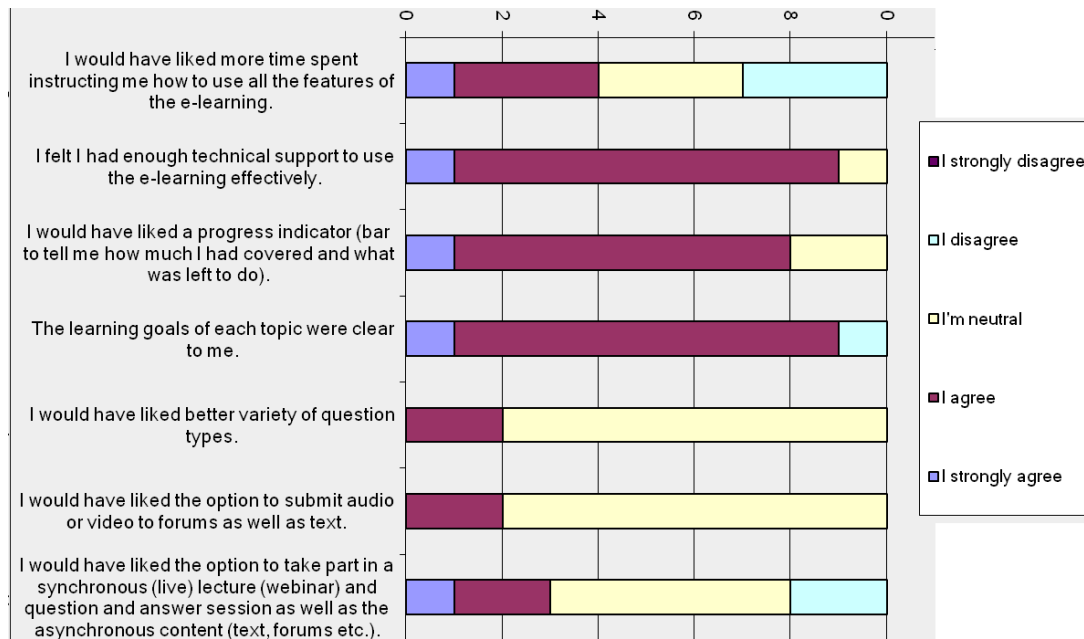


Figure 26: Results of Likert scale questions relating to UDL principle 2.

The first statement regarding the need to spend more time on initial instruction is probably the most important piece of information in this section. The respondent who strongly agreed with this statement was the same individual who gave the content in general negative feedback and a total of 40% would have liked more time and support. As stated earlier half an hour of class time was spent introducing the user interface of the LMS to the participants. This was sufficient for some but not a majority. It seems that this was the single most important factor deciding the success of the e-learning as a whole for one person and presumably had a negative impact on a substantial amount of participants. Although no more class time should be spent an additional scaffold will have to be investigated to mitigate the chances of a reoccurrence. An introductory orientation module on using Moodle with screen capture videos and some exercises to introduce the features could be a good strategy. The extraordinarily small amount of technical difficulties that were experienced over the three months of the course can

either be attributed an extremely well planned and implemented rollout of the LMS or beginners luck. The latter is suspected. 80% of respondents express a preference for some manner of progress indicator; this is easily implemented and will certainly be included in future iterations. 10% disagreed that the learning goals were clear; this needs to be rectified in the design of the learning content phase. Only single answer multiple choice questions were used within the modules, 20% would have liked a better variety of question types. Moodle core offers 7 different types of question (excluding the numerical question types) along with a host of third party types. Again, this will be incorporated into future versions. 20% would have liked the opportunity to submit audio or video to the forums instead of or in addition to text. Regarding the synchronous webinar type module there seems to be an interesting split. 20% agreed, 20% disagreed, 50% were neutral and 10% strongly agreed. It would be interesting to see if the 20% who disagreed would change their opinion if they were told that the sessions would be recorded and therefore live attendance would not be mandatory.

Principle III: Provide Multiple Means of Engagement

20% of respondents would have liked to be able to choose topics that were more relevant to their profession (10% strongly agreeing). Although a significant percentage it is perhaps somewhat lower than what might have been expected. Overall 70% felt they had enough engagement from the instructors within the forums. This is a good result as it seems to be a deciding factor influencing overall participation. 70% also felt they had enough engagement with fellow participants on the forums. This statistic will be examined further using the LMS logs and its reporting feature. The fact is it is entirely subjective. A good result for the Moodle theme chosen and the overall layout of the course, 80% disagreed with the statement that it was overly complex. This was one of the concerns and is a weak point of many LMS that have the number of features that Moodle does. 30% disagreed that the twitter feed used in the Future Technologies course was distracting (70% neutral). It was thought that the movement of the tweets updating might prove distracting. 80% agreed that they felt comfortable posting to the forums. This is perhaps not so surprising considering the proliferation of social media in the modern world. The proposal of an introductory forum where everyone would outline their role and previous AT experience received 50% agreement (20% strongly), only 10% disagreeing. This is also something that will be done in future iterations. It could probably be incorporated into the orientation module that was proposed for the

last principle. Finally 70% found the content sufficiently challenging, 10% disagreeing with the statement. It should be noted however that this was a relatively homogeneous group.

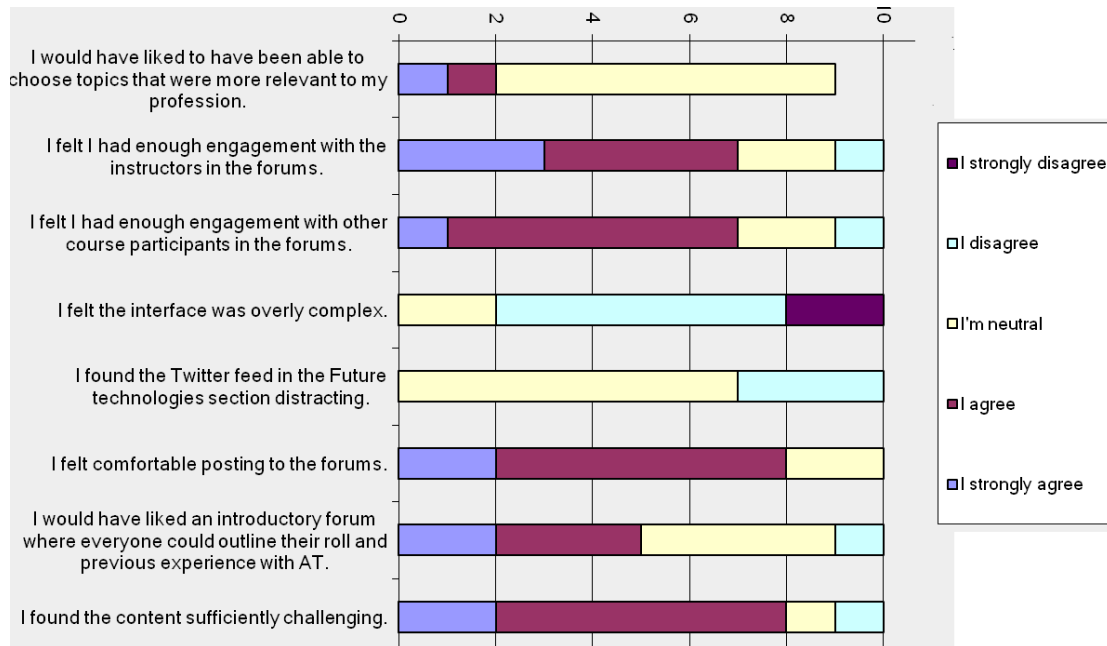


Figure 27: Results of Likert scale questions relating to UDL principle 3.

Blended Learning

The first two results categorically state that the goal of creating e-Learning that is more engaging and effective than classroom learning has not been achieved with this iteration of the design. This is far from what could be considered a failure however a great deal has been learned and excellent foundations have been laid. 90% considered the e-learning a positive experience but more pertinent for what will for the foreseeable future be a “blended learning” rather than a pure e-learning course, is a 70% agreement that the e-learning complemented the class aspect well.

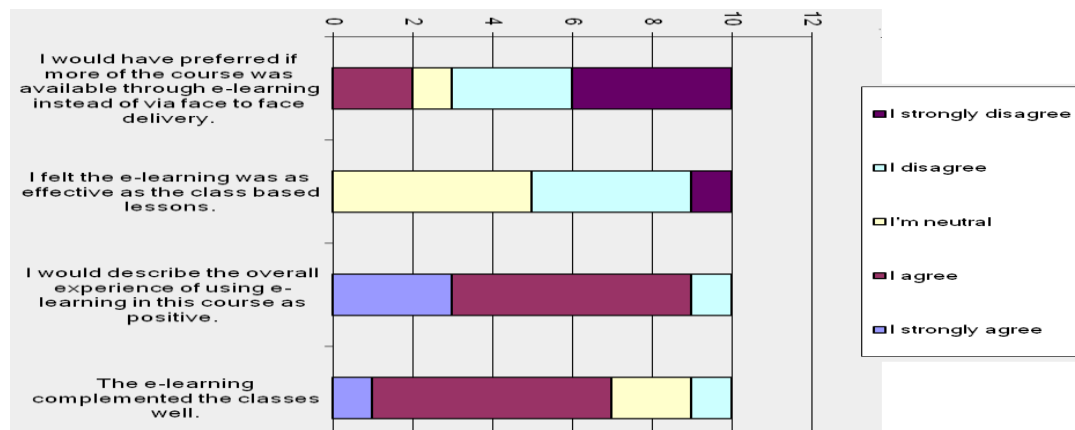


Figure 28: Results of Likert scale questions relating to Blended learning.

5.6.3 Moodle Usability

The third part of the questionnaire was about the usability of Moodle. 24 different actions that might be needed to be preformed were listed and respondents were given 6 choices; Very Difficult, Difficult, Easy, Very Easy, I didn't need this feature and I wasn't aware of this feature. The details of the responses are listed in the table (Appendix I). As can be seen from the results the vast majority of features were deemed either easy or very easy to use by course participants. This is an extremely positive result and reaffirms the decision to select Moodle as the LMS. The results of interest from this set in terms of improvements to further iterations of the e-learning are;

- Any features that users found difficult or very difficult to use.
- Any features that they were not aware of.

Any features that included either of the answers above were included in the graph below.

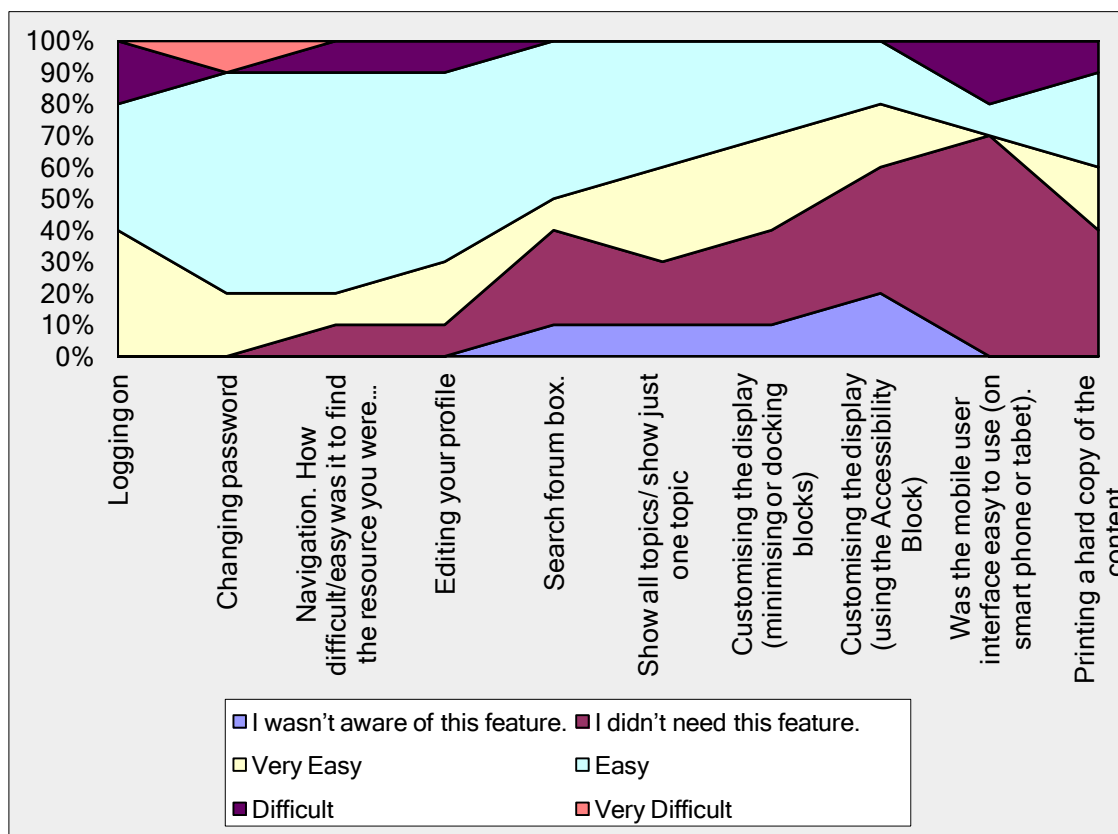


Figure 29: Negative responses from Moodle usability questionnaire.

The first areas of interest reading the chart from left to right are the purple and red sections in line with “Logging On” and “Changing Password” respectively. As was

mentioned earlier by default Moodle requires a password that contains 9 characters, a lower and upper case letter, a number and a symbol. From closer examination of the individual survey results it was confirmed that the same individual who had difficulty changing the password and difficulty logging on was also one of those who indicated that they felt that more time should have been spent introducing the interface and orientating users. Other areas where users encountered some difficulty were navigation, editing of their profile and using the mobile interface. This highlights that these are areas that should be included in a Moodle orientation module in the next iteration of the design. The difficulty with the mobile user interface which the participants were requested to try may have been down to the hardware they were using although this is just speculation. Regardless since this course Moodle have released a dedicated iPhone/iPad app (with an Android one in the pipeline) which should go a long way to increasing the usability of the LMS on at least those mobile devices. The four features that some users indicated they were not aware of are another indication that insufficient training on using the LMS was provided.

