Software Support for Podcasting Mobile Lecture Content for Education in Sub-Saharan African Universities

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Dissertation

Submitted in fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Department of Computer Science, Faculty of Science

UNIVERSITY OF CAPE TOWN

Rondebosch, South Africa

November 2013

Abstract

Podcasting is fast gaining traction in developing regions as a means to augment classroom instruction. Commercial podcasting tools such as Apple's Leopard Server, Tele-task and OpenEya, despite being successfully used in the developed world (where Internet connections are fast and students have powerful multimedia devices) may not be directly transferable to the developing world due to social, economic, technical, political and cultural differences. Thus, we need to gain an understanding of podcasting in developing world Higher Education Institutions in order to develop appropriate tools. Moreover, past podcasting research shows that there is an acute lack of theoretical models, conceptual frameworks as well as evaluation models.

Consequently, this thesis employs User Centered Design techniques to offer guidance for contextual podcasting design. In particular, Participatory Action Research was used to gain a deep knowledge of developing world academics' work context and needs, identify specific requirements, develop a novel podcasting application (called MLCAT – Mobile Learning Content Authoring Tool) and ensure that they accept and use the technology. The final stage of this research was an eight week prototype evaluation aimed at evaluating MLCAT. The main contributions of this thesis are: the identification of design opportunities for podcasting tools (using Participatory Action Research) to support faculty in developing HEIs; a podcasting information ecology model; an adaptation of podcasting to developing country HEIs and a series of design and methodological contributions relating to the design of podcasting tools and other information systems.

Findings suggest that academics and students alike valued the need for a seamless podcast production process – one that does not require expensive and sophisticated infrastructure; the ability to author short podcasts or package them into small chunks; the use of Bluetooth for access and sharing podcasts as well as building on tools already in their possession as opposed to completely new ones. This research is one of the few works that relate to podcasting in developing world Higher Education Institutions. It has implications for the design of podcasting applications through an appreciation of the usefulness of research and practice in Human-Computer Interaction for development and how easily this can be adapted to understand and improve mobile learning development practice.

Dedication

To my lovely wife (Evelyn), children (Raphael and Esther), dad (Samuel Ssentongo), mum (R.I.P Margaret Sentongo), my siblings Richard, Eva and Roland.

Acknowledgements

I am very grateful for the advice and encouragement from my two supervisors, Prof. Gary Marsden at University of Cape Town and Prof. John Traxler at University of Wolverhampton. They are always optimistic and very brilliant, a trait insanely intimidating at times, but in retrospective the one thing that made this thesis possible. Their determination, encouragement, and high spirits are what kept me motivated. Given their long experience in academia, the guidance and constructive feedback have proven invaluable for my personal as well as research progress. All in all, it has been a fruitful and rewarding collaboration and I am endlessly grateful for the opportunity to work so closely together. I would also like to thank Prof. Dick Ngambi and Dr. Richard Boateng for their mentoring. Thanks are also due to the time and interest of all the study participants. Without all of you, this work would not have been possible.

Many people at the Hasso Plattner Institute UCT Center in ICT4D also played a part: Christopher Chepken, Shikoh Gitau, Ilda Ladeira, Thomas Reitmaier, Grace Ssekakubo, Richard Ssembatya, Ntwa Katule, Sena Allen, Muthoni Masinde, Ian Saunder and Fritz Meissner….the list goes on. These guys made the research lab such a fun environment with the hectic coffee breaks, muffins during group meetings and insightful chats. I cannot forget to thank all my Cape Town buddies who made life so exciting with the beer drinking partnerships, Friday 7-a-side soccer games, braais, movie nights and all.

This work was supported by a Hasso Plattner Institute (HPI) scholarship and funding from the School of Computing and Informatics Technology, Makerere University Kampala. Without this funding, I would not have been able to support myself and the family and consequently would not be able to undertake this research.

I am very thankful to my wife (Evelyn) and children (Raphael and Esther) who were loving and patient enough to allow me undertake my studies away from home for very lengthy periods. I greatly missed them and I never took that for granted. I love you to bits my angels.

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List of Published Papers

Conference Publications

1. Chepken, .C, Mugwanya, .R, Marsden, G., Blake, .E (2012): *An analysis of ICT4D technology interventions: Trends over the last decade*; Fifth International conference on Information and Communications Technology and Development (ICTD'12); ACM New York, NY, USA. pp 241 – 248.

2. Mugwanya .R, Marsden .G, Traxler .J (2012): *Pragmatic Podcasting: Facilitating Podcasting in developing Higher Education Institutions;* International Association for the Development of Information Society (IADIS) Mobile Learning Conference. Berlin, Germany pp. 285 – 290.

3. Mugwanya, R and Marsden, G (2011): *Using paper prototyping as a rapid participatory design technique in the design of MLCAT – A lecture podcasting tool*; The International Association for the Development of Information Society (IADIS) Mobile Learning Conference. Avila, Spain. pp. 43 – 51.

4. Mugwanya, R., & Marsden, G. (2010). Mobile learning content authoring tools (MLCATs): a systematic review. In *E-Infrastructures and E-Services on Developing Countries* (pp. 20-31). Springer Berlin Heidelberg.

Journal Publications

5. Mugwanya .R, Marsden .G, Traxler .J, Ng`ambi .D (2012): *Using a participatory action research approach to design a lecture podcasting system*; International Journal of Mobile and Blended Learning 2012, 4(2), published by IGI Global. pp. 67 – 86.

6. Mugwanya .R and Marsden .G and Boateng .R (2011): *A Preliminary study of Podcasting in Developing Higher Education Institutions*: *A South African Case*, Journal of Systems and Information Technology – Special Issue on ICT adoption in SA, Vol. 13 Issue: 3, pp.268 - 285

Chapter 1 Introduction

In 1977, Alan Kay and colleagues at Xerox PARC envisioned a mobile electronic device called "Dynabook"- a small portable computer in the shape of a book intended for children to access interactive software applications and digital media (Kay and Goldberg, 1977). Since the commencement of the millennium, the high penetration of mobile devices; their adoption and integration into a wide variety of settings has allowed for the field of mobile learning to grow into a set of significant activities in schools, work-places, museums, cities, and rural areas around the world (Sharples et al., 2009).

The focus on mobile learning has increased in recent years, and it has led to many research endeavors aiming at designing, implementing and deploying mobile technologies to support education (Taylor et al., 2006). This focus on mobile learning realized the introduction of a concept known as podcasting which was put forward in 2004 by Adam Curry and colleagues. Podcasting arose from a combination of the terms "broadcasting" and "iPod" (Evans, 2008); Shim, Shropshire, Park, Harris, & Campbell, 2007; Jowitt, 2008; Edirisingha et al., 2007). Evans defines podcasting as *"a form of mobile learning in which audio or video content, available on the Internet or some server can be downloaded onto a computer then transferred to mobile devices for consumption"*(Evans, 2008 pg. 492).

There are varying definitions and conceptualizations of mobile learning. According to Traxler (2007), some researchers define it purely in terms of the technologies and hardware; or learning supported by handheld and mobile technologies such as personal digital assistants (PDAs), smartphones and wireless laptops. Additionally, Traxler and Kukulska-Hulme (2005) suggest that mobile learning is learning on the move, often enabling the learner to take control over time and place, making it more impulsive and individual. O'Malley et al. (2003, Pg.6) define mobile learning as: *"any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of learning opportunities offered by mobile technologies"*. The relationship between m-learning and podcasting is such that: with mobile learning, the assumption is that students or end users have content on their devices beforehand and consumption/learning is taking place while mobile whereas podcasting is a form of m-learning which encompasses the authoring, distribution and access mechanisms.

Mugwanya et al. (2011) reveals that numerous trends have brought about increased attention to podcasting by educationalists, practitioners and other technologists. For instance, media houses are increasingly making available podcasts of selected programmes such as news and sports. However, creating content for informal exchange and entertainment is different from that for academic learning. There exists some research on the use and evaluation of podcasts in developing countries (Ngambi, 2008a; Ngambi, 2008b) although greater focus is on the universities in developed countries (Shim et al., 2007; Edirisingha & Salmon, 2007).

Equally, there has been an apparent growth of mobile learning research across the developing world (although this has been under-reported) (Barker et al., 2005). The use of cellular technology for learning in HEIs presents opportunities as demonstrated by the high penetration statistics particularly for Asia and Africa (ITU facts and figures, 2013). Considerations to adopt m-learning in developing contexts are also largely derived from challenges such as: inadequate e-learning infrastructure (Motlik, 2008; Traxler and Kukulska-Hulme, 2005); prohibitive Internet costs; inadequate skilled human resources and divides amongst students as access levels remain disparate between demographic groups (Motlik, 2008; Sife et al., 2007; Brown, 2005 and Traxler, 2007).

While Internet based learning may be unsuitable for developing world needs, mobile phones particularly m-learning holds much greater promise. The technology is more affordable; familiar to students; and does not require expensive infrastructure (Motlik, 2008). Additionally, access to m-learning content in the form of podcasts gives the user the ability to play them off-line several times; on various devices and be shared amongst different users, thus reducing Internet bandwidth requirements.

Therefore, with adequate software support and good instructional design in the developing world, m-learning promises opportunities with improved flexibility (Brown, 2005). Additionally, m-learning projects need to deal with adoption challenges that result from an over-reliance on technology imports from the developed world (Adam, 2003; Ssekakubo et al., 2011 and Mugwanya et al., 2012). This is because a number of projects have been technology-driven and geared towards understanding impact within a given context and eventually sharing reasons for success of failure. In fact, many research publications report that either students or faculty received the technologies well or that students learnt better (Evans, 2008).

Nevertheless, there are cases where the researchers reported that results did not go well for instance in the MyArtSpace project (Sharples, 2007). Its goal was to support students in bridging classroom and field trip museum studies via a platform that facilitated the use of mobile phones. On the out-set, the curators were responsible for administering the mobile devices yet, it turned out that they did not want to be involved with maintenance, charging or instructing students on their use. This can potentially skew research results.

Therefore, in order to deal with these challenges, Sharples et al. (2009) suggest that the design of mobile learning should be driven by specific learning objectives and that technology should not be the target but rather a means to enable and facilitate learning activities. In fact, Taylor (2004) claims that the field of mobile learning must develop a thorough understanding of: its impact on the way people perform learning tasks; its impact on human social processes and interactions; the learning opportunities presented by the new mobile technology and how these in turn are changed or modified by the technology. The development and results in several mobile learning projects have been affected by the use of technology solutions that do not fit the intended context due to social, economic and cultural constraints (Uys et al., 2004). These challenges affect the development and adoption of mobile learning (Traxler and Kukulska-Hulme, 2005).

Mobile learning development involves research that spans across Information Systems, Computer Science, Human-Computer Interaction and Information and Communications Technology for Development (ICT4D). There are various definitions of development each with a different focus namely: the millennium development goals (MDGs, 2011); people's livelihoods (DfID, 2001); and development as freedom or capabilities (Sen, 1999). In the context of this thesis, development accentuates empowering of faculty in developing regions to design projects while particularly incorporating the use of Information and Communication Technologies (ICT) as part of their plan. On the other hand, ICTs are basically information-handling tools which include a varied set of goods, applications and services that are used to produce, store, process, distribute and exchange information. They include radio, television, telephones, computers, satellite and wireless technology and the Internet (UNDP, 2011). ICT is an umbrella term that refers to *"any communication device or application encompassing radio, television, cellular phones, computers, network hardware, software satellite systems as well as various services and applications associated with them such as video conferencing and distance learning"* (Mafa and Mpofu, 2013 p.33).

Moreover, many of the issues faced by mobile learning projects are similar to those in Information Systems development. This implies that improved development practice is key to more sustainable results in mobile learning. Thus, this thesis postulates that by involving academics in design, through Human-Computer Interaction for Development (HCI4D) approaches, the researchers can get a deep knowledge of their work contexts and needs, identify specific requirements and ensure that they adopt and use the technology (Boehner et al., 2007). This is one of the driving forces that helped to identify the questions that guided the research presented in this thesis.

1.1 Problem definition and motivation

Learning demands from mobile devices are increasing, thus presenting challenges for content creation (Gugerbauer, 2004; Kuo and Huang, 2009). The challenges lie in authoring quality content and difficulty in using podcast authoring tools by academics due to: steep learning curve(s); some academics being recalcitrant and resistant to change; and inadequate institutional support (Hsiao et al., 2008 and Tortora et al., 2002). Moreover, other challenges relate to a lack of appropriate design and evaluation techniques owing to the complexity of m-learning initiatives as they often propagate technology that lacks contextual fit; has limited reach; presents sustainability and adoption challenges (Traxler and Kukulska-Hulme, 2005; Ssekakubo et al., 2011 and Mugwanya et al., 2012).

Additionally, current developing world m-learning initiatives are developed world imports whose outcomes may not be directly transferable due to social, economic and cultural differences (Adam, 2003; Vesisenaho, 2010 and Chepken et al., 2012). Therefore, the research presented in this thesis applies User Centered Design (UCD) methods and techniques (Beyer & Holtzblatt, 1997). In particular, Participatory Action Research (PAR) (Montero, 2000) is used as presented in chapter four to create a more general system that is (a) human-focused through the use of UCD and (b) is focused on a minimum specification so it can be more general across technical contexts and (c) can work in a 'low-tech' place like Sub Saharan Africa.

1.2 Research Questions

This thesis postulates that mobile learning development practices can be improved to enhance the results of future research projects in terms of long-term utilizable results. In order to augment the understanding and aid the development process, the following research questions were identified:

RQ1. What are the current podcasting practices, limitations and experiences in developing world Universities?

RQ2. How can techniques from Human-Computer Interaction for Development (HCI4D) support the design of podcast production tools that are suited to lecturers and students needs in developing HEIs?

RQ3: How is podcast content/media used by students? What are lecturers' and students' perceptions of podcasts/podcasting?

The first research question aims to investigate the state of the art in m-learning research. In particular, the question seeks to provide a better understanding of the field, podcasting experiences and identify limitations so as to guide the development of relevant technology interventions. The second research question revolves around appreciating the usefulness of research and practice in HCI4D and how easily this can be adapted to understand and improve mobile learning development practice. Lastly, the third and final research question looks at how podcast content is used and the perceptions that students and lecturers have towards the podcasting processes.

1.3 Limitations

This thesis is concerned only with the development practices of mobile learning drawing from the field of HCI4D. The development of mobile learning indeed requires knowledge on pedagogy for instance learning, cognition theories and social communication although these areas are not explicitly addressed in this research. The development practices discussed in this thesis only point towards the need for such considerations.

1.4 Research Contributions

This thesis aims to explore and contribute to the growing body of m-learning research and literature by documenting some detailed studies where existing HCI methods were tried, tested and discussed. The technology designs are presented and evaluated in developing HEIs. In summary, the main research contributions presented in this thesis are:

1. The identification of design opportunities for podcasting tools to support faculty in developing HEIs. Based on a lead user study with academics at a developing region HEI, this thesis presents the major information needs and gaps.

2. The development of a podcast information ecology model. This is achieved by modeling observations from our early user studies, extrapolating and showing how developing world models differ from developed world models.

3. We show how ideas from our podcast ecology model were combined with ideas and concepts by other researchers to produce a new contextual podcast tool design using Participatory Action Research (PAR). This strategy led to the development of the novel Mobile Learning Content Authoring Tool (referred to as MLCAT) which is documented in this thesis.

4. Finally, we present an adaptation of podcasting to developing HEIs and a series of design and methodological contributions relating to the usage of MLCAT.

1.5 Thesis Overview

The rest of this thesis is organized as follows. The second chapter introduces the theoretical foundations of this work. It begins with an overview of the status of ICTs in African HEIs then reviews the diffusion of ICTs in African HEIs as well as their implications for m-learning. This information helps to frame the domain to which this thesis attempts to contribute. This is followed by a review of mobile learning development and subsequently podcasting. This chapter then goes on to review podcasting tools, trends in podcast tool design as well as constraints for podcasting tools - a central theme to this thesis.

In chapter three, this thesis provides an overview of what is meant by ICT4D and HCI4D. This is followed by a review of existing mobile learning literature in order to determine what methods or techniques have been used within the m-education space. More specifically, this chapter reviews mobile learning literature related to empirical research, technology prototypes and relevant theories. Each of these areas is concluded by critical discussions of contributions towards empirical research, technology prototypes and theory respectively.

This is followed by a presentation of the critical analysis of previous research which describes the selection of research methodology; a narrative on Participatory Design; an account of how the design solution was generated and evaluated as well as the research challenge put forward in this thesis.

Chapter four describes the Action Research – Participatory Design cycles which led to the identification of opportunities for designing a podcasting system to support faculty in developing HEIs. The first study (i.e. study A) provided a baseline for podcasting in African HEIs. The primary data collection tools were six semi-structured interviews and a students' survey (between July and October 2009) to find out their experiences and challenges with podcasting.

In Study B, the researcher scheduled Participatory Design Workshops with eight academics from Computer Science and Information Systems departments between November and December 2009. These sessions were conducted on different days at the University of Cape Town and Makerere University with a purpose of refining requirements for the proposed tool. The designer facilitated a PD process in order to develop a new version of a podcast authoring tool. Consequently, Study C involved evaluating the low-fidelity prototypes with five of the seven academics (from study B) during the period between January 2010 and February 2010.