5.6.4 Moodle Logs

Moodle along with most LMS tracks all user actions and stores them in a log. This log can often provide an interesting insight into how users interact with the LMS. The reporting features in Moodle core are relatively basic but a third party plugin called Configurable Reports (http://docs.moodle.org/22/en/Configurable_reports) allows more in depth reports to be run.

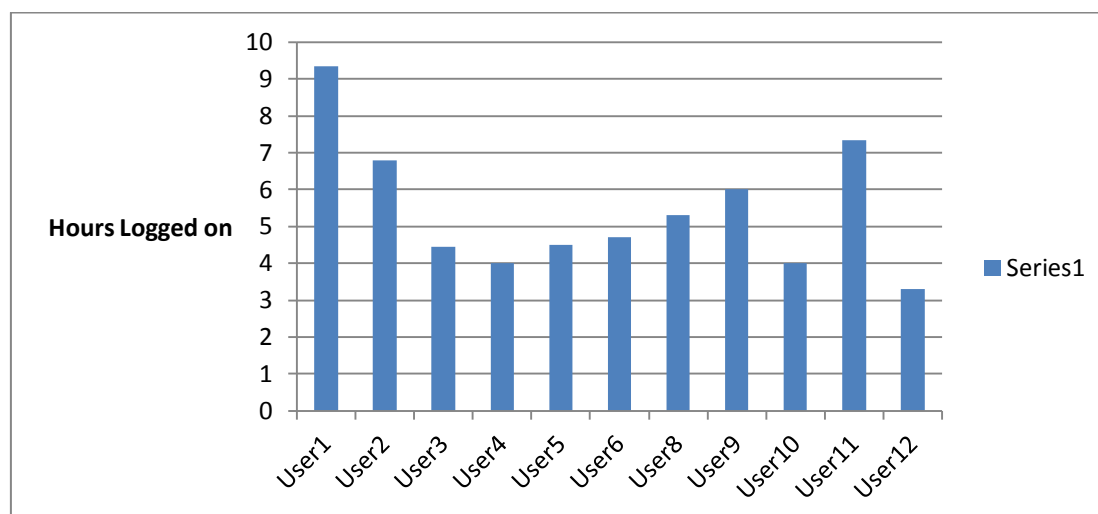


Figure 30: Hours participants spent logged onto the LMS.

The above graph (Figure: 31) illustrated the amount of time each user who completed the course spent logged into the LMS. It averages at just under 5 and a half hours per participant. Although this seems quite impressive and is quite close to the estimated 1 hour per module in reality it could vary quite considerably from this figure. The reason for this is that session handling was set on the server for 2 hours. This means that if a participant was logged in but inactive they would remain logged on for 2 hours before the server would automatically log them out. This could explain some of the higher results. An estimate of between 3 and a half and four hours per participant would seem to be a more accurate.

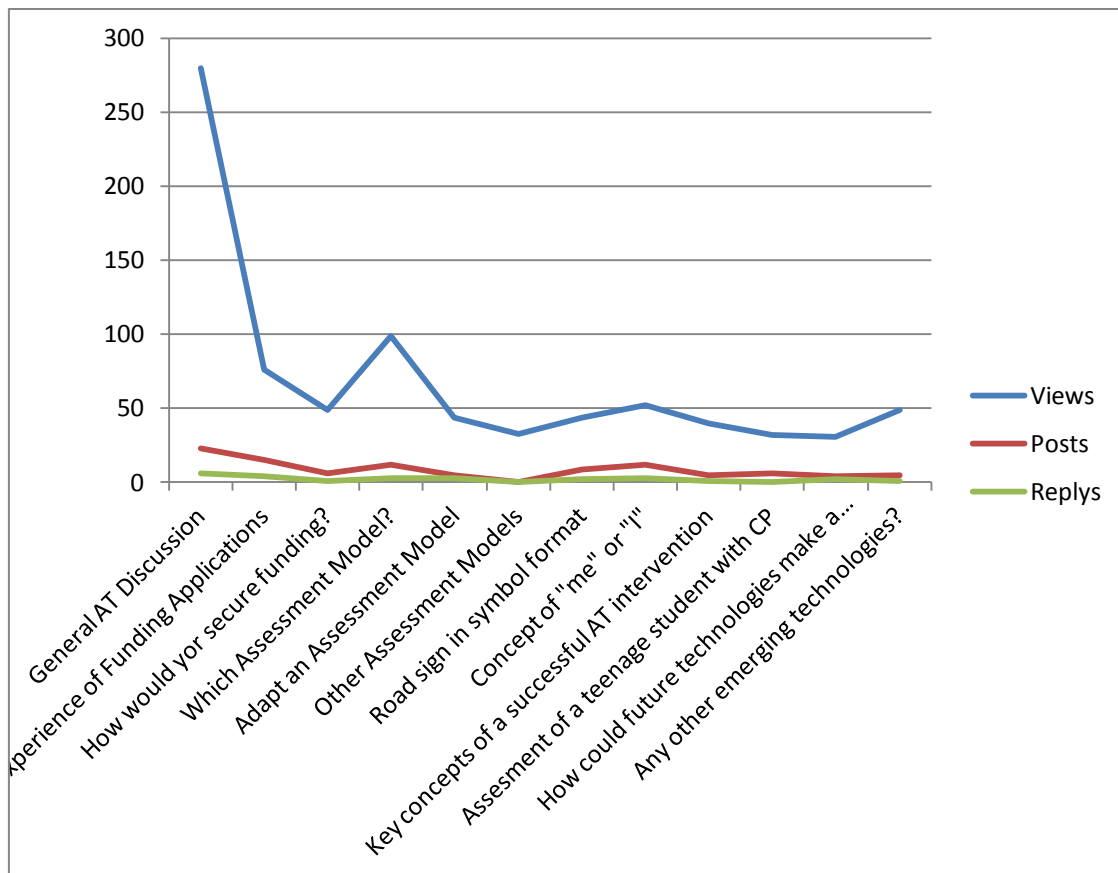


Figure 31: Graph illustrating the amount of forum views, posts and replies

The graph above outlines the number of participant forum views against forum posts and the third value is where participants have replied to other participants. The General AT Discussion Forum, the first value, was used throughout the course which accounts for the additional views. Over the duration of the course there was a ratio of roughly 8:1 views to posts. Although what can be interpreted with certainty from these results is perhaps limited somewhat from the small sample size, such a small ratio of views over posts would be indicative of a high level of engagement among participants. For

example other studies that have been done over forum usage within an LMS gave results of 47.6 : 1 views over posts (Burr & Spennemann 2004). The relationship between views and posts is graphed below on a scatter chart. The General AT Discussion Forum has been removed from these values as it was used in a different way to the other forums.

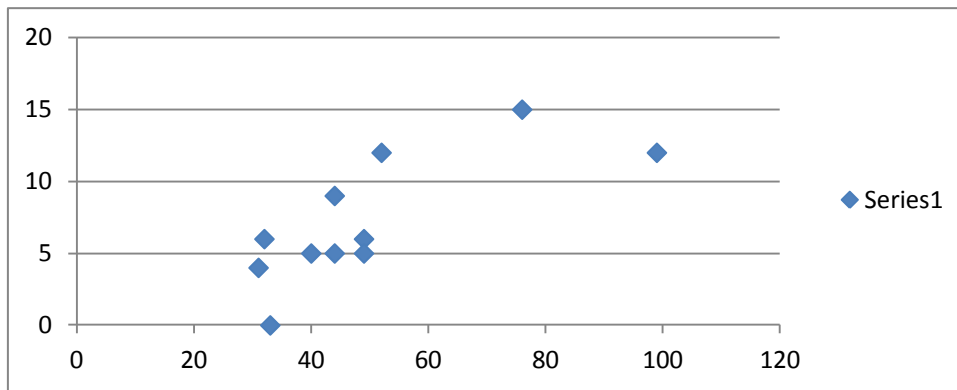


Figure 32: Scatter graph illustrating the relationship between forum views and posts.

The graph above would seem to indicate that there a positive relationship between forum views and posts. Pearson product-moment correlation coefficient (PMCC) which is represented by r is a numerical value between -1 and 1 that expresses the strength of the linear relationship between two variables. The closer the value of r to 1 indicates that it has a more positive relationship, 1 being a perfect positive relationship which would appear as a straight line sloping up. A value of 0 indicates that there is no relationship and values close to -1 signal a strong negative relationship, which would appear as a straight line sloping down. The hypotheses being made here is that if there is a strong positive relationship between views and posts combined with the small ratio of views over posts should indicate a good level of engagement of participants with the forums.

Data Summary

$$\sum X = 549 \quad \sum X^2 = 31629$$

$$\sum Y = 79 \quad \sum Y^2 = 757$$

$$\sum XY = 4623$$

$$r = .76$$

A Pearson product-moment correlation coefficient value of 7.6 indicates a reasonably strong relationship between views and posts this alongside a ratio of 8:1 could indicate a high level of engagement.

If the same technique is used to examine posts and replies (Figure: 33) a product-moment correlation coefficient value 0.784 is found with a ratio of posts over replies of 3.95:1.

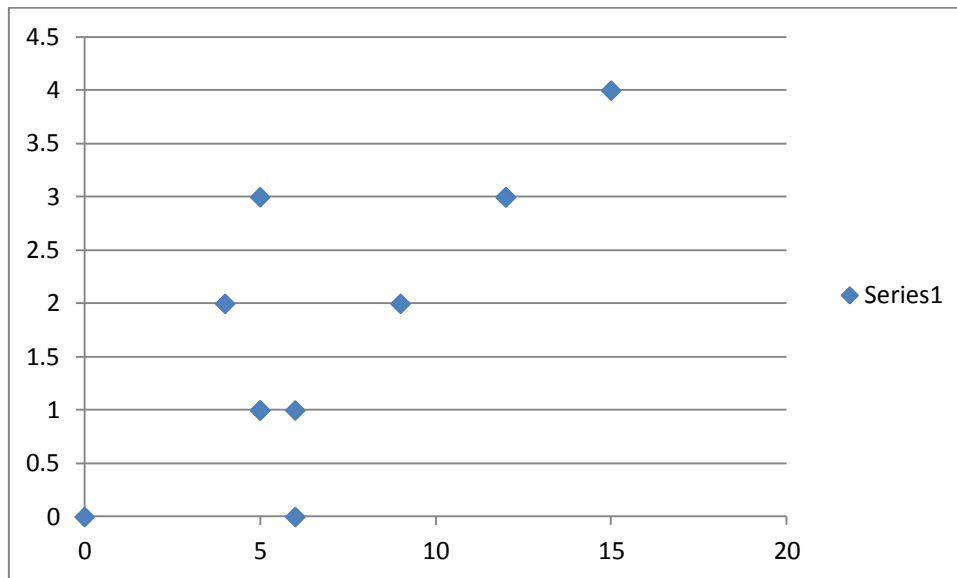


Figure 33: Scatter graph illustrating the relationship between forum posts and replies.





$$r = .784$$

This result, although indicating a strong engagement between participants is misleading. If the posts are examined it seems that many forum participants replied to the last post in the forum as a matter of convenience since to reply to the instructor would have involved scrolling up the page. In many cases the content of the reply was not directly related to the post to which it was replying. This indicates there was actually a much lower level of engagement between participants on the forums.

5.6.5 UDL Evaluation

The second evaluation approach to be taken is concerning the success of the modules in relation to the checkpoints of the principles of UDL. The UDL Guidelines educators' checklist (CAST, 2012) was completed for each of the finished modules (Appendix J). These results are summarised in the colour coded chart below and on the following page..

Table 5 Legend for Figure: 34

Achieved		Partially Achieved		Not achieved		Not applicable	
----------	---	--------------------	---	--------------	--	----------------	---

Checkpoints	Funding AT	Assessment Models	Effective use of Symbols	Case Study	Future Technology
1.1 Offer ways of customizing the display of information	Green	Green	Green	Green	Green
1.2 Offer alternatives for auditory information	Blue	Blue	Blue	Blue	Yellow
1.3 Offer alternatives for visual information	Green	Green	Green	Green	Red
2.1 Clarify vocabulary and symbols	Green	Red	Green	Green	Green
2.2 Clarify syntax and structure	Green	Red	Green	Green	Green
2.3 Support decoding of text, mathematical notation, and symbols	Blue	Blue	Blue	Blue	Blue
2.4 Promote understanding across language	Green	Red	Green	Green	Green
2.5 Illustrate through multiple media	Red	Red	Red	Red	Green
3.1 Activate or supply background knowledge	Green	Green	Green	Green	Green
3.2 Highlight patterns, critical features, big ideas, and relationships	Green	Green	Yellow	Green	Green
3.3 Guide information processing, visualization, and manipulation	Yellow	Yellow	Yellow	Yellow	Yellow
3.4 Maximize transfer and generalization	Yellow	Yellow	Yellow	Yellow	Yellow
4.1 Vary the methods for response and navigation	Yellow	Yellow	Yellow	Yellow	Yellow
4.2 Optimize access to tools and assistive technologies	Green	Green	Green	Green	Green
5.1 Use multiple media for communication	Red	Red	Red	Red	Red
5.2 Use multiple tools for construction and composition	Red	Red	Red	Red	Red
5.3 Build fluencies with graduated levels of support for practice and performance	Yellow	Yellow	Yellow	Yellow	Yellow
6.1 Guide appropriate goal setting	Yellow	Yellow	Yellow	Yellow	Yellow
6.2 Support planning and strategy development	Red	Red	Red	Red	Red
6.3 Facilitate managing information and resources	Yellow	Yellow	Yellow	Yellow	Yellow
6.4 Enhance capacity for monitoring progress	Red	Red	Red	Red	Red
7.1 Optimize individual choice and autonomy	Yellow	Yellow	Yellow	Yellow	Yellow
7.2 Optimize relevance, value, and authenticity	Yellow	Yellow	Yellow	Yellow	Yellow
7.3 Minimize threats and distractions	Yellow	Yellow	Yellow	Yellow	Yellow
8.1 Heighten salience of goals and objectives	Yellow	Yellow	Yellow	Yellow	Yellow
8.2 Vary demands and resources to optimize challenge	Yellow	Yellow	Yellow	Yellow	Yellow
8.3 Foster collaboration and community	Yellow	Yellow	Yellow	Yellow	Yellow
8.4 Increase mastery-oriented feedback	Yellow	Yellow	Yellow	Yellow	Yellow
9.1 Promote expectations and beliefs that optimize motivation	Yellow	Yellow	Yellow	Yellow	Yellow
9.2 Facilitate personal coping skills and strategies	Yellow	Yellow	Yellow	Yellow	Yellow
9.3 Develop self-assessment and reflection	Yellow	Yellow	Yellow	Yellow	Yellow

Figure 34: Colour coded table illustrating what checkpoints of UDL had been satisfied by the Modules.