In Study D (i.e. the TSiBA exploratory study), the researcher attended ten meetings, usually in the afternoon, for periods of one to two hours each between June and August 2011 with three academics at TSiBA – a private Higher Education Institution in Cape Town, South Africa. The researcher conducted interviews with the three academics and a survey with twenty six students in order to find out their experiences and challenges with podcasting given that the researcher was planning to change test site for the MLCAT deployment. In order to evaluate the high-fidelity prototype (Study E), it was deployed at TSiBA between September and November 2011. The prototype was used by three lecturers who were teaching undergraduate courses in business namely; Strategic management, a foundations course in economics and applied financial management. Results from this study led to alterations to both the client and server systems in time for further deployments at Makerere University in Uganda.

The fifth chapter then discusses a prototype evaluation of MLCAT. During the Makerere University deployment, the researcher wanted to be sure (with the usability evaluation conducted in July 2012 and presented as study F) that the podcasting system was robust enough. Makerere University academics who all lecture at the International University of East Africa were allowed to use MLCAT from July to September 2012 and students to access lecture podcasts. Consequently, semi-structured interviews with the five academics (i.e. study G); surveys with twenty six IUEA students (i.e. study H) and three focus groups with six students each (study I) were conducted between July and September 2012 in order to find out their experiences with MLCAT; what access devices students owned and their perceptions of podcast use. Studies G and H helped in deriving themes and their respective verbatim quotes to support them.

Results from the previous studies (i.e. F, G, H and I) fed into the card sort study with Makerere University academics (i.e. study J). The dataset was rich in qualitative data which provided a number of keywords/phrases which were used to form word cards. Card Sorts with three MAK academics were carried out in September 2012 in order to uncover, in more depth, how podcasting is constructed by academics and students during their different snapshots of use. The constructs identified by participants during the card sorts formed the basis for the laddering interviews (i.e. study K) which followed through directly after. Therefore, the same participants from the card sort study took part in the laddering sessions.

Finally, chapter six concludes by providing a summary of thesis contributions and perspectives for future work.

Chapter 2 Conceptual Background

2.1 Introduction

This chapter provides a conceptual grounding to the research in this thesis, and defines the key terminology used in subsequent chapters. In fact, many sections of the text in this chapter have appeared in the author's paper titled *"A Preliminary Study of Podcasting in developing Higher Education Institutions"* (Mugwanya et al., 2011). Section 2.2 describes an overview of the status of ICTs in African HEIs; sub-section 2.2.1 describes ICTs diffusion in African HEIs while sub-section 2.2.2 reviews implications for m-learning in Africa. Section 2.3 explores mobile learning development while section 2.4 is concerned with podcasting. Sub-section 2.4.1 presents podcasting tools; sub-section 2.4.2 discusses trends in podcast tool design - a central theme to this thesis whereas sub-section 2.4.3 explores constraints for podcasting tools. Section 2.5 then provides a summary of chapter two.

2.2 Overview of the status of ICTs in African HEIs

In their status reports on ICT and Higher Education (HE) in African countries, Ngugi et al. (2007) and Farrell et al. (2007) reveal that many African governments identified ICTs as a national development priority over a decade ago. This is evident through the formation of dedicated ministries to facilitate the technology birth. They are tasked with developing and improving ICT infrastructure, creating information societies, national ICT plans and strategy, provision of Internet access, educational reforms, reducing the computer-to-student ratio, realizing computer literacy, communication facilitation, setting up e-learning centers and sharing content and curricula (Ngugi et al., 2007).

The term Information and Communication Technologies (ICTs) refers to information-handling tools – a varied set of goods, applications and services that are used to produce, store, process, distribute and exchange information. They include the "old" ICTs of radio, television and telephone, and the "new" ICTs of computers, Internet, satellite, wireless and handheld technology (UNDP, 2001). In the context of this research, the term ICTs is also used to include e-learning, m-learning and podcasting technologies. These technologies refer to those that are used in authoring, distribution, access and tracking of educational activities in HEIs.

South Africa, where the researcher is undertaking their doctoral studies has moved forward in terms of ICTs access since 2000 compared to the rest of Sub-Saharan Africa (SSA). South Africa has more fixed lines, Internet users (including broadband subscribers) and mobile subscribers – this increased from 29.78 subscribers per 100 inhabitants in 2002 to 126.83 subscribers per 100 inhabitants by 2011 (ITU, 2011). Additionally, ICTs are being taken seriously in teaching and learning in South African HEIs (Brown, & Czerniewicz, 2008). They further reveal that SA HEIs are spending more on ICTs than previously, despite a lack of knowledge about how these developments have panned out in practice. Some successful projects include Dr. Maths on MXit (a free mobile instant messenger service) which provides a platform for tutors to help students with Mathematics homework (Ford and Botha, 2009).

Despite these developments, developing world HEIs have generally remained very much behind those of other regions such as the Americas, Europe and the Pacific's in embracing sector reforms and the successful use of ICTs (Adam, 2003). In fact, even in South Africa, progress on the adoption of ICTs has remained uneven with the majority of HEIs adopting a piece-meal add-on approach (Moll et al., 2007 and Mugwanya et al., 2011). Although, there has been some progress, the effectiveness of ICT usage in many HEIs has proved very complex. Consequently, Brown et al. (2007) reveal the following as barriers to implementing e-learning technologies:

- Infrastructure – lecturers are constrained in their use of ICTs for teaching through lack of adequate on-campus facilities and poor institutional and collegial support for e-learning; lack of local technological capacity to sustain use of ICTs; technical problems associated with using ICTs for teaching/learning and lack of infrastructure off-campus.

- Lack of capacity/skills – this is a major concern for some academics when it comes to the use of technology in learning.

2.2.1 ICTs diffusion in African HEIs

The majority of HEIs in Africa have neither well established ICTs strategies nor management information systems that provide consistent figures on their ICT usage (Brown et al., 2007).

Departments that are more technologically inclined are normally mandated to implement ICT related infrastructure and therefore often receive ICT equipment through donations and direct purchase without any institutional-wide coordination (Adam, 2003). Nevertheless, it is possible to make an inference on the overall perspective of African countries using HEI-ICTs related variables such as: the existence of a national ICT policy framework (a set of principles and goals intended to govern the development, implementation, adoption, monitoring, evaluation and application of ICTs in Institutions or nations); mobile subscriptions (subscriptions to a public mobile telephone service using cellular technology which provides access to the public switched telephone network (World Bank, 2013).

Mobile subscription figures are normally used to give an indication of mobile phone prevalence and ownership and e-learning initiatives (ICT projects that facilitate teaching and learning in HEIs). Examples of such projects are presented in Farell et al., 2007); availability of institutional e-learning policy (a set guidelines intended to govern the development, implementation, adoption, monitoring, evaluation and application of ICTs within the HEI setup); infrastructure access (availability of hardware, software, networks, internet connectivity, buildings and electricity among others); Internet connectivity (i.e. the ability to access and connect to Internet services and the World Wide Web via individual computer terminals, computers, mobile devices, and computer networks); local content access (refers to the accessibility of digital education content based on the local curriculum frameworks available in the different African countries' educational institutions); rural-urban divisions (refers to the disparity in access to ICTs between rural and urban areas); gender inequalities (refers to the disparity in access to ICTs across gender); human resource development capacity (HRD) (In the context of this thesis, it refers to the availability of adequate highly qualified staff to develop, monitor and evaluate ICTs usage within African HEIs); availability of m-learning initiatives e.g. podcasting (refers to ICT projects that facilitate teaching and learning with mobile handheld devices in HEIs) and whether the ICT initiatives are sustainable (refers to the performance and impact of ICTs usage in HEIs).

These variables were adopted from status reports on surveys of ICTs and education in Africa by Farrell et al. (2007) and Ngugi et al. (2007). These variables represent what helps and what hinders in the implementation of ICTs in African HEIs. Moreover, the status of ICTs in African higher education mirrors the overall e-readiness of the respective countries.

Table 2-1: ICTs in Education variables cross tabulated against their provisioning in 53 African Countries

Variable Country	ICT Policy Framework	Mobile Subscription (per 100 p'ple - 2007)	E-learning Initiatives	Institutional E-Learning Policy	Infrastructure access	Internet Connectivity	Local content access	Rural/Urban Divisions	Gender Inequity	HRD	M-Learning Initiatives	Sustainability
Algeria	✓	63.34	✓	??	Still poor	Still poor	??	✓	✓	X	X	X
Angola	??	19.43	??	??	Still poor	✓	X	✓	??	X	X	X
Benin	??	20.98	✓	??	Still poor	✓	X	✓	??	Still low	X	X
Botswana	✓	75.84	✓	??	Very good	Still poor	X	✓	??	Still low	X	X
Burkina Faso	✓	10.9	✓	??	Still poor	Still poor	??	✓	✓	??	X	X
Burundi	X	2.94	X	X	Still poor	Still poor	X	✓	✓	X	X	X
Cameroon	X	24.45	✓	X	Still poor	Still poor	X	✓	✓	Still low	X	X
Cape Verde	✓	27.9	??	X	Still poor	✓	??	✓	X	??	X	X
CAR	✓	2.99	??	X	Still poor	Still poor	??		✓	??	X	X
Chad	X	8.52	✓	X	Still poor	✓	X	✓	✓	X	X	X
Comoros	✓	4.77	✓	X	Still poor	Still poor	X	✓	??	Still low	X	X
DRC	X	10.52	✓	X	Still poor	Still poor	X	✓	✓	Still low	X	X
The Congo	✓	35.4	✓	X	Still poor	Still poor	??	✓	✓	X	X	X
Cote d'Ivore	??	36.6	✓	X	Still poor	Still poor	??	✓	✓	X	X	X

Key:

✓	Existence		??	Not Clear		X	Non-existence

Table 2-1: ICTs in Education variables cross tabulated against their provisioning in 53 African Countries

Variable Country	Policy Framework	Mobile Subscription (per 100 p'ple - 2007)	E-learning Initiatives	Institutional E Learning Policy	Infrastructure access	Internet Connectivity	Local content access	Rural/Urban Divisions	Gender Inequity	HRD	M-Learning Initiatives	Sustainability
Djibouti	X	5.4	✓	X	Good	some	??	✓	X	Still low	X	X
Egypt	✓	39.8	✓	X	✓	✓	✓	✓	✓	Still low	X	✓
Equatorial Guinea	X	43.35	✓	X	Still poor	Still poor	??	✓	✓	??	X	X
Eritrea	✓	1.44	??	X	Still poor	Still poor	??	??	??	Still low	X	X
Ethiopia	✓	1.45	✓	X	Still poor	Still poor	X	✓	✓	Still low	X	X
Gabon	✓	87.86	??	X	✓	✓	??	✓	✓	Still low	X	X
The Gambia	??	46.58	??	X	Still poor	Still poor	X	✓	✓	Still low	X	X
Ghana	✓	32.39	✓	X	✓	✓	X	✓	✓	✓	X	X
Guinea	??	2.36	??	X	✓	✓		✓	✓	Still low	X	✓
Guinea Bissau	X	17.48	X	X	X	X	X	??	??	X	X	X
Kenya	✓	30.48	✓	X	✓	✓	X	✓	✓	Still low	X	X
Lesotho	✓	22.71		X	Still poor	Still poor	X	✓	✓	Still low	X	X
Liberia	X	15.01	??	X	Still poor	Still poor	X	✓	✓	Still low	X	X
Libya	✓	73.05	✓	X	✓	✓	✓	✓	✓		X	✓

Key:

✓	Existence		??	Not Clear		X	Non-existence

Table 2-1: ICTs in Education variables cross tabulated against their provisioning in 53 African Countries

Variable Country	Policy Framework	Mobile Subscription (per 100 p'ple - 2007)	E-learning Initiative	Institutional E-Learning Policy	Infrastructure access	Internet Connectivity	Local content access	Rural/Urban Divisions	Gender Inequity	HRD	M-Learning Initiatives	Sustainability
Madagascar	✓	11.27	✓	x	Still poor	Still poor	x	✓	??	x	x	x
Malawi	✓	7.55	??	x	Still poor	Still poor	x	✓	✓	x	x	x
Mali	✓	20.13	??	x	Still poor	Still poor	x	✓	✓	x	x	x
Mauritania	??	41.62	✓	✓	✓	??	??	✓	✓	x	x	x
Mauritius	✓	74.19	✓	x	✓	✓	??	??	??	??	x	x
Morocco	✓	64.15	✓	x	✓	✓	??	??	??	x	x	x
Mozambique	✓	15.42	x	x	Still poor	Still poor	x	✓	✓	x	x	x
Namibia	✓	38.58	✓	x	✓	✓	x	??	✓	x	x	x
Niger	✓	6.33	✓	x	Still poor	Still poor	x	✓	✓	x	x	x
Nigeria	✓	27.28	✓	x	✓	✓	x	✓	✓	x	x	x
Rwanda	✓	6.98	✓	x	✓	✓	x	✓	✓	x	x	x
Sao Tome & Principe	x	19.09	??	x	Still poor	Still poor	x	✓	✓	x	x	x
Senegal	✓	33.31	✓	x	✓	✓	✓	✓	✓	x	x	x
Seychelles	✓	89.23			✓	✓			??	x	x	x
Sierra Leone	??	13.23	??	x	Still poor	Still poor	x	✓	✓	x	x	x

Key:

✓	Existence		??	Not Clear		X	Non-existence

Table 2-1: ICTs in Education variables cross tabulated against their provisioning in 53 African Countries

Variable Country	Policy Framework	Mobile Subscription (per 100 p'ple - 2007)	E-learning Initiative	Institutional E-Learning Policy	Infrastructure access	Internet Connectivity	Local content access	Rural/Urban Divisions	Gender Inequity	HRD	M-Learning Initiatives	Sustainability
Somalia	x	6.9	✓	x	Still poor	Still poor	x	✓	✓	x	x	x
South Africa	✓	87.08	✓	✓	✓	✓	Still low	✓	??	✓	✓	✓
Sudan	✓	19.39	✓	x	✓	✓	x	✓	x	x	x	x
Swaziland	✓	33.29	✓	x	Still poor	Still poor	x	✓	??	x	x	x
Tanzania	✓	20.4	✓	x	Still poor	Still poor	x	✓	??	??	x	x
Togo	✓	18.08	✓	x	✓	✓		✓	✓	x	x	x
Tunisia	✓	75.94	✓	x	✓	✓	??	✓	x	Still low	??	??
Uganda	✓	13.58	✓	x	✓	✓	x	✓	✓	Still low	x	x
Zambia	✓	22.14	✓	x	✓	✓	??	✓	✓	Still low	x	x
Zimbabwe	✓	9.18	✓	x	Still poor	Still poor	x	✓	??	x	x	x

Key:

✓	Existence		??	Not Clear		X	Non-existence

Source: adapted from Farrell et al. (2007) and Ngugi et al. (2007)

The matrix in Table 2-1 presents a summary of the ICT variables cross tabulated against their provisioning in all African countries. Countries with higher mobile penetration rates, e-learning initiatives and Internet penetration enjoyed significant ICTs access in general. Adam (2003) reveals that an indication of ICTs use in HEIs can be obtained from basic indicators i.e. penetration of telephones, mobile phones, computers and the Internet. Therefore, countries like South Africa, Tunisia, Seychelles, Morocco, Libya, Gabon, Egypt and Botswana have achieved increased ICTs penetration (particularly "new ICTs" i.e. computers, Internet, mobile devices, etc.) as well as a relatively advanced use of ICTs in their higher education sectors.

Additionally, these countries rely heavily on innovations in the HEIs and have thus attained high ICTs penetration in addition to a relatively sophisticated use. These countries have also achieved mobile subscriptions of over one hundred per a hundred inhabitants. The greater part of the matrix represents the gaps or challenges and hence opportunities similar to those presented by Isaacs et al. (2011). For instance; over 36 countries in Africa have ICT policy frameworks with only Somalia, Liberia, Guinea Bissau, Equatorial Guinea, Djibouti, Democratic Republic of Congo, Chad, Cameroon and Burundi not having as of 2007. This may have implications on the implementation and adoption of ICTs in HEIs. Similarly, the matrix reveals that Guinea Bissau, Mozambique, Burundi had no e-learning initiatives whereas it was not clear for Eritrea, Gabon, the Gambia, Guinea, Liberia, Malawi, Mali, Sierra Leone, Sao Tome & Principe, Lesotho, Cape Verde, Central African Republic and Angola. Only South Africa and Mauritania had institutional e-learning policies whereas only Senegal, Egypt and Libya had local content access. Generally, 43.4% of the countries had some Internet connectivity access whereas Guinea Bissau was the only country reported not to have Internet connectivity as of 2007. This situation should improve in the near future with the layering of more undersea cables and the lowering of data costs. Additionally, only South Africa reported having some m-learning initiatives implying that Africa has not yet fully exploited the prevalence of mobile phones, to develop content within the HEI set-up that can be consumed on these devices.

Therefore, the diffusion of ICTs in African HEIs has been limited by the following factors: HEIs have still failed to develop and implement institutional ICT strategy with a few exceptions and increasing student enrolments (which has been partially overcome by an increase in the number of public, private universities and other tertiary education institutions) (Ojo and Awuah, 1998).