What this chart will tell even a casual glance is there is a good deal of work needed in order to make any claims that this is UDL e-learning. The predominance of amber is a good sign however. Moodle offers almost all the tools to completely satisfy many of the checkpoints in the Affective domain (checkpoints 7 to 9 inclusive) within its core install. It could be reasonable to expect if planned for in the design phase and given time and experience using these features these checkpoints could be fully satisfied. Checkpoints within the Strategic section (4 to 6 inclusive) will need additional tools to fully satisfy them as well as consideration in the Analysis stage. Finally the Recognition section (checkpoints 1 to 3 inclusive) are likely to cause the most work to satisfy. Four of these modules did not make use of multiple media which is contradictory to Checkpoint 2.5 and the ethos of UDL as a whole. Multiple media was not used because it had never been used for these modules when delivered as face to face classes and so wasn't even considered when designing the content. This failing in the design of the modules will be discussed in more detail further into this section. What is important here is that by not illustrating with multimedia these modules fared better in the recognition section than they perhaps should have. Providing alternatives for audio and video (checkpoints 1.2, 1.3) are undoubtedly the biggest single task when it comes to designing UDL e-learning and as such should be planned for and organised as early as possible in the design process.

5.7 Conclusion

Following the evaluation of the five e-learning modules an action plan has been drawn up. Before laying out the points of action it is worth reflecting also on what aspects were successful.

The implementation of the TextHelp toolbar, once the initial bugs were sorted out was a complete success. Some participant comments from the General AT forum were;

"I found the texthelp toolbar to be a great addition to the site. Its features are very easy to use and extremely helpful..."

And

"I really liked the toolbar, the dictionary and factfinder are good additions and easy to use." (General AT Discussion Forum/Texthelp)

The overwhelmingly positive feedback was also encouraging. Participants were also asked how they might apply what they learned over the AT course. Some of the comments included;

“I’ve already had a visually impaired student whom I showed the Windows accessibility features for the visually impaired. Even very small things like changing the background colour of PDF documents and Word documents etc. had an immense impact on the student.”

And

“I have already shared information re: AT resources available with colleagues in my department and have supported two of the SLTs in the department with sourcing appropriate AAC resources for patients.” (General AT Discussion Forum/Course Review)

Another positive that should not be overlooked is the results of the Moodle usability survey. The fact that only a few areas caused any difficulty is extremely encouraging. The areas that have been highlighted should be easily resolved. Finally the high engagement of participants with the forums was also encouraging although it is still an area that requires some work. Experience within the training team should go a long way towards improvement in this regard.

5.7.1 Action Points arising out of Evaluation

From the positive results of the questionnaire it can be ascertained that the choice of Moodle as the LMS was a good one, at least in regard to this group. Difficulties were highlighted in some areas; logging on, passwords and editing the user profile. There should also be some concern as to the replies to questions in regard to the Moodle features that were answered with the option “I wasn’t aware of this feature” although they were relatively low (three 10% and a 20%). Finally the 40% agreement to the statement *“I would have liked more time spent instructing me how to use all the features of the e-learning.”* These results all point to inadequate training on effectively using the LMS. The 50% who indicated they would like an introduction forum (also outlining previous experience with AT) can also not be ignored. This would be an activity that would fit well in an orientation module. Also although not arising out of these results, but rather from previous reading, general accessibility information

regarding the correct use of alternative text and web accessibility could be included too. Therefore the first action point is that;

- A Moodle orientation module that contains accessibility information (to inform participants on strategies to ensure their contributions are accessible) and a general introduction and experience with AT forum (ice breaker) needs to be built and made available.

This action point is future work that will be completed before the 2013 course is made available.

The second action point arises out of the evaluation of the completed modules against the UDL Checkpoints. Although UDL was initially identified as both an accessibility and pedagogical strategy there were clear shortcomings in this regard within the final product. The ADDIE design methodology overall proved to be a good design process but in its generic form wasn't sufficiently focussed for the purpose it served on this occasion. UDL wasn't given enough consideration within the Analysis and Design phases, the majority of UDL considerations being implemented within the Development phase. If the principles of UDL are formally embedded into the design process from the first stage it will transform the ADDIE model into a more user centred design process by forcing the consideration of difficult to accommodate groups right from the start. In terms of ensuring accessibility this has been proposed as being the most effective and economical method (Asakawa, 2005). UDL is about more than just accessibility however, it is about engaging all learners. While the feedback was positive for the initial modules the fact remains that the stated goal of creating e-learning that is as at least as effective as face to face learning was not achieved. 50% of respondents disagreed with the statement "*I felt that the e-learning content was as effective as the class based content*". UDL, particularly in the affective domain has the potential of providing the direction needed to improve in this regard.

Improvement also needs to be made within the ADDIE model in relation to its specific purpose in this situation, what is the task here and is ADDIE the most suitable tool? The task here is not creating e-learning from scratch but rather transforming what is a highly successful model within a classroom setting into one that will be delivered on line. The ADDIE model as it was used in the first iteration led to what was in effect a pure substitution of delivery method without enough consideration being given to the

intrinsic properties or characteristics that were unique to each delivery method. The incorporation of the SAMR model of technological transformation (Puentedura, 2006) which has been discussed earlier could be a useful tool to encourage fresh thinking. If used within the Analysis phase the SAMR model would be particularly useful in regard to encouraging thought about how the characteristics of the World Wide Web could be effectively utilised. This could be expected to be of particular benefit to the Affective domain, an area the evaluation of the first iteration of the e-learning showed was in need of improvement.

The final aspect of the proposed improved design process will be concerned with efficiency. There is no escaping the fact that to produce truly universally designed e-learning will be more time consuming and therefore costly than producing e-learning that is not built in accordance with UDL. Therefore reusability of content is of prime importance. The concept of the reusable learning object (RLO) has been discussed earlier as have properties of AT. The new design process will attempt to provide a framework that will allow the dissection of individual modules into independent stand alone RLO that can be tagged with metadata to allow easy search and retrieval from storage in a learning object repository. The Book module could provide an appropriate tool with which to do this as it facilitates exporting as an IMS CP. The second action point is therefore that;

- The design process needs to be improved and formalised and the principles of UDL need to be embedded into the process throughout.

The third and final action point is concerned with the identification of settings, tools and strategies within Moodle core along with Moodle plugins and third party applications that be used, installed or enabled to help satisfy the principles of UDL. As stated Moodle itself is particularly strong in the affective domain but lacking somewhat in the representation and strategic domains. As the success of the TextHelp web app illustrated the availability of a tool can make a big difference when it comes to the effectiveness of a LMS. The third action point is;

- To create a reference chart to assist in the identification of tools and settings that will help Moodle satisfy the checkpoints of UDL.

Action points 2 and 3 will be addressed in the next chapter.

6 EMBEDDING UDL IN THE DESIGN PROCESS

6.1 Introduction

As was outlined in the conclusion of the previous chapter UDL needs to be embedded throughout the design process. ADDIE is still an appropriate design methodology however the following chapter will propose a much more structured approach to it, UDL providing much of that structure. Before this done however action point 3 of the previous chapter will be addressed. A reference chart to assist in the identification of tools and settings within Moodle satisfy the checkpoints of UDL and therefore prove a valuable aid in creating UDL e-learning.

6.2 UDL and AT education

From the success experienced implementing the TextHelp toolbar along with CASTs own estimation that digital technologies, when applied using UDL principles, can enable easier and more effective customisation of learning content. Modern LMS can allow the individualisation learning content in a practical and cost-effective way. They can also offer many supports, scaffolds, and challenges to help learners understand, navigate, and engage with the learning environment (CAST, 2011). One of the reasons for selecting Moodle as the LMS for this project was because of the wide range of features it offers. It is also extensible, with a vast range of third party plugins available to download and install. The following chart is the result of research into the features and settings within Moodle core, the wide array of third party plugins available for Moodle LMS, as well as some external tools and Web Apps that could prove useful. Plugins that either satisfy or partially satisfy UDL Guidelines and checkpoints have been aligned under those checkpoints and will link to the relevant site for either download instructions and/or information. All third party plugins used within this chart have been installed and tested on Moodle 2.2 by the author. However as these are open source projects and they are constantly being updated (as is Moodle) no guarantee is being made about any of the software in this chart. It is strongly recommended that the user conducts their own test before deploying any third party applications on a production server.

6.2.1 Moodle UDL Toolkit – MUDL Chart

UDL Checkpoints satisfied by global Moodle Settings, Strategies, Tools or Plugins listed.		Checkpoint can only be fully satisfied through design strategies within Learning Object.		Tools or strategies that if used within learning object will satisfy UDL checkpoint.	
Principle 1	Provide Multiple means of Representation				
Guideline 1	Provide options for perception				
Checkpoints	Customising the Display	Alternatives for Auditory Information	Alternatives for Visual Information		
Overall	Checkpoint satisfied	Multiple media needs to be gathered and made accessible in the design phase.			
Moodle Settings & general	Allow Docking of Blocks	Transcript of all audio	Screen Reader setting (per user)		
	Allow users themes		Alt text, Longdesc and transcriptions		
Core Tools	Docking of Blocks	Upload ISL Video	Upload mp3 narration		
	My Moodle	Multiple media and HTML			
Moodle Plugins	AccessibilityBlock	Skype	Nanogong		
	Theme Switcher	OpenMeeting	Pcast - Podcasting		
External Tools or Information	Readability	Kaltura - Section 508 Accessibility media player			
	Browser and OS Accessibility	MAGpie2 Caption Authoring	MAGpie2 Audio Description Authoring		
	Apple	Microsoft	WebAim	WebAim	

Perception | Language | Comprehension | Physical Action | Communication | Executive Functions | Recruiting interest | Effort and persistence | Self-regulation

Figure 35: First page of the MUDL chart, guideline 1.

[Link to Online Chart](http://www.electroat.com/UDLCharts/mudlweb.htm) - <http://www.electroat.com/UDLCharts/mudlweb.htm>

[Link to Excel File](http://www.electroat.com/UDLCharts/mudlweb.xlsx) - <http://www.electroat.com/UDLCharts/mudlweb.xlsx>

Structure of the MUDL Chart

A full explanation is contained in the accompanying handbook that can be downloaded or viewed online at <http://www.electroat.com/UDLCharts/handbook/handbook.html>.

There are nine UDL Guidelines, the chart has nine pages in total, one page for each UDL Guideline. Each Guideline in turn has a number of Checkpoints (ranging from 3 to 5). In this chart the checkpoints are listed from left to right near the top of each page. All information in the column below that checkpoint therefore relates to that checkpoint. The column on the left of the chart gives the user more information about the contents of that row. Rather than listing all the tools and settings addressed by the toolkit the table: 7 shows a selected range and outlines how they satisfy UDL checkpoints. The chart itself it made up of hyperlinks that lead to explanations and instructions for each entry so repeating them all here is unnecessary.

6.3 Improved Design Methodology

As stated earlier the design methodology used for the first iteration of the e-learning has been identified as the primary cause of its poor result when evaluated against the UDL Checklist and also participants' views that it was less effective than content delivered face to face.

Three improvements have been identified and resulting from them a fourth strategy will also now be included in the new design process.

- 1) The design process should be formalised. The generic ADDIE model that was used is too loose. This process needs to be repeatable and so it should be better defined.
- 2) UDL was not properly considered early enough in the design process (Analyse and Design phases). It was only really a kind of bolt on at the end of the development phase. UDL needs to be considered throughout the design process.
- 3) The approach that was taken to e-learning was wrong. An attempt was made to directly substitute one delivery method (classroom) for another (online) without enough consideration being given to the intrinsic properties or characteristics that were unique to each delivery method.

The final consideration is that because creating truly UDL e-learning will be time consuming and therefore expensive, the e-learning should be designed so that each subject could be split up into reusable learning objects (RLO) that can stand independently. This will allow them to be repurposed in different courses and in different ways without (or with a minimum) editing. Or even better (this will be pursued in the further work section) perhaps create a shared learning object repository among different organisations who undertake AT training.