Although, this is in line with World Bank's Millennium Development Goals (MDGs, 2011), it has led to overcrowding and straining of the HEI system. Furthermore, there is reduced HEI funding as many African governments focus on primary education (Keats and Schmidt, 2007; Adam, 2003). As a result, HEIs are forced to recruit more students despite inadequate infrastructure and staffing, implying difficulty to sustain the various ICT initiatives; empower teaching professionals to create local educational content and increase awareness and commitment by HEI administrators. The quality and availability of Internet speeds available to universities in Africa continues to remain inadequate; there is a lack of resources to provide training for ICT staff as well as the large rural-urban divisions. Moreover, there is limited research on the impact of ICTs in HEIs – the impact is definitely there but unclear (Uys et al., 2004).

African HEIs are making some progress for instance on Internet connectivity and ICTs access but are still lagging far behind their developed world counterparts in the knowledge and information society revolution (Keats and Schmidt, 2007). Firstly, they need knowledge, skills and vast resources to partake in the knowledge society discourse. *"In the developed world, governments have played a key role in creating conducive environments for the flow of knowledge whereas many African governments create difficulty, making it challenging for ICTs adoption and knowledge diffusion"* (Adam, 2003: pp 199). In order to review and compare the situation in developed world HEIs, Altbach et al. (2009) in their report on trends in global higher education: tracking an academic revolution, prepared for the UNESCO world conference on higher education, reveal that the United States of America was one of the first countries to realize mass higher education, with 40% of the age cohort attending post-secondary education in 1960.

While some developing countries (as of 2003) were still educating fewer than 10 percent of the age group, almost all countries have dramatically increased their participation rates. This was followed by Western Europe and Japan which experienced rapid growth in the 1980s, followed East Asia and Latin American countries. Currently, China and India have the worlds' largest and third largest academic systems respectively. Figure 2-1 shows that by 2007, there were 150.6 million HEI students globally representing an increase of approximately 53% since 2000. In low-income countries tertiary-level participation has improved only marginally, from 5% in 2000 to 7% in 2007 with Sub-Saharan Africa having the lowest participation rate in the world (i.e. 5%).

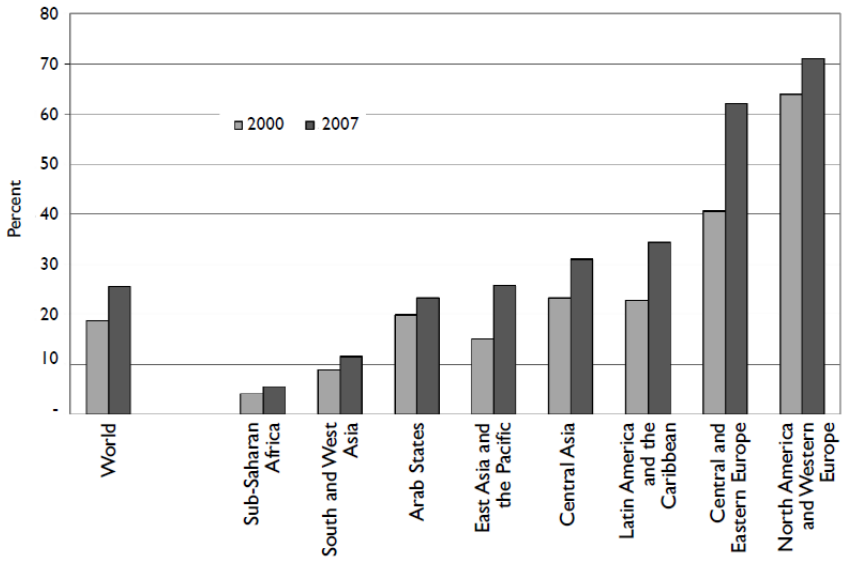


Figure 2-1: Tertiary gross enrolment ratio by geographical region from 2000 to 2007

Source: (Altbach et al., 2009)

If you compare ICT figures in the developed world with those of the developing world, the rate of diffusion in the developing world appears more startling still. For instance, according to ITU facts and figures (2013), Africa had 63.5 mobile cellular subscriptions per one hundred inhabitants compared to Europe's 126.5 and the America's 109.4. Despite the fact that these figures are higher than those in Africa, it has registered higher increments year on year and the figures will continue to rise. Households with Internet in Africa were only 6.7 per one hundred inhabitants compared to 77.3 in Europe and 60.3 in the Americas.

According to Motlik (2008), the developed countries were strong adopters of Internet technology. For instance, in North America, the lack of a unified standard (by 2008) inhibited the growth of hand-held technologies as well as the growth and development of the 3G digital wireless networks and mobile phones that can allow high speed data transfers. Despite this, North America has been the driving force behind Internet-based distance education. Currently, according to ITU (2013), mobile penetration figures in developed countries stand at 128% versus 78% households with Internet. These figures are considerable higher than in the developing world where there is 89% mobile penetration and 28% households with Internet.

Therefore, African HEIs have much to contribute to bridge the digital divide. Most notable is the recognition that the use of ICTs (particularly mobile devices which are the preferred technology in SSA) can enhance the development process, principally through its application in education.

2.2.2 Implications for m-learning in Africa

In many developing countries, new technologies are often considered the key to increasing access to higher education (Isaacs et al., 2012). Despite this, there are huge costs and challenges associated with ICTs in terms of hardware, software, technical support, licences, training and continual upgrades (Vesisenaho, 2010; Uys et al., 2004 and Adam, 2003). Moreover, Africa is still lagging behind in terms of access to high speed Internet in addition to being left behind as information production and diffusion moves down technological pathways to which they have limited or no access (Adam, 2003). Hence, this research aims to take into account the challenges presented in Table 2-1 in order to create opportunities for developing relatively cheap software that can help academics author podcast content for students is developing HEIs. This will help reduce pressure on HEI infrastructure which is limited or non-existent in some cases by offering a stand-alone tool that can author and distribute content for students to access via Bluetooth using feature phones (i.e. those with basic functionality e.g. camera, Bluetooth and some storage space). This may solve the inadequate bandwidth problem prevalent in developing HEIs (Mugwanya et al., 2012).

2.3 Mobile Learning Development

There has been noticeable growth of mobile learning research across Africa - frequently, this duplicates the experiences and challenges elsewhere i.e. local infrastructure, cultural issues whereas other times it characterizes the work of not-for-profits (Pachler et al., 2010 and Motlik, 2008). Despite this trend, this research has been under reported and yet, it deserves a bigger audience. A community of practice has developed and is currently visible mainly through devoted international conference series (Traxler, 2007). An early definition of mobile learning referred to it as e-learning using mobile computational devices such as Palms, Windows CE machines and cell phones (Quinn, 2000). This definition carries over the e-learning focus on technology to mobile learning and considers it as a means to access content, rather than as a way to integrate learning as a part of an increasingly mobile lifestyle. Traxler (2007) further highlights the following as forms of mobile learning after studying a number of case studies and pilots.

- **Technology-driven mobile learning** – some specific technological innovation is deployed in an academic setting to demonstrate technical feasibility and pedagogic possibility.

- **Miniature but portable e-Learning** – mobile, wireless, and handheld technologies are used to re-enact approaches and solutions already used in 'traditional' e-Learning.

- **Connected classroom learning** – the same technologies are used in classroom settings to support collaborative learning, perhaps connected to other classroom technologies such as interactive whiteboards.

- **Informal, personalized, situated mobile learning** – the same technologies are enhanced with additional functionality, for example location-awareness or video-capture, and deployed to deliver educational experiences that would otherwise be difficult or impossible.

- **Mobile training/ performance support** – the technologies are used to improve the productivity and efficiency of mobile workers by delivering information and support just-in-time and in context for their immediate priorities.

- **Remote/rural/development mobile learning** – the technologies are used to address environmental and infrastructural challenges to delivering and supporting education where 'conventional' e-Learning technologies would fail, often troubling accepted developmental or evolutionary paradigms.

There is another form of mobile learning that has emerged known as Podcasting. It could fall into any of the categories highlighted in the previous paragraph with the exception of the 'connected classroom learning'. Podcasting technology offers innovative and creative opportunities for academics to support learning. It involves authoring of audio, video and other media files, distribution and subscription thereof via Real Simple Syndication (RSS) mechanism. Its development will depend in part on the affordances of any given situation for instance infrastructure (i.e. power supply, postal services, Internet connectivity, etc.); sparsity; technical support, etc.

Therefore, in the next section, this thesis provides an exposition of podcasting which forms the core of this thesis and tools that support podcasting activity. We further analyze how it is done in the developed world HEIs versus developing world HEIs in order to identify gaps that may form key requirements for the proposed technology interventions.