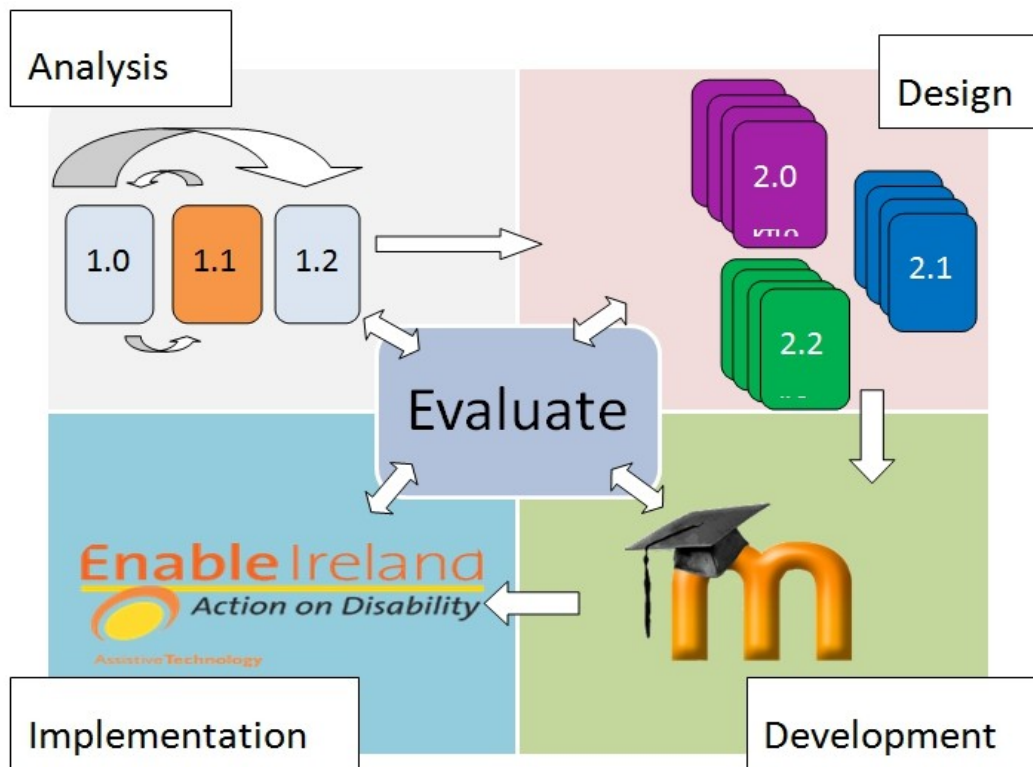


Figure 36: Improved design methodology.

The overall design methodology as outlined in the graphic above is still based on the ADDIE Model. To give the process more structure templates of forms have been made to assist in the first to stages Analysis and Design. These are the most important stages at which to plan for the implementation of the principles of UDL. By ensuring that UDL is considered throughout the process in this way, issues will be avoided in the Development and Implementation stages where they could potentially prove more costly to resolve. The forms can be downloaded in MS Excel format or printed and viewed in non-editable form within the web browser at: <http://www.electroat.com/UDLCharts>

Moodle UDL Chart previously discussed has been created to be used as a reference throughout the process of completing the forms. These forms are intended to guide the user through the process of converting an Assistive Technology training module that had previously been delivered in the traditional face to face manner within a classroom setting, into one that will be delivered online using the LMS Moodle. Therefore the assumption has been made that the user is embarking on this process with some course materials and a thorough understanding of the subject. Although the forms can be printed out (A3) and used as a hard copy, opening the file in Microsoft Excel is

preferable as the user may wish to revisit some of the decisions made within the first form as they work through the subsequent forms.

The forms are shown in Figure: 37 & 38. A handbook to guide the user in completing these forms was prepared and is available online at <http://www.electroat.com/UDLCharts/handbook/handbook.html> with a hyperlinked index for easy referencing. This handbook provides details on what information is required within every field of the forms. Rather than repeating that information here a summary of the main areas and reason for their inclusion will be outlined over the next few pages.

6.3.1 Analysis

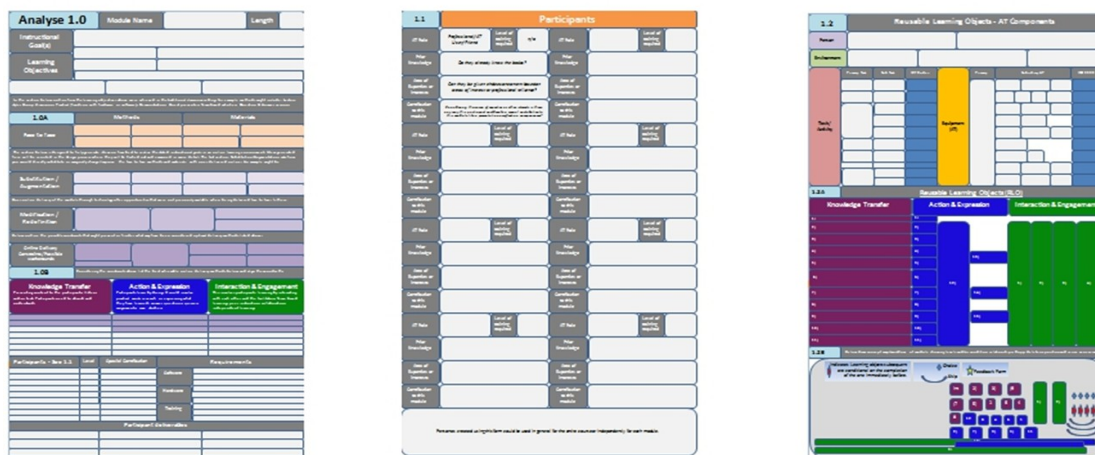


Figure 37: Three forms (1.0, 1.1, 1.2) to be used in the Analysis stage of the process.

Section 1.0

This first form is designed to allow the user outline where they are coming from and where they wish to go. It is the first stage in transforming a face to face module to one which will be delivered online and as such is about generating ideas and new possibilities. This is the first stage and used as a general analysis tool. The user is first asked to fill in the Instructional Goals and the Learning Objectives of the module. They are then asked to outline the method and materials used when delivering the module as face to face instruction. This part of the form is based on Ruben R. Puentedura’s theory on technology and transformation (Puentedura 2006). The idea is that the user first considers how the module was delivered when it was part of a face to face course (which has been outlined in the field above).

Table 6: Field from Analysis form 1.0 section 1.0A

	If the user is not familiar with the features offered within Moodle it is recommended they refer to the MUDL guide during the following fields.
Substitution	How can the Face to face techniques be directly substituted by online techniques?
Augmentation	How can the substituted online techniques be improved by other online technologies?

In this field they are asked to then suggest how those techniques and materials can be replicated or slightly improved using an online medium. For example if the module was delivered using the lecture supported by PowerPoint method a substitution might be to use SlideShare with accompanying text or an online meeting platform (Webinar) like Microsoft Meeting. An augmentation might be to record that live presentation so that it could be replayed by the course participant. It's basically the same thing with some added value like convenience and the ability to replay. Although Puentedura considers this the lower level of technological transformation it is important to point out that some content is inherently suited to this kind of presentation and it could be the best option.

Table 7: Field from Analysis form 1.0 section 1.0A

Modification	How can the use of online technologies significantly improve or add a new dimension to how the module was previously delivered?
Redefinition	Is there a completely new way the module can be delivered?

In this field the user is asked to try and think of what new possibilities might now be available to increase the effectiveness of the training now that it is being delivered online. What are the characteristics of eLearning and the World Wide Web (particularly Web 2.0) that might allow an entirely different approach to be taken, one that may have previously been impractical or even inconceivable? Some characteristics of e-Learning to be considered here might be; the ability to differentiate instruction, allowing participants with different levels of prior knowledge or different abilities to be sufficiently challenged or supported, allowing participants the scope to follow an area of particular interest or professional importance within the module. Offer a range

of methods and media to suit different learning styles. How can the features of Web 2.0 be exploited? Puentedura highlights that if appropriate and successfully implemented there is a lot of potential to create powerful new learning experiences here so it is worth the extra effort it might involve. A team brainstorming session could be a good way to approach this part of the form, all suggestions should be considered

Table 8: Field form Analysis form 1.0 section 1.0A

Online Delivery Constraints or Possible workarounds	Consider the three areas above and look for potential difficulties
--	--

Section 1.0B

The fields in this section introduce some of the concepts of Universal Design for Learning (UDL). Here the user considers the learning objectives and the methods and materials that have been suggested to achieve them and aligns them under three distinct approaches to how people absorb knowledge.

Table 9: UDL fields in form 1.0

Knowledge Transfer	Where all the content aimed at the Recognition network will be gathered. Text, presentations, audio and video all fall into this category.
Action & Expression	Where activities aimed at the Strategic network should be gathered. Where participants get to demonstrate the knowledge from the previous section and where it can be quantified, the expression of knowledge. Activities such as quizzes and assignments fall into this group, as do practical activities.
Interaction & Engagement	Where activities and tasks aimed at the Affective Network should be gathered. Activities designed to engage the participants and promote collaboration, interaction and independent learning.

Form 1.1 - Participants

In this form the user should outline the potential course participants. As this will most likely be done in advance of there being any specific knowledge of the actual participants the information entered here should be more concerned with creating persona or archetypal users. This technique has been borrowed from User Centred Design and is considered a good strategy for aiding Universal Design. A reasonable level of accuracy can be achieved because there is a defined range of roles that could

be potential participants of an AT course but the user of the forms is encouraged to use their imagination to enrich the persona.

Form 1.2

This form is where the detailed analysis of the module takes place. The subject of the module needs to be broken down into the smallest independent subsections possible. These are called Learning Objects (LO) or Reusable Learning Objects (RLO). If care is taken and they are broken down in the correct way we are offered the possibility of reusing these LO in different modules. This is important for a few reasons.

- UDL eLearning content is expensive and time consuming to produce therefore reuse if possible will allow greater value and increased efficiency.
- An AT course is often approached in different ways. The two most common approaches would be from the perspective of the technology involved, as in the “Switch Access Module” example given here, or from the task perspective, for instance Computer Access or Communication (this is the approach WATI take). It can also be approached from the Person perspective (a module on Specific Learning Difficulties for example) or from the Environment perspective (AT in School/Work). With individual modules broken down into stand alone RLO that are tagged and stored in a Learning Object Repository it is much easier to repurpose content without having to edit it. This will allow an organisation to be much more efficient when tailoring courses for specific groups.
- With content broken into subject specific chunks, RLO, it is much easier to offer course participants alternative learning paths and differentiate the instruction.
- If this becomes common practice among organisations involved in AT training there is the possibility of sharing content thus allowing for higher quality materials to be produced and organisations to specialise in producing content within their area of expertise.
-

To successfully break down an AT module we must first break down AT itself. AT involves the complex interaction of a number of components. This interaction has been examined within literature on numerous occasions and a number of theoretical

frameworks have been developed (HAAT Model, Cook and Hussey, 2002) ((Scherer,2004, MPT, 2005). The four components used here are Person, Environment, Task/Activity and AT. Most AT areas can successfully be broken down into RLO by just concentrating on the Task/Activity and AT components. There are fields for ICF and ISO 9999 codes within this section. They will be used for the tagging of the individual learning objects. This metadata will enable the easy search and retrieval of these RLO, the use of the codes will enable searches to be more accurate in cases where different terminology is used. If the RLO are not being stored in a repository filling out the codes may not be necessary.

Section 1.2A

In this section UDL is revisited but this time after completing Section 1.2 specific subjects for individual RLO should be clear and the process of aligning them to learning type should be straightforward. In general each Knowledge Transfer Learning Object (KTLO) will have one or more opposing Action Learning Object (ALO). Allowing participants an opportunity to express the knowledge or skill they have acquired. The ALO could be as short as one multiple choice question or it could be a much more complex assignment or practical work. This will usually depend on the amount or type of content covered in the KTLO. When a particular ALO relates directly to the content covered in a specific KTLO they both can be regarded as one single learning object. The reason they are dealt with separately here is purely for technical reasons concerning the authoring tools in Moodle and how it deals with questions. The Interaction Learning Objects (ILO) will generally cover content from the module as a whole. It is a good idea to have ILO as ongoing activities that will engage the participants as they progress through the module and at the end when all content is covered.

Section 1.2B

In this area the user should draw a map or plan of how the finished module and how the individual learning objects relate to each other. They should include details like conditional activities, choices and if appropriate levels. This will be the blueprint used in the Development stage.

End of Analysis Phase - Evaluate

Once section 1.2B is complete the user should evaluate what has been achieved and decided upon in the Analysis phase.

- Does this module design satisfy the Learning Objectives?
- Has the Analysis process created new Learning Objectives?
- If achieved will the Learning Objectives satisfy the Instructional Goal?

6.3.2 Design

The design phase is concerned with the design of the individual Learning Objects that together will form the complete module. The extent of the reusability of the ALO and the ILO is limited but that isn't a concern because reusability is only really important for the KTLO because of the considerable resources required to make them UDL. Any ALO that are directly related to corresponding KTLO will most probably only ever be used with that particular resource. The KTLO will however be reused and therefore each one must be capable of standing alone as a learning event. It should therefore follow an instructional design plan and UDL principles.