2.4 Podcasting

Podcasting has transformed the way in which people engage with multimedia and has empowered many to become amateur broadcasters (Dale, 2007). Within an educational context, podcasting offers innovative and creative opportunities for academics to support learning. It is important to understand what is meant by the notion of podcasting. It involves authoring of audio, video and other media, distribution and subscription thereof via Real Simple Syndication (RSS) mechanism (Malan, 2007 and Lonn & Teasley, 2009). The process of podcasting is such that a content provider (podcaster) authors media files and makes them available on the Internet via an RSS feed, to which the audience subscribes using aggregation software (e.g. a podcatcher). When a new podcast is published, it can be automatically uploaded to their portable device and hence they can listen to it at their convenience.

In this thesis, we use a broader definition of podcasting i.e. a form of mobile learning in which audio/video content is authored, distributed to a server, downloaded to the access computer and transferred to a cell phone via data cable or accessed using cell phone via Bluetooth. Consequently, emphasis is not on the subscription mechanism but the ability to have authoring, distribution and access mechanisms as depicted in figure 2-4. For instance, lecturers normally organize and author content using tools i.e. Microsoft PowerPoint and eventually (at their convenience) upload it onto a server/LMS for students to download (normally using computers). Students are notified through group e-mail or via notices from class representatives. Figure 2-2 below exemplifies podcasting models in developed countries HEIs and identifies gaps for the developing countries HEI models.

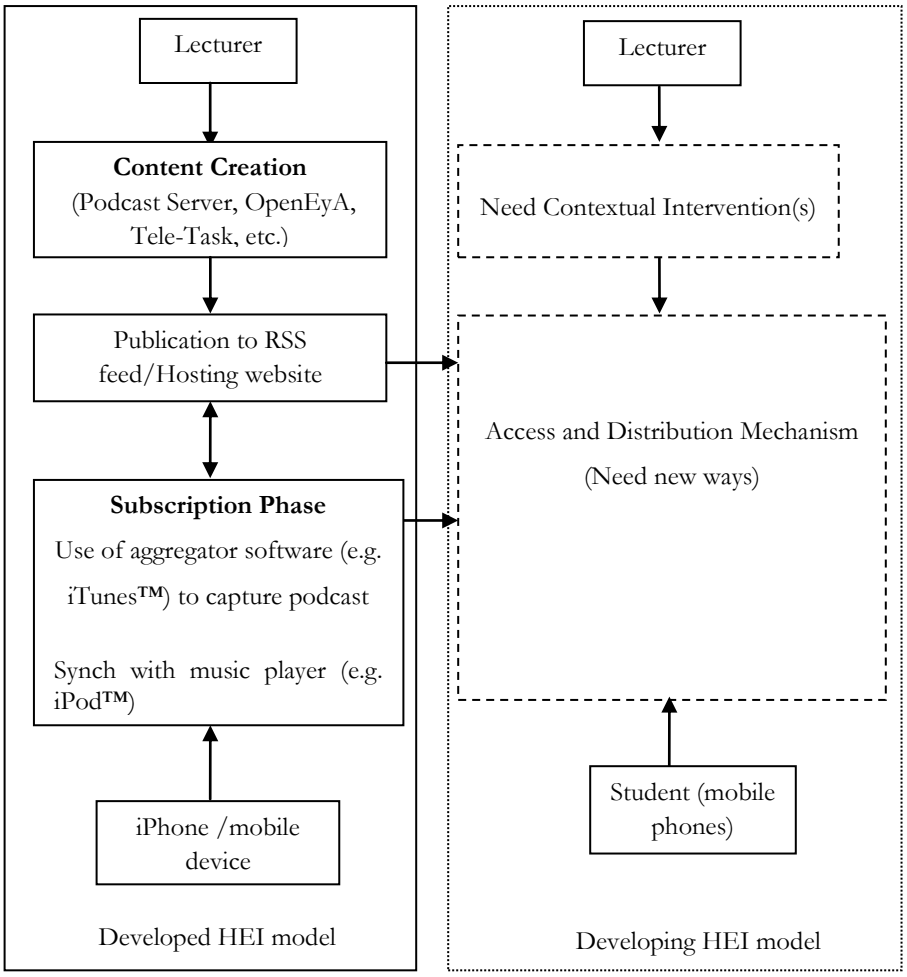


Figure 2-2: Developed Vs Developing HEI Podcasting model

In the developed world model, HEIs may have integrated lecture room infrastructure for recording lectures, automatically publishing to a server. Students subscribe to these lecture episodes and sync their mobile devices so as to automatically download new content. In the developing world case, there are challenges which necessitate the need for appropriate tool support. In the past five or six years, there has been a rapid noticeable growth of mobile phones penetration in Africa (see figure 2-3). In fact, sixty three per one hundred inhabitants in Africa, according to the latest International Telecommunications Union figures (ITU facts and figures, 2013) owns or has access to a cell phone. However, there is no established e-learning infrastructure in African HEIs as already indicated by the challenges presented in earlier sub-sections. Therefore, mobile learning seems like a reasonable place to start.

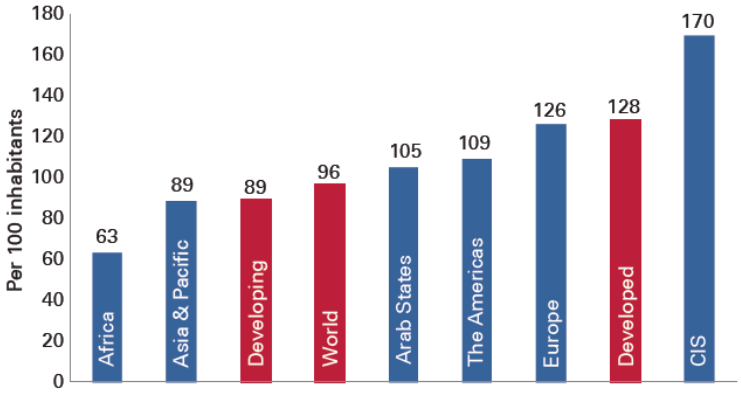


Figure 2-3: Mobile cellular penetration 2013

Source: ITU facts and figures (2013)

There is enormous published research on podcasting in HEI contexts and one such popular project is the Duke University's "Duke Digital Initiative". In this trial, 1600 first year students were given iPods to access audio lectures via Apple iTunes and apply them as a learning tool (Duke University, 2005). Results suggested that iPods were convenient for conveying course content and reduced the strain on the computer laboratories and libraries. However, Belanger (2005) reported the following challenges: difficulty integrating multiple Information Systems, limited training and documentation and lack of input devices for integrating text and audio.

2.4.1 Podcasting tools

In the context of this research, a podcasting tool is defined as software that allows a user to author podcast content for educational purposes. The podcasting tool interface defines how users author, publish and distribute content in various domains (Virvou and Alepis, 2005). Figure 2-4 illustrates an abstract podcasting model consisting of support for four sub-activities namely:

- Organize content
- Support for authoring – a mechanism author content
- Distribution mechanism – a mechanism to publish episodes of content.
- Retrieval/Access – a mechanism to access content through the mobile device.

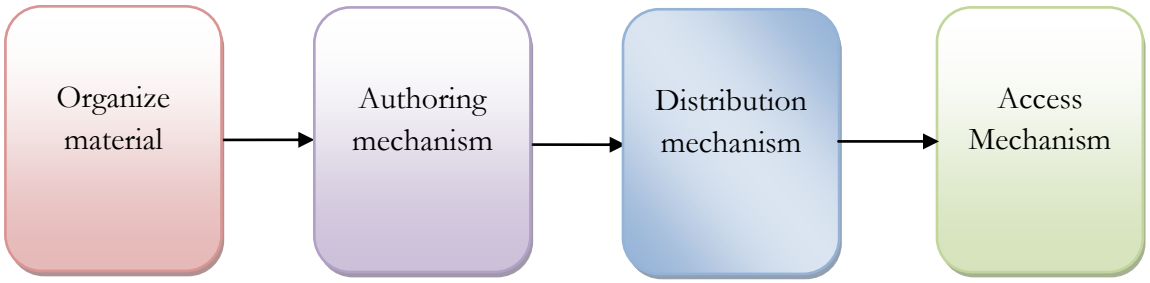


Figure 2-4: Abstract podcasting model

During content authoring, academics use a number of sources such as the Internet, books and journal articles to organize content and create mostly PowerPoint slides which are the preferred way of presenting content to students. Creating and publishing podcasts involves the recording of audio or video content using a laptop or other recording equipment, editing of the recorded content and hosting of the content on a server system. In other scenarios, podcast authors may edit an XML feed file to publish the presence of new content, list the XML feed file in a podcast directory – such as iTunes and finally users subscribe. The success of the next wave of podcast adoption is going to largely depend on the reduction in the complexity of the process. Podcasting will continue to evolve, with the inclusion of rich media podcasts which combine video, audio, and other digital media.