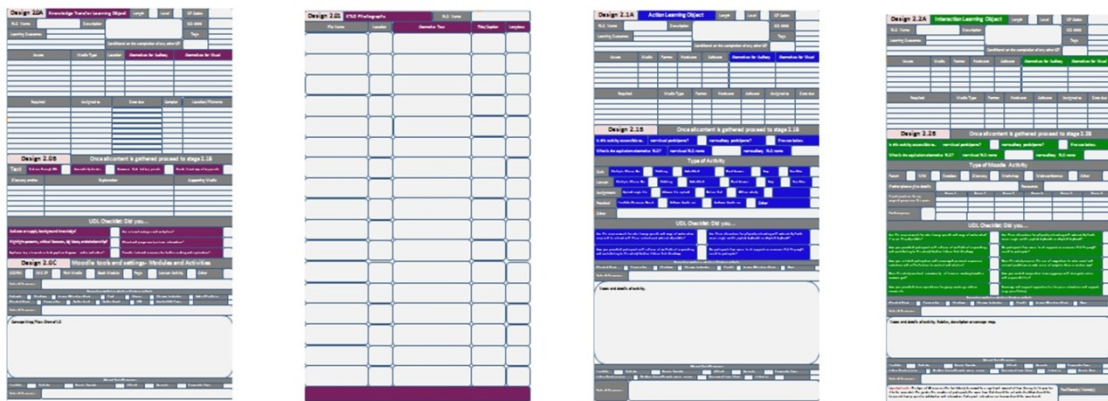


Figure 38: Four forms 2.0 (KTLO), 2.01 (Alternative Text), 2.1 (ALO), 2.2 (ILO) to be used in the design stage of the process.

Form 2.01

Form 2.01 is specifically for gathering together images and their corresponding alternative text that are to be used in each of the LO. This form should be used with any of the other design forms where images are used. The advantage of doing this at this stage ensures that the authors of the instructional content are responsible for writing the alt text or longdesc. It is common practice for alt text and longdesc to be

written by the developer of the content who often is not an expert in the subject matter and therefore may provide a substandard description of the relevant content of the image. Putting it in the hands of the content authors should ensure a higher quality.

Forms 2.0, 2.1, 2.2

Each LO must have a name, a description, learning objective(s) (these can be the overall learning objectives broken down even further or just the original learning objective of the LO), the approximate length of time to complete the LO and the level (if appropriate). As mentioned, if the LO is going to be stored in a repository then the fields for; ICF Codes, ISO 9999 and additional Tags should be completed to enable easy retrieval. The last field in the top section is related to conditional completion. If the LO is dependent on the completion of another LO, that LO's name should be entered here. This is potentially important for all LO but will be found most frequently in ALO, particularly quizzes that are based on a previous KTLO. Other major fields required for these forms are outlined in the table (APPENDIX K).

All forms should be evaluated before proceeding to the next stage.

6.3.3 Development

A copy of the form 1.2 and all 2.0, 2.01, 2.1, 2.2 forms will be given to the Moodle Developer along with any assets and content referred to within those forms. All the information needed to create the Moodle module will be contained within these forms. Once the Module has been created within Moodle final touches, graphic design and labels can be added to increase usability. The module should be fully tested at this stage using an automatic accessibility checker. Once the automatic accessibility checking has been completed and all errors fixed the module is ready for user testing. The module should be tested by a broad range of users that represent the target audience. It is likely that these tests will highlight further accessibility and usability issues. These issues must be addressed before proceeding to full implementation.

6.3.4 Implementation

Once in the production stage the instructors' roles as facilitators are one of the key factors to success. Users will need different levels of support depending on their prior experience of eLearning or ability. In order to foster participation and collaborative

practice the facilitators should be available to guide discussions on the forums, respond to messages and questions and offer timely and supportive feedback. It is a good rule of thumb when allotting time to facilitate a module to heavily weight the time in favour of the first few weeks. This is the time most support will be needed and once people start participating early in the collaborative aspects of the module they are more likely to continue.

6.3.5 Evaluation

Although formative evaluation takes place at every stage once the module has been completed summative evaluation is possible. This can involve examining all participant deliverables and assessing whether the learning objectives have been achieved and also issuing a feedback form. All participants should be asked to return the feedback form and it is a good idea to make this process part of the module. The feedback form will help further evaluation of the module and inform future iterations of the design. Questions should cover usability, features, content, participation (both of the facilitators and the other end users) and overall satisfaction. An abridged adaptation of the IDEA Centre Student Reactions to Instruction and Course could be used along with more Moodle specific questions regarding design and features. The results of the feedback form can be used in conjunction with Moodle's detailed reporting features to give a clear picture of what succeeded and what did not. If participants claimed to have liked a feature but the report shows hardly any of them actually used it, it does not necessarily mean the feature is superfluous. It could be a feature that participants thought could potentially be of use to them but happened to not be required this time. The module is never completely finished. Content will need updating and design is done in iterations with constant improvements. If the module is designed as a series of learning objects this process should be easier to accomplish.

6.3.6 Example of process used on a Switch Access Module

As the forms are acknowledged to be somewhat complex, particularly the first three, an example of them after being filled with the proposed content of a Switch Access Module is also available to users (APPENDIX L). This example can be downloaded from <http://www.electroat.com/UDLCharts> in Microsoft Excel format. They have also been included in APPENDIX I for illustration purposes. Forms 2.0 and 2.01 are also

included in APPENDIX L. All these forms illustrate the complete process of designing a UDL Knowledge Transfer Learning objects. If the switch access module was completed an additional nine 2.0 forms (KTLO), twelve 2.1 (ALO) and four 2.2 (ILO) forms would be needed. Once supplied with these it would be a relatively easy job for the Moodle developer to create a high quality UDL e-Learning module on switch access whose elements could easily be moved around and reused in different AT courses where appropriate.

6.4 Conclusion

It is proposed that through the use of these forms in the appropriate stages of the ADDIE Model and with the MUDL Chart as a reference throughout the process that a UDL AT eLearning can be created and delivered through the Moodle LMS. Furthermore because it is created in the form of Reusable Learning Objects it value as a resource will outweigh the cost of additional time and effort that it is acknowledged this process will take. Modules and entire courses could be quickly reconfigured and tailored for particular audience or theme. Differentiated instruction can be achieved in a cost effective manner allowing learners follow their own unique learning path with a comfortable learning curve that both scaffolds and challenges at the right level. This could potentially make e-learning much more effective than face to face learning. Finally modules could be easily shared among likeminded organisations using the IMS CP or the SCORM standard.

7 EVALUATION

7.1 Introduction

In the previous chapter a modified design methodology based on the generic ADDIE model was outlined. It is proposed that this improved design methodology through the incorporation of the principles of UDL throughout every stage of the process will facilitate the creation of inclusive, engaging and effective e-learning. The use of RLO serves two purposes. As it is envisaged that the creation of UDL content will involve a significant additional investment of time it is imperative that full value is extracted from the content created. It is proposed that if the content is divided into the smallest possible constituents that are still capable of producing a learning outcome these constituents or components could be easily repurposed within different modules or courses. The creation of a local Learning Object Repository has been done in the test Moodle Site <http://www.electroat.com/moodle>. This repository would be available to any instructor through the file picker making adding a RLO as easy as adding a photo. Once a critical mass of UDL RLO have been created and are available for use in this way it is proposed that it will result in significant gains in terms of efficiency for the creation and modification of modules representing at the very least a return for the additional time invested in their creation.

The second major advantage of RLO is that they greatly increase the potential of the feature in Moodle called Conditional Activity and the related Activity Completion. The combination of these two features allows an instructor (from within settings) make individual RLO only visible to participants on the completion of certain criteria. A simple example of this being used might involve an instructor starting a module with a quiz designed to assess the prior knowledge of the participants. Any participants who get 5/5 in the quiz immediately get access to more advanced RLO. Those who get 4/5 get slight scaffolding by getting access to a couple of lower level RLO before being given access to the higher level RLO and so on. Using conditional activity in this way the instructor is more likely to pitch the right level to the participant. It could also be used to pitch the right kind of content to the participant. For example participants could be asked to do a pre course questionnaire. They fill in interests as part of the

questionnaire and content could be automatically built into their course based on their interests. This is of course possible without RLO but it is not practical as the time it would take would be prohibitive. Using RLO will allow the process to be automated. The course can be created with all the RLO included however only the ones relevant to the participant will be visible to them.

It is proposed here that UDL e-learning designed and implemented as outlined above will successfully address the challenges to creating inclusive and effective AT e-learning that emerged within the literature review.

- Content will be learnable for participants regardless of ability or disability.
- It will be of relevance and interest regardless of professional background.
- Through the correct use of Moodle's many tools that could be considered aligned within the affective domain it will be effective in creating a community of practice, foster communication and collaboration within multidisciplinary groups.
- Through participants use of the e-portfolio tool it will aid the reflective process while also providing participants with a resource that they have constructed that is therefore in line with their interests both professionally and personally.

7.2 Evaluation

The improved design process posed some challenges in terms of evaluation. As it involves AT, Moodle, UDL and Learning Objects finding expert reviewers with knowledge in all four areas was difficult. The handbook, MUDL chart and design forms were made available on <http://www.electroat.com/UDLCharts>. Emails were sent to a number of international AT education experts with a request to review the work. It was also made available on the Moodle for teaching forum and the Moodle Accessibility forum <http://moodle.org/mod/forum/discuss.php?d=205677>

Contact has been received from Joy Smiley Zabala, Ed.D., ATP, Director of Technical Assistance for CAST and the National Center on AIM. Her initial feedback has been very positive but in her own words as the work is quite extensive she will need time to review it. This can be considered a positive result in itself that someone of her stature

in the AT community considers it worth reviewing. Unfortunately feedback has yet to be received from the other parties contacted.

As this process is to be used by Enable Ireland AT Training Service the review of the team members there who ultimately will be using it was always going to be of paramount importance. To these ends during a meeting with Juliann Bergin, Lead Trainer and Siobhan Long, Manager the process was worked through resulting in the Switch Access module forms in the previous chapter. The act of using the methodology along with an in-depth explanation of the process and the theory behind it gave them a thorough understanding. They were then asked a series of focused questions designed to estimate the processes usefulness to them as a training team in regard to creating inclusive e-learning and to identify any improvements that could be made to the design (APPENDIX M).

They were first asked if the design methodology outlined was a viable design process. Both answered yes, with some modification. Expanding on that one of them explained that it was enlightening and comprehensive, but they were concern about the amount of time required for preparing each module. The second question was regarding the use of Learning Objects. They were first told that the design methodology proposes splitting up the content of an AT course into small independent learning objects, primarily for efficiency and reusability. Then asked if they could think of any positive or negative impact this might have on the pedagogical effectiveness of the final course. One of them suggested that overall, for the course designers they felt this would be extremely useful and time efficient way of creating courses, but from the student's viewpoint, would have to be careful of repetition if someone takes on multiple modules. This is of course a fair point but perhaps strategies could be developed by the course designers to turn this negative into a positive. When a participant encounters an RLO they have completed in a previous module perhaps they are offered an alternative task to demonstrate their mastery of the particular concept, thus possibly allowing them to take their understanding to a higher level. The other respondent outlined two positives; firstly this design strategy facilitates designers to reconsider content in terms of: a) degree of experience/expertise of learner and b) context in which they are learning about the topic. The potential advantages of conditional activities are being alluded to here. When asked if they thought UDL was a good approach for creating

accessible e-learning both replied positively but with some reservations as to the work involved. Again concerns are expressed in relation to the amount of time that may be required to reach that critical mass of RLO that would result in increased productivity. They were then asked whether this process might be something you or your colleagues would find useful if creating inclusive e-learning? Again both replied positively to this one suggesting that it *“prompts you to think about differing ways of presenting materials to ensure all learners can access.”* When asked if they thought that the forms were overly complex one replied yes and one replied no. When asked if the accompanying handbook explain the process sufficiently both replied positively; *“Very useful, practical guide”* and *“Very clear”*. The final question was in relation to any suggested improvements to the process. The first respondent *suggested “A simplified form once individuals have designed their first few modules, with more tick/check boxes, to allow for quicker completion perhaps”*. This is a possibility in that as RLO are created they become available for use in other appropriate areas. Once there is a critical mass of RLO there could indeed be simplified forms, in fact in many cases the forms might be redundant. The second respondent replied *“Sorry, too early to comment. I welcome this UDL framework as it will assist us in shaping our approach to E Learning, using best practice in a field that to date, has had very limited e-learning materials developed for learners. I hope that this framework will assist us in extending our reach nationally and internationally, with the ultimate goal of putting more AT in the hands of end users. That will become the ultimate measure of our success.”* This in fact sums up the current stage the project is in. The methodology is ready to be used but that unfortunately is future work.

7.3 Conclusion

This chapter has outlined some evaluation of the proposed design strategy by two highly experienced and well regarded AT Training professionals. The honest appraisal of the proposed process highlighted some concerns in regard to the time and resources that might be involved in creating content of this quality. This evaluation was all the more important as they will be the trainers involved in using the process to creating the first UDL AT e-learning in the coming months. It is regrettable however that more feedback from UDL and Moodle experts was not available. Contact has been established with CAST and that will be followed up on over the coming months.

8 CONCLUSION

8.1 Introduction

In this final chapter what has been learnt over the course of this research will first be outlined in the Research Overview section, followed by what are considered to be the major contributions to the field of AT distance education and perhaps other areas. That in turn will be followed by an outline of some of the considerable amount of further work that has been identified. This chapter and dissertation will then be ended with a short conclusion.

8.2 Research Overview

The following research objectives were identified in the introduction. Here the findings will be outlined.

Establish through literature review the intrinsic properties of Assistive Technology and how they might influence an approach to AT education. The properties of AT that of particular importance in terms of education are;

AT is a system of four main components; Human, AT, Activity and Context (Cook & Hussey, 2002) Student, Environment, Task and Tools (Zabala, 2002) that all influence the outcome. These components must be considered in any modules whether they coming from the technology perspective, the task/activity perspective, the person or the environment. AT devices can be classified using the ISO 9999 and the other components can be classified using the ICF. This could provide an accurate means of tagging resources for easy search and retrieval. The ICF could potentially provide a common language for AT professionals regardless of background. The potential audience for AT education is varied. Even without considering the range of AT users, the professionals involved in the field could have very diverse educational backgrounds and interests. In the field AT support is usually carried out by a multidisciplinary team. AT Education should be user centred in line with the social model of disability. Training is usually best carried out from the activity/participation perspective.

Despite almost 20 years of work at European education in the field of AT is still quite disparate.

Review previous AT Education and Distance AT Education projects and those used in more contemporary Interprofessional Education e-learning and identify techniques and successful approaches.

Much can be learnt from the success of Enable Ireland's Certified AT Training Course. Case Studies and practical hands on approaches were particularly well received by participants. Finding the right level for the group was always a challenge as was covering content that was of perceived relevance to all participants. The Heart and subsequent KPT and "Guidebook for lifelong learning in AT" provide an excellent foundation from which to build on. The importance of the multidisciplinary aspect of AT education cannot be over emphasised. IPE informed the strategies for delivering effective e-learning to multidisciplinary groups. The IPAT case study showed how hands on practical work can be achieved as distance education through the use of videoconferencing and an equipment loan library.

Identify best practice approach in terms of its implementation and select an appropriate instructional design methodology and Learning Management System.

- The ADDIE Model as an appropriate design methodology
- Moodle as the most appropriate LMS.
- UDL as a strategy for accessibility and pedagogy

Address potential difficulties regarding accessibility and investigate Universal Design for Learning as a possible solution to these difficulties and also as a prospective pedagogical strategy.

The case study of the NDA experience creating accessible universally designed e-learning proved to be a valuable resource in informing the subsequent design of the test modules.

Investigate Universal Design for Learning as a possible solution to accessibility and also as a prospective pedagogical strategy.

Through the NDA Case Study and the subsequent review of the principles of UDL it was concluded that UDL could serve both as an accessibility and a pedagogical strategy.

Develop a Beta Prototype. Evaluate Beta Prototype and design methodology used. Bases on evaluation develop improved design methodology and supporting literature and offer it for expert review.

The user feedback from the evaluation of the pilot modules was very informative and allowed the improved design methodology to be developed. This new design methodology embeds UDL throughout the process and thus creates a much more inclusive end product.

8.3 Contributions to the Body of Knowledge

This research has made a significant contribution to the body of knowledge in a number of ways;

1. An efficient system for splitting up content on an AT course into its constituent parts to enable it to be delivered the activity/participation or technology perspective has been developed.
2. Using the ICF and ISO 9999 codes for identifying UDL AT Reusable Learning objects has been suggested. This system could be used as the basis for creating a shared Learning Object Repository between disability organisations involved in AT and greatly advancing AT distance education.
3. A connection between AT Education and UDL has been made that will make instruction in AT more inclusive and accessible.
4. The MUDL chart that maps the Principles, Guidelines and Checkpoints of UDL to specific technologies and settings within Moodle, the most widely used OSS LMS has been made available. A similar tool has not been available previously and it should enable e-learning developers create inclusive courses in any subject.
5. The design forms created, from the research carried out in this paper, are the first that have been developed for creating on-line AT training and should facilitate other AT course designers.

8.4 Future Work & Research

8.4.1 Introduction/Orientation Module

An orientation module will be created to introduce participants to the Moodle LMS.

This orientation module will have the following components;

1. Screen casts on how to use the various features and settings.
2. Alternative audio based orientation for screen reader users.
3. Guidelines on what is expected in terms of accessibility, participation and etiquette.
4. An “Ice breaker” activity.
5. An introduction forum where everyone outlines their previous experience with AT.

From the feedback received there was an obvious need for extra support for participants in using the LMS. There also was an interest expressed in a general introduction and AT experience forum. Some manner of “Ice Breaker” also seems to be effective in encouraging people to get started in the LMS (Sax, 2002). Guidelines for participation as used by (Kuech & Kimball, 2003) would be helpful for participants in clearly outlining what is expected of them. Accessibility of content from the participants’ perspective has been identified as a possible weak link in the overall UDL aspirations of the course. Again clearly outlining what is expected of participants in this regard right from the start along with providing them with the strategies they will need to employ to contribute accessible materials should go some way to mitigating this danger. Resources have been identified in this regard including the GRADE (Georgia Tech Research on Accessible Distance Education) and Open University LabSpace resources (particularly their Guidelines for describing visual teaching material).

8.4.2 First Round of Test Modules

Over the coming months it is planned that the first test module built using the design methodology outlined in this paper. The full Enable Ireland Assistive Technology Training team are invested in this project. In the evaluation concern was expressed as to the amount of time might be involved but full commitment has been given to seeing the process through for one module. The topic of the module has not been decided

upon at this stage but Speech Recognition is being considered as it is a relatively mainstream technology that is utilised by a wide range of users for different reasons. RLO from a UDL designed Speech Recognition module would fit into topics such as Computer Access, Environmental Control, Specific Learning Difficulties and Mobile Technologies as well as being a topic in itself. It would also be a topic that the Enable Ireland AT Training service is aware there is significant interest in and also one that is poorly supported to date. Once this module is built there will be extensive user testing and it is expected that findings from this as well as what is learned from working through the process will inform improvements in the methodology.

8.4.3 CAST

CAST expressed a particular interest in the MUDL chart that was compiled as part of this project. Any improvements suggested by them will be made and a fully accessible version of the chart will be made available on-line. The current on-line version of the chart is not built to web accessibility standards as it is expected it will be modified. Once a final design has been decided upon a fully accessible version will be completed. Any suggestions made by Joy Smiley Zabala in relation to the AT aspects of the design methodology will be acted upon.

8.4.4 AT Learning Object Repository (ATLOR)

The creation of a shared AT Learning Object Repository (ATLOR) with the cooperation of other disability organisations could greatly increase the efficiency and quality of online AT education. Organisations could contribute materials based on their area of expertise. The Certified Assistive Technology Training Course has since its inclusion of AT for sensory disabilities contracted out this work to presenters from the relevant areas (NCBI and DeafHear). If this strategy could be continued digitally it would undoubtedly increase the overall quality of the content. NCBI particularly have expertise in regard to creating accessible video that would be a significant resource to be able to tap into in terms of creating UDL materials. This repository would contain small reusable chunks of content that could be tagged with metadata. The metadata would allow it to be searched efficiently and provide instructions for reuse. A metadata schema would have to be agreed upon so that a general consensus on terms is reached. One possibility proposed in this paper would be to use the ICF for disability related

tagging and maybe ISO 9999:2011 for specific technologies. Codes indicating the Accessibility level of the module would also have to be agreed upon, whether it is in accordance with the principles of UDL. If an LO is not accessible to a particular segment of the population (obviously every effort will have been made to make it accessible however in certain instances it may simply not be possible) details of an equivalent will be provided. The metadata could also contain details about the level of the LO, its order (full module – higher order, video clip – lower order) and whether it is core to any course. There could also be a mechanism put in place to allow it to work in conjunction with a loan bank that would facilitate course participants to borrow hardware that is relevant to the module they are currently studying. This further work is perhaps down the line somewhat but should be achievable considering the relatively small and “tight” community that the AT Community is in Ireland, indeed worldwide. One possibility would be joining forces with NDLR (National Digital Learning Resources, of which Dublin Institute of Technology is a leading member) and creating an AT Education community or SMART CoPs. This would seem to be achievable in the short term as the infrastructure is already in place. If it was decided to go it alone the repository software Equella from Pearson has been identified as being the most suitable platform upon which to build a dedicated AT Learning Object Repository.

8.4.5 Test Moodle Site <http://www.electroat.com/Moodle>

The Moodle site that was built to install and test all the plugins and third party applications for this paper could in itself be a powerful resource;

When used with the MUDL Chart a developer could identify all the additional plugins they need to create their UDL Moodle site. Using the test Moodle site (where all these plugins are installed) they could test out the plugins to ensure that they are what is required. Finally a plugin has been installed on the test site called Moodle Flavours. This plugin allows someone with administrator permissions to select from all the third party features and Moodle settings and download them in a .zip file. Once the same Moodle Flavours plugin is installed on their own Moodle site they can use it to upload and install all the plugins and settings in one go. This has the potential to save days of time installing all the features and changing all the settings manually. The Moodle site itself would have to automatically wipe every 24 hrs if anybody was to be allowed access as an administrator. Secondly because Enable Irelands production Moodle at

<http://www.enableirelandat.com> is managed by Synergy control is limited and so many of the features on the test site cannot be implemented. A way around this is to use the Moodle test site as an LTI Provider. Learning Tools Interoperability (LTI) which has been developed by IMS is an established standard way of integrating rich learning applications (often remotely hosted and provided through third-party services) with platforms like learning management systems, portals, or other educational environments. In LTI these learning applications are called Tools (delivered by Tool Providers) and the LMS, or platforms, are called Tool Consumers (IMS, 2012). Moodle 2.2 is by default a LTI Consumer. The Moodle LTI Provider plugin can allow Moodle to act as Tool provider allowing remote systems users (LTI consumers) access to Moodle courses or Moodle activities inside a course. Therefore with this plugin installed on the test site (which it is) the production site can access to any modules built on the test site (and all the additional features). This will allow Enable Ireland to benefit from the security of a managed site and the freedom of full control over third party software.

8.5 Conclusion

The aim of this research was to develop a framework within which to create and deliver AT education as e-learning that is engaging, effective and accessible in an efficient manner through which Enable Ireland Assistive Technology Training Service can expand their reach. Universal Design for Learning was identified as the accessibility and pedagogical strategy whereby the engaging, effective and accessible targets could be achieved. Moodle was identified as the platform that would enable maximum reach and through Reusable Learning Objects and the use of a learning object repository an efficient process of creating courses will be arrived at after an initial investment of time in their construction. The design methodology outlined should insure all content created is done so in accordance with the principles of UDL. It will enable course designers who have previously only experience of designing content for face to face delivery to think in terms of the unique properties that online delivery offers. It will also assist in the breaking up of subject matter into its constituent parts to allow it to be easily repurposed in multiple courses and topics thus increasing productivity and facilitating differentiated instruction.

BIBLIOGRAPHY

Allan, C.M. et al., 2006. A conceptual model for interprofessional education: The international classification of functioning, disability and health (ICF). *Journal of Interprofessional Care*, 20(3), pp.235–245.

Allen, E. & Seaman, J., 2007. *Online Nation. Five Years of Growth in Online learning.* Needham, Mass.: Sloan Consortium. Available at: <http://www.bobbebaggio.com/Presentations/PADLA111208/online-nation.pdf> [Accessed July 13, 2012].

AS Al-Ajlan - 2009 *intechopen.com* - A Comparative Study Between E-Learning Features- <http://cdn.intechweb.org/pdfs/27926.pdf>

Asakawa, C., 2005. What's the web like if you can't see it? In *Proceedings of the 2005 International Cross-Disciplinary Workshop on Web Accessibility (W4A)*. W4A '05.

Azevedo L, Féria H, Nunes da Ponte M, Wänn J-E, Zato Recellado J (1993). *Existing Programmes in Europe and North America. Report E.1.1, European Commission Heart Line E Rehabilitation*

Barr H, Koppel I, Reeves S et al 2005 *Effective interprofessional education: argument, assumption and evidence.* Blackwell Science, Oxford

Bauer, S.M., Elsaesser, L.-J. & Arthanat, S., 2011. Assistive technology device classification based upon the World Health Organization's, *International Classification of Functioning, Disability and Health (ICF)*. *Disability and Rehabilitation. Assistive Technology*, 6(3), pp.243–259.

Bernd, T., Van Der Pijl, D. & De Witte, L.P., 2009. Existing models and instruments for the selection of assistive technology in rehabilitation practice. *Scandinavian Journal of Occupational Therapy*, 16(3), pp.146–158.

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (1956). *Taxonomy of educational objectives: the classification of educational goals; Handbook I: Cognitive Domain* New York, Longmans, Green, 1956.

Bremer, D., & Bryant, R. (2005). *A Comparison of Two Learning management Systems: Moodle vs. Blackboard* (pp.135-140). Concise paper. Otago Polytechnic. Dunedin, NZ.

BRI, D. GARCÍA, M. COLL, H LLORETA, J., 2009- Study of Virtual Learning Environments, WSEAS TRANSACTIONS on ADVANCES in ENGINEERING EDUCATION, <http://www.wseas.us/e-library/transactions/education/2009/28-888.pdf>

Burr, L. & Spennemann, D. (2004). Patterns of user behaviour in university online forums. International CAIPE, 2002 <http://www.caipe.org.uk/resources/> (Accessed 04/07/12)

Casimiro, L. et al., 2009. Grounding theories of W(e)Learn: A framework for online interprofessional education. *Journal of Interprofessional Care*, 23(4), pp.390–400.

CAST (2011). Universal Design for Learning Guidelines version 2.0. Wakefield, MA: Author.

Cook, A. M. and Hussey, S. M. Assistive Technologies. Principles and Practice, Second Edition (Mosby, St. Louis, USA 2002),

Cowan, D.D., Turner-smith, D.A. & Engineering, C.O.R., 1999. The role of assistive technology in alternative models of care for older people, in [26. Research, HMSO, 2, pp.325–346.

Craddock, G. & McCormack, L., 2002. Delivering an AT service: a client-focused, social and participatory service delivery model in assistive technology in Ireland. *Disability & Rehabilitation*, 24(1-3), pp.160–170.

de Bono, E., 1985. The Practical Teaching of Thinking Using the CoRT Method. *Special Services in the Schools*, 3(1-2), pp.33–47.

Deloitte & Touche, 2003, Access to Assistive Technology in the European Union, Social security and social integration, European Commission, Directorate-General for Employment and Social Affairs, Manuscript completed in June 2003

Disability Federation of Ireland, <http://www.disability-federation.ie/index.php?uniqueID=10246>

EIS, European Information Society, http://ec.europa.eu/information_society/activities/eten/cf/opdb/cf/project/index.cfm?mode=detail&project_ref=ETEN-510822 (Accessed, 12/07/2012)

Elsaesser, L.-J. & Bauer, S.M., 2011. Provision of assistive technology services method (ATSM) according to evidence-based information and knowledge management. *Disability & Rehabilitation: Assistive Technology*, 6(5), pp.386–401.