This research aims to provide a stand-alone application since majority of academics even in developing HEIs own a laptop or personal computer. Indeed, the majority own one running Windows Operating System and Microsoft Office Suite of applications. Additionally, students in African HEIs now own feature phones, or better, hence the focus on mobile phone content. The choice of stand-alone tools is because of inadequate HEI e-learning infrastructure in terms of hardware, software, networks, internet connectivity, buildings and electricity among others.

Equally, it is important that the tool can operate with minimum equipment requirements, author content offline and have a mechanism to distribute content to a server for student access. The drawings of existing tools such as Apple's keynote, Microsoft PowerPoint, Adobe and Camtasia Studio among others is that they require users to purchase software licences. Chapter three, section 3.4 presents a comparison of the various published podcasting tools including their offerings and drawings. In the later chapters, this thesis details how the challenges of podcasting in developing HEIs are transformed into the development of a lecture podcasting tool (Mugwanya et al., 2012).

2.4.2 Trends in podcast Tool Design and Usage

Literature on podcasting mostly covers "How to" create podcasts, the technical requirements and perceptions of use. For instance work presented by Ketterl et al. (2006) describe the use of VirtPresenter – a PowerPoint based lecture recording system currently integrated into Stud.IP – a Learning Management System to create a web enabled presentation for further adaptation to mobile devices while Gannod et al. (2008) use Profcast for capturing Microsoft Power Point and Apple Keynote presentations with voiceovers; Snapz for capturing full motion presentations of software use (e.g. a screen cast); iMovie for capturing full motion talking head lectures; iWeb for deploying the podcasts onto a standard web server and Black Board for storage, grade book and assessment management.

Other such works by Copley, 2007; Brown et al., 2008; Chandra, 2007; Rech (2007), Larraga et al. (2007), Rugg (2009) and Wolf et al. (2007) reveal that many of the applications use software such as iMovie, iWeb and Garage Band normally shipped with Apple computers, which in most cases are expensive and therefore limited in ownership by lecturers and students in the developing world. Other tools such as Podcast Producer, Adobe Connect and Camtasia Studio among others require licenses, cost money and in some cases require users to be online or the ability for online distribution of content. Academics need tools that do not require additional institution-wide infrastructure or that do not require internet connectivity for the production and distribution of podcast lectures. On the other hand, students need to be able to access lectures using feature phones and without Internet connectivity requirements.

Supplementary research presents perceptions on usage of podcasts, for instance Shim et al. (2007) provide an overview of podcasting and webcasting and examine student perceptions, preferences and receptiveness between the different delivery richness of communication media in the USA; Jowitt (2008) presents perceptions and usage of library instructional podcasts by staff and students at New Zealand's Universal College of Learning. Ractham and Zhang (2006) provide a technological overview of podcasting, and examine the potential of podcasting usage within educational settings, podcasting academia, and suggest future directions for podcasting in the United States of America. Despite the reported successes, there is still a gap in the literature on design, evaluation, usage and perceptions of podcasting tools in developing countries HEIs.

Mugwanya & Marsden (2010) also note that the majority of tools published for authoring podcast content report on their use in developed HEIs. Therefore, there is need for exploration of their usage in African HEIs.

2.4.3 Constraints for Podcasting Tools

The majority of published tools are developed for user contexts in the developed world and thus do not represent the needs of academics and learners in the developing world. Despite recent advances in podcasting and its subsequent increased popularity in higher education, there is limited published work to evaluate podcasting of educational lectures in developing regions, let alone the design of tools to support these tasks.

Therefore, if podcasting is to be successfully used, there is a need for appropriate tools. Jalali et al. (2011) present the following barriers to use as cited by students: work overload or time constraints and lack of perceived need or non-auditory learning style (Berger, 2007; Fernandez et al., 2009). Another major concern for academics is the student perception that podcasts are a substitute for traditional lectures, thus negatively impacting attendance. Numerous studies have shown that there is no direct linkage between availability of podcasts and attendance (Frydenberg, 2006; Maag, 2006; Copley, 2007; Walls et al., 2010). However, Bell et al. (2007) cited a prior study in which the posting of video recordings of lectures resulted in a reduction of attendance. Traphagan et al. (2010) also showed a negative impact on attendance, but no resulting impact on performance.

Additionally, according to Moses & Morales (2006), there are other issues that may impact on podcasting namely:

Rights Management: For instance, digital rights management content cannot be uploaded to iTunes and yet HEIs may want to protect their content in much the same way as music in iTunes.

Production and Maintenance of Content: In the past, producing video lecture recordings required an AV department and yet to date, anyone can do this. The challenges associated with this are that quality then becomes an issue as students demand high quality content.

End-user experience: The process of setting up and maintaining podcasting needs to become intuitive and simple in order to lower the barrier for entry that is exhibited with some of the current tools such as Podcast Producer server, OpenEya, etc.

Integration with Learning Management Systems: Current Learning Management Systems integrate podcasts with some limited functionality. The most common practice when using podcasts include providing a link to the audio file.

2.5 Summary

This chapter has presented an overview of the status of ICTs in African HEIs and reviewed ICTs diffusion in African HEIs, while detailing the opportunities and challenges. Sub-section 2.2.1 then highlighted the implications for m-learning. Section 2.3 reviewed m-learning development whereas section 2.4 examined podcasting tools, trends in podcasting tool design as well as the constraints for podcasting tools. Chapter 3 then moves on to review relevant research within m-learning and other related disciplines. This is aimed at investigating podcasting practices, experiences, limitations, theoretical frameworks, technology prototypes and user needs regarding podcast authoring tools and designing improved technology to support the podcasting process.

Chapter 3 Literature Review

3.1 Introduction

This section provides an overview of ICT4D, HCI4D and lastly podcasting research – the different fields to which the thesis contributes. In fact, many sections of the text in this chapter have appeared in the researcher' articles titled *"A Preliminary Study of Podcasting in developing Higher Education Institutions"* (Mugwanya et al., 2011), *"Mobile Learning Content Authoring Tools: A systematic Review"* (Mugwanya and Marsden, 2010) and *"ICTD technology interventions: Trends over the last decade"* (Chepken et al., 2012). This section then goes on to present related work on podcasting which is described under three general themes, namely: empirical studies, technology prototypes and frameworks/models with the goal of presenting the state-of-the art and hopefully identifying and re-applying (in later chapters) tested design and evaluation methods. Subsequent sub-sections draw together from these areas, identify key research gaps and explore the lack of empirical support for the design of podcasting tools. Based on this analysis, this chapter sets out a research agenda for the thesis, and justifies the selection of methodology employed in later chapters.

3.1.1 Information and Communications Technology for Development (ICT4D)

Recent years have seen a growing interest in applying ICT for global development – normally referred to as ICTD. The term ICTD involves a broad range of activities in which electronic technologies such as the personal computer and the mobile phone are utilized for socio-economic development, particularly in the world's developing countries (Toyama and Ali, 2009; Dias and Brewer, 2009). ICTD draws interest from multiple disciplines such as sociology, economics, political science, engineering, and computer science among others. ICTD research does not necessarily present technological contributions but impact studies or how individuals, communities and institutions interact with technology. On the other hand ICT4D refers to the aspects most relevant to computer scientists and engineers (Toyama and Ali, 2009). It is mostly concerned with building technology artefacts for the developing world and later on studying their impact on communities.
ICT4D research has concentrated more towards the broader issues such as education, healthcare, finance and peoples' livelihoods (Donner et al., 2008; Dhakhwa et al., 2007; Findlater et al., 2009; Sherwani et al., 2009; Chetty et al., 2004; Maunder et al., 2007; Parikh, 2005; Kumar, 2008).

Technology created for the developed world has often been a poor fit in the developing world, due to issues of cost, inadequate infrastructure and social factors. Therefore, there is a need for technology research specifically aimed at developing regions – the gap that ICT4D aims to fill (Toyama and Ali, 2009). Although televisions, radios, and landline phones are not outside of the scope of ICT4D, more recent technologies, such as personal computers, mobile phones, and wireless networks are what dominate many ICT4D projects (Chepken et al., 2012). ICT4D research involving cellular phones is attracting noteworthy attention because they are not only able to send, receive, manipulate and present information to their users but also provide a powerful computing platform. Indeed, there are many opportunities for these and related technologies in developing regions.

3.1.2 Human Computer Interaction for Development (HCI4D)

Ho et al. (2009) reveal that the earliest HCI4D efforts occurred in 1982, with the establishment of the World Center for Computer Science and Human Resources in France, which was intended to develop computer-based education projects in Senegal, Kuwait, Ghana, and the Philippines. Although the program lost impetus thereafter, it revitalized itself as the One Laptop Per Child (OLPC) project (Camfield, 2007). In the late 1990s, Liebenberg and Blake reported on CyberTracker – a field computer system designed to support scientific data collection from expert animal trackers who were not textually literate (Blake et al., 2001). During this time, Professor Gary Marsden joined Professor Edwin Blake at the University of Cape Town in South Africa to specifically work on mobile computing for development.