Equella - <http://www.equella.com/> (Accessed 04/05/2012)

Fagerberg, G., 2011. From HEART to date. *Technology and Disability*, 23(3), pp.183–189.

- Feyerer, E., Miesenberger, K. & Wohlhart, D., 2002. ICT and Assistive Technology in Teachers Education and Training. In K. Miesenberger, J. Klaus, & W. Zagler, eds. Computers Helping People with Special Needs. Lecture Notes in Computer Science. Springer Berlin / Heidelberg, pp. 297–334. Available at: <http://www.springerlink.com/content/xmjw64n3umhmk0vf/abstract/> [Accessed July 12, 2012].
- Fish, W & Wickersham, E , Best practices for Online instructors, Author, Quarterly Review of Distance Education, IAP 2009.
- Fuhrer, M. et al., 2003. A framework for the conceptual modelling of assistive technology device outcomes. *Disability & Rehabilitation*, 25(22), pp.1243–1251.
- Garrison, D.R. & Kanuka, H., 2004. Blended learning: Uncovering its transformative potential in higher education. *The Internet and Higher Education*, 7(2), pp.95–105.
- Gilligan, J and Smith, P 856 / Representing Interaction Knowledge and Capability Demands of an Assistive Technology System IOS Press 2011 doi:10.3233/978-1-60750-814-4-852 2011
- Gordon, F., Booth, K. & Bywater, H., 2010. Developing an e-pedagogy for interprofessional learning: Lecturers' thinking on curriculum design. *Journal of Interprofessional Care*, 24(5), pp.536–548.
- GRADE – Geoga Tech Research on Accessible Distance Education - <http://www.catea.gatech.edu/grade/> (Accessed 14/02/2012)
- Heerkens YF, Bougie T, de Kleijn-de Vrankrijker MW. 2012. Classification and terminology of assistive products. In: JH Stone, M Blouin, editors. *International Encyclopedia of Rehabilitation*. Available online: <http://cirrie.buffalo.edu/encyclopedia/en/article/265/>
- Heerkens, Y., Bougie, T. & Claus, E., 2011. The Use of the ICF in the Process of Supplying Assistive Products: Discussion Paper Based on the Experience Using a General Dutch Prescription Guideline. *Prosthetics and Orthotics International*, 35(3), pp.310–317.
- Hitchcock, C, Jackson, R, Meyer, A, Rose, D (2002). Providing New Access to the General Curriculum, *Universal Design for Learning*. *Teaching Exceptional Children*, Volume 35, No. 2, pp. 8-17.
- Hoening H, Landerman LR, Shipp KM, Pieper C, Richardson M, Pahel N, George L. A clinical trial of a rehabilitation expert clinician versus usual care for providing manual wheelchairs. *J Am Geriatr Soc* 2005;53:1712_20.

<http://www.tinymce.com/>

<http://www.universaldesign.ie/exploreampdiscover>

IMS Global Learning Consortium – Learning Tools Interoperability

<http://www.imsglobal.org/toolsinteroperability2.cfm> (Accessed 14/07/2012)

International Standards Organisation. ISO 9999 2011,

http://www.iso.org/iso/catalogue_detail.htm?csnumber=50982

IPAT Website <http://www.ndipat.org/about/> accessed 12/6/12

Irlbeck, S., Kays, E., Jones, D., and Sims, R. (2006). The Phoenix rising: emergent models of instructional design. *Dist. Educ.*, 27(2), 171–185.

ISO, 2009-

http://www.iso.org/iso/home/news_index/news_archive/news.htm?refid=Ref1217

Jette, A.M. & Keysor, J.J., 2003. Disability models: Implications for arthritis exercise and physical activity interventions. *Arthritis Care & Research*, 49(1), pp.114–120.

Jette, A.M., 2006. Toward a Common Language for Function, Disability, and Health. *Physical Therapy*, 86(5), pp.726–734.

Journal of Instructional Technology & Distance Learning, 1(10) [Online]

Juntunen, A. & Heikkinen, E., 2004. Lessons from interprofessional e-learning: piloting a care of the elderly module. *Journal of Interprofessional Care*, 18(3), pp.269–278.

KPT , 2007. Guidelines for Lifelong Learning in Assistive Technology. Keeping Pace with Assistive Technology. KPT Consortium, legally represented by AIAS Bologna onlus.

KPT-WP3 – Keeping Pace With Technology Final Report Workpackage, 2006

Kraus, Greg - 2011, NC State University Moodle 2.1.1 Accessibility Evaluation, <http://accessibility.oit.ncsu.edu/reports/moodle-2-1/> Accessed, 13/04/2012

Kuech, R.K. & Kimball, W.H., 2003. Preparing Teachers For Assistive Technology Using Online Learning: A Descriptive Study. *The Journal of Interactive Online Learning*, 1(3), pp.1–11.

Kumar, P., 20061000. Using Universal Design Principles for e-learning. World Conference on E-Learning in Corporate, Government, Healthcare, and Higher Education 2006, 2006(1), pp.1274–1277.

Kumar, S., Gankotiya, A.K. & Dutta, K., 2011. A comparative study of moodle with other e-learning systems. In *Electronics Computer Technology (ICECT)*, 2011 3rd International Conference on. pp. 414 –418.

- Lenker, J.A. & Paquet, V.L., 2003. A Review of Conceptual Models for Assistive Technology Outcomes Research and Practice. *Assistive Technology*, 15(1), pp.1–15.
- Long, T.M. & Perry, D.F., 2008. Pediatric Physical Therapists' Perceptions of Their Training in Assistive Technology. *Physical Therapy*, 88(5), pp.629–639.
- Luke, R. et al., 2009. Online interprofessional health sciences education: From theory to practice. *Journal of Continuing Education in the Health Professions*, 29(3), pp.161–167.
- MacDonald, C.J., Stodel, E.J. & Casimiro, L., 20060000. Online Dementia Care Training for Healthcare Teams in Continuing and Long-Term Care Homes: A Viable Solution for Improving Quality of Care and Quality of Life for Residents. *International Journal on E-Learning*, 5(3), pp.373–399.
- Machado, M. & Tao, E., 2007. Blackboard vs. moodle: Comparing user experience of learning management systems. In *Frontiers In Education Conference - Global Engineering: Knowledge Without Borders, Opportunities Without Passports, 2007. FIE '07. 37th Annual*. p. S4J–7 –S4J–12.
- Mada, Qatar Assistive Technology Centre, <http://mada.org.qa/en/> (Accessed 13/07/12)
- Matausch, K., Hengstberger, B. & Miesenberger, K., 2006. 'Assistec' – A University Course on Assistive Technologies. In K. Miesenberger et al., eds. *Computers Helping People with Special Needs. Lecture Notes in Computer Science*. Springer Berlin / Heidelberg, pp. 361–368. Available at: <http://www.springerlink.com/content/r4140l055m2m2t05/abstract/> [Accessed July 15, 2012].
- Misra, U. et al., 2005. Telemedicine in neurology: Underutilized potential. *Neurology India*, 53(1), p.27.
- Mitra, S., 2006. The Capability Approach and Disability. *Journal of Disability Policy Studies*, 16(4), pp.236–247.
- Molenda, M, (2003) The ADDIE model, *Encyclopedia of Educational Technology*, ABC-CLIO
- Mozilla, 2012, OpenBadges-Working-Paper 012312.pdf, https://wiki.mozilla.org/File:OpenBadges-Working-Paper_012312.pdf
- NDLR, National Digital Learning Resources - <http://www.ndlr.ie/> (Accessed 04/05/2012)
- Open University - Guidelines for describing visual teaching material - <http://kn.open.ac.uk/public/workspace.cfm?wpid=2709> (Accessed 14/02/2012)

Open University Labspace – Accessible e-Learning –
<http://labspace.open.ac.uk/mod/resource/view.php?id=374015> (Accessed 14/02/2012)

Puentedura, R. R. (2006). *Transformation, Technology, and Education*. Hippasus. Retrieved

Ripat, J.D. & Woodgate, R.L., 2011. Locating assistive technology within an emancipatory disability research framework. *Technology and Disability*, 23(2), pp.87–92.

Robinson, S., 2002. Video-conferencing: under-used by rural general practitioners. *Aust. Health Review*, 25(6), pp.131–135.

Scherer, M.J. & Glueckauf, R., 2005. Assessing the Benefits of Assistive Technologies for Activities and Participation. *Rehabilitation Psychology*, 50(2), pp.132–141.

Scherer, M.J. ed., 2002. *Assistive technology: Matching device and consumer for successful rehabilitation*, Washington, DC, US: American Psychological Association.

Schneidert, M. et al., 2003. The role of Environment in the International Classification of Functioning, Disability and Health (ICF). *Disability & Rehabilitation*, 25(11-12), pp.588–595.

Schraner, I. et al., 2008. Using the ICF in economic analyses of Assistive Technology systems: Methodological implications of a user standpoint. *Disability & Rehabilitation*, 30(12-13), pp.916–926.

Seelman, K. D. (2002). *Disability Studies and the Disciplines: Bridges and Chasms*. Paper presented at the Invest in Disability Week, Ann Arbor, Michigan.

Seelman, K. D. (2004). Trends in Rehabilitation and Disability: Transition from a Medical Model to an Integrative Model. *Disability World* Issue no. 22. http://www.disabilityworld.org/01-03_04/access/rehabtrends.shtml

Smith RO, Jansen CJ, Seitz J, Longenecker Rust K. ATOMS Project Technical Report: <http://www.r2d2.uwm.edu/atoms/archive/technicalreports/fieldscans/fs7/tr-fs-taxonomiesmodels-resource.html> (Accessed 12/07/2012)

Star, Susan; Griesemer, James (1989). "Institutional Ecology, 'Translations' and Boundary Objects: Amateurs and Professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39". *Social Studies of Science* 19 : 387–420

Steel, E.J. & de Witte, L.P., 2011. Advances in European Assistive Technology service delivery and recommendations for further improvement. *Technology and Disability*, 23(3), pp.131–138.

- Stern, P. & Trefler, E., 1997. An Interdisciplinary Problem-Based Learning Project for Assistive Technology Education. *Assistive Technology*, 9(2), pp.152–157.
- Stokes, Jones Toni and Richey, Rita C. (2000) Rapid prototyping methodology in action: A developmental study. *Educational Technology and Development*, 48(2), 63-80.
- Strategy for Equality, 1995, [http://www.nda.ie/cntmgmtnew.nsf/0/9007E317368ADA638025718D00372224/\\$File/strategy_for_equality_17.htm](http://www.nda.ie/cntmgmtnew.nsf/0/9007E317368ADA638025718D00372224/$File/strategy_for_equality_17.htm) (Accessed 13/07/2012)
- Technology Training project. C.Barnes and G.Mercer, Theorising and researching disability from a social model perspective, in: *Implementing the social model of disability: Theory and research*, C. Barnes and G. Mercer, eds, Leeds, The Disability Press, 2004.
- Thistlethwaite, J. & Moran, M., 2010. Learning outcomes for interprofessional education (IPE): Literature review and synthesis. *Journal of Interprofessional Care*, 24(5), pp.503–513.
- Turner-Smith, A. & Devlin, A., 2005. E-learning for assistive technology professionals—A review of the TELEMATE project. *Medical Engineering & Physics*, 27(7), pp.561–570.
- US ATA 2004. United States of America. Assistive Technology Act of 2004 <http://www.gpo.gov/fdsys/pkg/PLAW-108publ364/html/PLAW-108publ364.htm>
- US Department of Education. Evaluation of Evidence-Based Practices in Online Learning - A Meta-Analysis and Review of Online Learning Studies 2010. <http://www.ed.gov/rschstat/eval/tech/evidence-based-practices/finalreport.pdf>
- üStüN, T.B. et al., 2003. The International Classification of Functioning, Disability and Health: a new tool for understanding disability and health. *Disability & Rehabilitation*, 25(11-12), pp.565–571.
- Van Woerden, K. Mainstream developments in ICT: Why are they important for Assistive Technology? *Technology and Disability* 18 (2006), 15–18.
- Verdonck, M., McCormack, C. & Chard, G., 2011. Irish occupational therapists' views of electronic assistive technology. *The British Journal of Occupational Therapy*, 74(4), pp.185–190.
- Wainwright, K. et al., 2007. Traversing the LMS terrain. In *Proceedings of the 35th annual ACM SIGUCCS fall conference. SIGUCCS '07*. New York, NY, USA: ACM,

pp. 355–359. Available at: <http://doi.acm.org/10.1145/1294046.1294130> [Accessed April 15, 2012].

Web Content Accessibility Guidelines (WCAG) 2.0, <http://www.w3.org/TR/WCAG20/>

Whitney, G. et al., 2011. Twenty five years of training and education in ICT Design for All and Assistive Technology. *Technology and Disability*, 23(3), pp.163–170.

World Health Organisation. Glossary Of Terms For Community Health Care And Services For Older Persons”, 2004 http://whqlibdoc.who.int/wkc/2004/WHO_WKC_Tech.Ser._04.2.pdf

World Health Organization, 2010. Framework for action on interprofessional education and collaborative practice. Geneva: WHO Press.

Wynne R, ASSET PROJECT, http://www.assetproject.info/learner_methodologies/before/characteristics.htm, Accessed 04/06/12

Zabala, J. (2002). SETTING the stage for success: Building success through effective selection and use of assistive technology systems. Retrieved March 11, 2003, from <http://www.joyzabala.com/>
<http://hippasus.com/resources/tte/-> 02/05/2012

NDA, 2012, <http://www.nda.ie/cntmgmtnew.nsf/aboutushomepage?OpenPage>
<http://www.resnaprojects.org/statewide/webed/gmu03-2012.html>

APPENDIX A. Guidelines for Lifelong learning in Assistive technology- Template for designing a learning program – On Accompanying Disk

APPENDIX B. Conducting Distance Assistive Technology Services - PRESENTERS: Marci Kinas-Jerome, George Mason University and Peggy Shireley, North Dakota Interagency Program for Assistive Technology Interview transcript and email correspondences on disk.

APPENDIX C. NDA Tender Document - On Accompanying Disk

APPENDIX D. NDA e-Learning Specification Document - On Accompanying Disk

APPENDIX E. NDA User Testing Tender Document - On Accompanying Disk

APPENDIX F. NDA Interview Notes - On Accompanying Disk

APPENDIX G. Plus Minus Interesting technique done on e-learning

Plus	Minus	Interesting
<ul style="list-style-type: none"> • Flexible in terms of any time any place (as long as a computer and internet are available). • Using ICT is an important skill in terms of AT. Online course will have added benefit of strengthening this skill. • Using the principles of UDL online course could be more effective for a greater number of people. • If done right it will be more accessible to people with mobility and sensory disabilities. 	<ul style="list-style-type: none"> • The LMS and use of ICT itself might be seen as an extra barrier that less tech aware must overcome. • People need access to a computer and the internet. • Subjects that involve hands on with specialised hardware will be problematic. • Might be more difficult to assess if someone needs extra assistance. • New skills need to be learned by staff. • Impersonal. • Accessibility. • Less effective. 	<ul style="list-style-type: none"> • Making an additional module available to people not confident with ICT should be considered. • Hands on subjects involving the use of AT software could be provided using VMWare or cloud OS. • Actually easier to identify when a student is in difficulty and allows support to be given in a more discrete way. • Opportunity to learn new skills or increased workload? • Some people are different characters on line, sometimes for

<ul style="list-style-type: none"> • Will allow a small team much greater reach. • Possible revenue stream. • Opportunity to personalise learning – make everyone happy. • More cost effective for both course participants and trainers (travel expenses). 		<p>better sometimes for worse.</p> <ul style="list-style-type: none"> • Face to face interpersonal skills are very important working in AT, no online substitute for meeting someone in the flesh. • Most of the minuses can be mitigated by the right approach to e-learning.
---	--	--

APPENDIX H. Questionnaire and results – On Accompanying Disk

APPENDIX I. AT Course E-Learning Usability Responses

If you are unfamiliar with a term or can't remember how it looked open www.electroat.com/EIATScreenshots to see screen shot of that feature.

Answer Options	Very Difficult	Difficult	Easy	Very Easy	I didn't need this feature.	I wasn't aware of this feature.
Logging on	0	2	4	4	0	0
Posting to the forum	0	0	6	4	0	0
Downloading a file	0	0	5	3	2	0
Uploading a file	0	0	3	4	3	0
Changing password	1	0	7	2	0	0
Navigation. How difficult/easy was it to find the resource you were looking for?	0	1	7	1	1	0
Editing your profile	0	1	6	2	1	0
Answering quiz questions	0	0	5	4	1	0
Search forum box.	0	0	5	1	3	1
Using the Book module	0	0	7	1	2	0
Using PDF	0	0	7	3	0	0
Using the Lesson activity	0	0	6	3	1	0
Using the page resource	0	0	7	2	1	0
Using the Glossary	0	0	6	2	2	0
Using the Calendar	0	0	3	2	5	0
Sending a message	0	0	4	4	2	0
Show all topics/ show just one	0	0	4	3	2	1

topic						
Customising the display	0	0	3	3	3	1
Customising the display	0	0	2	2	4	2
Texthelp toolbar	0	0	6	1	3	0
Links to external sites	0	0	5	3	2	0
Customising the “My Home” or profile page.	0	0	6	1	2	0
Was the mobile user interface easy to use (on smart phone or tablet).	0	2	1	0	7	0
Printing a hard copy of the content.	0	1	3	2	4	0

APPENDIX J. UDL Checkless compiled for each module

APPENDIX K. Additional fields from Design forms 2.0, 2.1, 2.2

Assets & Required	The next section is where any assets from the face to face course that can be reused in the LO should be listed.
Text	This section is concerned with making the text easily to understand and accessible and a number of tools to aid this process are suggested and explained.
Glossary	All words considered difficult or unfamiliar with explanations and supporting media should be listed in this section for addition to the glossary.
UDL Checklist	The UDL Checklist section contains some key UDL checkpoints that should be used to guide the design of the LO.
Concept Map/Flow Chart	A space is provided here to allow the designer map out where assets should be used and decide the overall structure of the LO. This map will be important for the developer in the next stage.
Type of Activity (ALO)	For details see the links from the MUDL Chart. The Practical section will be used if an external activity like a Web/Resource Quest or a software or Hardware hands on session is required.
Groups (ILO)	Of the activity involves Groups or teamwork the groups can be set out here. The user personas developed in 1.1 should be used to construct these groups. In this way group activates can be planned in advance of knowing the details of the actual participants. It could significantly improve the effectiveness of this activity if the right mix of people are put in groups together. One clinical, one technical and one social for example. If random groups are required tick the appropriate box.
Blocks, Activities etc.	For details on each of these follow the links on the UDL Moodle chart.
Facilitator Name (ILO)	This is important because in order to ensure this kind of activity is successful there can be a significant ongoing time commitment. If a facilitator is defined at this point the activity will be less likely to fall through the cracks. It should also help ensure that nobody is assigned to more than they can handle, time wise.

APPENDIX L. Switch Module Example Analyse and Design Forms

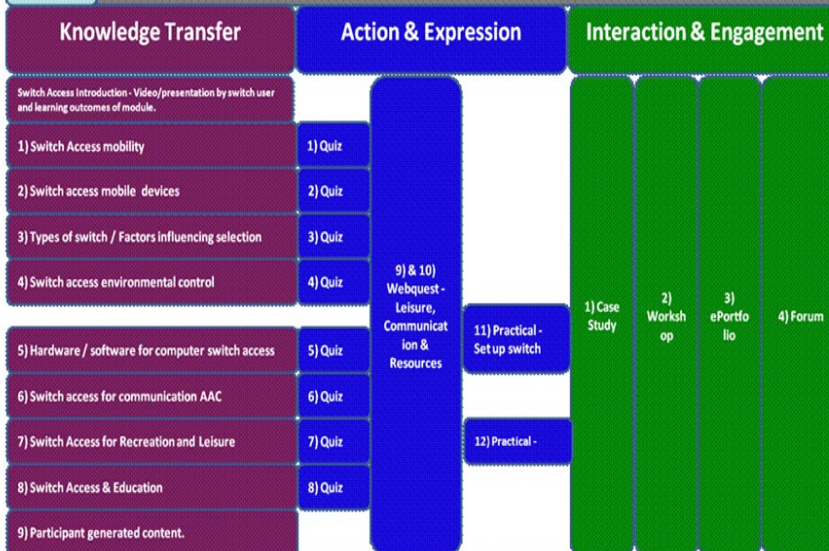
Analyse 1.0		Module Name	Switch Access	Length	2hr
Instructional Goal(s)		Participants will be familiar with hardware, software and techniques used for switch access. They will understand for whom switch access is an appropriate solution and the activities that can be achieved using the technology.			
Learning Objectives		Understand the difference between direct and indirect access.	Case Study: Based on a fictional case participants should evaluate and discuss possible software, hardware and scanning techniques to allow the user achieve the required task.		
		Participants will be able to identify and online resources for switch access.	Participants should be able to demonstrate the ability to set up switch access on a computer and send an email/access internet using an OSK and scanning.		
		Participants should be able to suggest appropriate software and hardware options for achieving various tasks.			
Participants should show evidence of learning in their eportfolios		Identify common switch types and how they should be positioned and operated.			
In the section below outline how the learning objectives above were achieved in the traditional classroom setting. For example methods might include; Lecture style, Group discussion, Practical (hands on with hardware or software), Demonstration, Guest presenter, Team based activities, Question & Answer session,					
1.0A	Methods		Materials		
Face to face	Lecture	Practical	PowerPoint/Video	Handouts	
	Discussion	Q&A	Computer/Switch	Switch access software	
The section below is designed to help generate ideas on how best to realise the stated instructional goals in an online learning environment. Ideas generated here will be revisited in the design process where they will be fleshed out and examined in more detail. The first section; Substitution/Augmentation, asks how you would directly substitute or marginally change/improve the face to face methods and materials with ones delivered online. An example might be					
Substitution / Augmentation	Quiz	Synchronous Webinar	Rich Media/Book Module	PDF Download	
	Forum	Practical	Loan of Switch/Joycable	Free/Trial Software	
Does online delivery of the module through technology offer opportunities that were not previously available when being delivered face to face. Is there a					
Modification / Redefinition	AT webquest. Given task like "Single switch user wants to text his friends. Find software/hardware to allow him achieve this task? Then vote on the best solution.		Case study using the Moodle workshop. One group comes up with a solution. Second group assess their solution using the MPT as a rubric.		In teams create a YouTube video on some aspect of switch access
					Some kind of game. Figure out the fastest scanning method of typing a certain phrase. Least amount of clicks.
Below outline the possible constraints that might prevent or hinder what may have been considered optimal delivery methods listed above.					
Online Delivery Constraints/Possible workarounds	Might be forced to use OSS scanning software if trials or licences are problematic		People who use work computers may not be allowed install software. Is there portable app switch software?		
1.0B	Considering the constraints above list the best achievable online delivery methods below and align them under the				
Knowledge Transfer Presenting content to the participants. Video, audio, text. Participants need to absorb and understand.		Action & Expression Participants learn by doing. It could involve practical work, research or expressing what they have learned; answer questions, quizzes, assignments, case studies.		Interaction & Engagement This involves participants learning by interacting with each other and the facilitators. Team based learning, peer instruction, collaboration, independent learning.	
Rich Media Module, Book Module or page		Practical		Workshop	
Know common Switch types, software and hardware		Quiz		YouTube Video	
Know activities possible using switches		WebQuest		WebQuest	
Know some Online resources		Quiz based on Knowledge transfer content		Collaborate on solution to case study	
Know different scanning techniques and when to use.		Set up switch access on a windows or Mac		Vote and comment on webquest	
		Find a technology solution and supplier		Evaluate other groups solution to case study	
				Add learning to eportfolio	
Participants - See 1.1	Level	Special Contribution	Requirements		
Personal assistant	N/A		Software	Switch Driver	
Occupational Therapist		Experience with Clicker paint and		Either SAWS or the Grid if licences can be acquired	
AT Technician			Hardware	Switch (Buddy Button)	
Social Worker				JoyCable	
Managerial Administration			Training	N/A	
Participant deliverables					
Answer all Quiz Questions		Maintain exhibis eportfolio of learning		2 practical assignments (managerial/admin exempt.)	
Start 2 discussions on forum		Contribute to Case Study		Complete at least 1 choice module	
Comment on 2 forum posts		Contribute to Workshop			

1.2		Reusable Learning Objects - AT Components								
Person	For the purposes of planning learning content the person in this case can be defined as a "switch user". Any further description or references to the ICF are not required. Relevant factors concerning body functions and structures will be considered within each learning object.									
Environment	Environmental factors such as Natural Environment & Human-made changes to environment, Support and relationships, Attitudes & services, systems & policies should be considered within all learning objects.									
Task/Activity	Primary Task	Sub Task	ICF Codes	Equipment (AT)	Primary	Subsidiary AT	ISO 9999			
	Recreation & Leisure		d920	Equipment (AT)	Games	Toys	Music	Photography	30 03 03, 30	
	Communication	Mobile communications			d3600	Mobile Phones	Tablets/Smartphones	Software/Apps		22 24 06, 22
		AAC			d335, d360	AAC Hardware	AAC Software			22 21 09, 22
		Written Communication			d3601					
	Mobility				d465	Powerchair				12 23 06
	General Tasks and demands				d2302	Door, window, curtain openers	Lights			18 21
Major Life Areas	Work		d849 - d859							
	Education		d810 - d839							

1.1		Participants					
AT Role	Professional/IT Specialist	Level of learning module	N/A	AT Role	N/A	Level of learning module	N/A
Pris Knowledge	Do they already know the basic?	Pris Knowledge	How worked with switch users before, know the basic				
Area of Expertise or Interest	Can they be given choices on content based on areas of interest or professional interest?	Area of Expertise or Interest	Special interests in IT				
Contribution to this module	Will there be levels of learning in this module? What level do they require or is appropriate?	Contribution to this module	Could be asked to outline their experience of working with switch users in the group?				
AT Role	OT	Level of learning module	N/A	AT Role	AT Technician	Level of learning module	N/A
Pris Knowledge	Yes, has worked with switch users in the past	Pris Knowledge	Some but has never worked with switch users				
Area of Expertise or Interest	working also interested in art	Area of Expertise or Interest	environmental controls, motor racing				
Contribution to this module	could do a presentation on clicker pen	Contribution to this module	Pris Knowledge could create for IC and post to forum				
AT Role	Admin	Level of learning module	N/A	AT Role		Level of learning module	
Pris Knowledge	very little	Pris Knowledge					
Area of Expertise or Interest	Interested in Learning, has done in spare time	Area of Expertise or Interest					
Contribution to this module		Contribution to this module					
AT Role		Level of learning module		AT Role		Level of learning module	
Pris Knowledge		Pris Knowledge					
Area of Expertise or Interest		Area of Expertise or Interest					
Contribution to this module		Contribution to this module					

This sheet could be filled out in general once for the entire course or independently for each module. It could be used to pitch the appropriate level for the participants.

1.2A Reusable Learning Objects (RLO)



1.2B Below draw concept map/workflow of module showing levels and/or condition relationships