In the course of 2003, Susan Dray and others edited a special issue of interactions on HCI4D reporting on work in China, South Africa, India, and Brazil (Dray et al., 2003). By mid 2006, HCI4D had started to gain acceptance, with the ICTD 2006 conference and the HCI4D workshop at CHI 2007. Since then, many projects have examined the design and use of technologies for a variety of domains in the developing world (Chetty and Grinter, 2007). A common theme in HCI4D research is expanding what is possible using mobile devices particularly cell phones, as a primary computing platform. This is evident in the early work of Blake and colleagues using handheld devices. The advantage with mobile phones for development is that operators discount their purchase prices but recuperate costs through usage charges.

However, less research has focused on applying or adapting HCI methods, tools and techniques to the educational technology design processes in these regions. Therefore, the questions about what methods, tools and techniques are available to a researcher aiming to design educational technology for the developing world then arise. Since HCI methods are a social product of the developed world, they also influence the way we think about technology design and evaluation (Chetty & Grinter, 2007). Muller (1991), Chetty et al. (2004) and Maunder et al. (2007) advocate participatory approaches such as participatory design for developing world contexts in view of the fact that they involve users directly during the design and evaluation processes.

3.2 Mobile Learning Research

While mobile learning is growing and maturing as a discipline, there is a need to review progress in the field and offer guidelines for the development of future research projects. Despite the increased attention from conferences and journal publications, there is still no singly agreed understanding of mobile learning. In this section, and subsequent sub-sections, three main areas of research related to podcasting are discussed namely: empirical studies, technology prototypes and theoretical research. Empirical studies are concerned with understanding the use of existing mobile learning artifacts, observing users' while identifying problems and making recommendations for improving design; whereas the second body of research reviews the design of technology prototypes (new artifacts aimed at providing improved educational support for user needs). The third body of research discusses theoretical work relevant to mobile learning and highlights the overall lack of appropriate podcasting theory. Relevant theories from related fields such as Information Systems, HCI and Sociology are also identified. The studies of mobile learning discussed in the next sub sections point to state of the art in the area.

3.3 Review of Empirical Work

Baker et al. (2008) present a pilot empirical study on the effectiveness of podcasting as a course supplement. The rationale of the study was to empirically evaluate the benefits of incorporating podcasting into a university course. The study offers a comparison in mean scores with podcast use and no use while utilizing a relatively small sample size of 21. They also use a qualitative survey methodology and reveal that podcasts were well received and that the major concern was the level of background noise. Baker et al. (2008) were cognizant of the fact that more data needed to be collected to better understand students' decisions on whether or not to use supplemental podcasts.

The responses also indicated that the background music in the supplemental podcasting materials causes distractions and should be reduced in volume before implementing future podcasts.

Hürst et al. (2007) compare the results of two surveys done with German students who had access to podcasts for replay on mobile devices as well as high-quality media files for play back on laptops and desktop PCs. The aim of the study was to analyze the usage and usefulness of podcasting mobile lectures versus the desktop compatible ones. Observations revealed that the added value of mobile compatible lecture podcasts is mainly in their potential for 'mobile usage' whereas most of the other arguments given in favor of such delivery are due to better visibility and "advertisement" of podcasts than justifiable by the technology used.

They also present an evaluation of actual usage; explored features that are unique for podcasting i.e. mobility issues (files are replayed at home or "on the road" with a mobile device); compared subscription via RSS and automatic download to manual download of files as well as the quality of the audio and video files. Overall feedback from the external users was very positive as represented by various encouraging and positive remarks at the end of the survey as well as the rating of the podcasts' learning effect. In addition, students reported that they often used the podcasts while being "on the road", i.e. when using public transport or during workout. Hence, the study concludes that the change in attendance of the live lecture and viewing behavior of the PC versions of the recordings was mainly based on the ability for mobile access.

Murphy and Wolff (2009) describe the incorporation of video podcasts into a Java CS1 course. They assumed that students would subscribe to the RSS feed simply because it was announced on the first day of class and was available via links from the class "resources" page and course management site. Instead, preliminary survey results suggest that initial integration and promotion of the podcasts was inadequate as only seven out of thirty five students (i.e. 20%) reported subscribing to the RSS feed. In subsequent terms, students were sent several reminders as well as a demonstration and written instructions on how to subscribe during the first week of class resulting in an insignificant increase in subscription. This is because most students only used the podcasts to help them install software, revision for exams and lab preparation.

The study also reports important lessons for faculty considering producing video podcasts for their courses i.e.

- *Once is not enough* – provide students with multiple reminders to subscribe.
- *Watch the clock* – keep the length of your videos reasonably short i.e. not more that 5-10 minutes long modules so that participants are able to use their small fragments of waiting time.
- *Integration is important* – link podcast viewing to other aspects of your course (e.g., labs, exam review and class preparation).
- *Consistency* – offer relevant podcasts at regular intervals rather than a single repository all at once.
- *Aim for intrinsic payoff* – encourage viewing by designing podcasts to help students succeed on specific assessments (e.g. an assignment, passing an exam).
- *Let go of perfection* – don't get caught up in producing the perfect podcast, just do the best you can. Your students will appreciate it!

Bhaskar and Govindarajulu (2008) present results of an experimental case study on the effect of mobile technology usage in a learning process. They study learners' attitudes and interests towards content in a learning activity supported by mobile devices. This is followed by an attempt to identify the impact of mobile technology usage on learners and their knowledge as well as examining whether this would improve the overall learning experience. In examining their uses of instructional podcasting, the faculty applied an Action Research approach, making use of the Cooperative Inquiry model. Results of the study indicate the growing interest of the students towards the usage of mobile devices in the learning process. This is similar to studies by Murphy and Wolff (2009) where they propose that a good approach would be to fill the gaps of time (possibly while on the move) by short (from 30 seconds to 10 minutes) learning modules to capture the highly fragmented attention of the learner.

Chandra (2007) reports on the tools used, the associated network cost and experiences with video recording of an undergraduate Operating Systems course. At the end of the course, an informal survey was given to students to take part.

Results from the survey highlight some interesting findings as represented by these verbatim quotes: *"if you want to see the lectures you'll have to take the 50 min of time to devote to it whether it is to a video or to the live lecture. Honestly, going to lecture and seeing everything in person is much less of a hassle than trying to catch things from a video"; "One student mentioned that when he dozed off in class, he made it a point to note the exact time that he woke up in order to go back to the materials that he missed"; "Several students expressed the view that they prefer the organized class setting over a chaotic dorm"*. The survey reveals that video was the only option when the instructors' or students' were traveling. Additionally, storing videos along with the printed notes would be more useful to give some context to the hard copy notes and that students would archive the videos in a DVD for their future personal use.

Evans (2008) describes a study of the effectiveness of podcasting for teaching undergraduate students in Higher Education. In this study, a separate group of 200 first-level students were given a series of revision podcasts after completing a course in ICT. In order to subscribe to podcasts, students had to complete an online questionnaire about their experiences. Results suggest that the use of podcasts as a revision tool has clear benefits as perceived by undergraduate students in terms of the time they take to revise and how much they feel they can learn. Furthermore, results showed that students valued the flexibility offered by podcasts in terms of the ability to study when and where you want. This suggests that podcasting can fill an important needs gap by allowing learners to continue the learning activities when it might not normally be possible. Moreover, podcasts did not facilitate multi-tasking, with most participants claiming that they did not undertake any other activities whilst listening to podcasts and that travelling is the main mobile benefit.

Fernandez et al. (2009) emphasize the usefulness of podcasting in higher education but highlight an important gap between the theory on good practice and empirical studies. They conducted an empirical study which consisted of the creation and broadcast of 13 podcasts for an undergraduate degree course in Information Systems Management. Podcasts were distributed over four months and ninety distance students took part. Data were evaluated regarding the feelings, perceptions, reactions, and suggestions of students and other teachers in relation to the tool through a permanent forum of discussion, emails, interviews and questionnaires. Results show that students' expectations of podcasting were very high at the beginning of the course.

This was expected due to the fact that it was the first contact with podcasting for many students and, more especially, with educational podcasting. Subsequent results reveal that the students' perceptions were not as high as at the beginning of the course partly because podcasts could not generate learning independently.

Jowitt (2008) uses Rogers' (2003) diffusion of innovations theory to determine how podcasts are disseminated; their rate of adoption; the five-stage decision making process for adoption and the characteristics they must possess to be attractive to adopters. By assuming some of the respondents are "Innovators" or "Early adopters", conclusions are drawn that these respondents are progressing through the five-stage decision making process and that they may be of benefit to the new innovation through encouraging late adopters in its uptake. Podcasting possesses important characteristics that aid in its adoption. In this study, six sample podcasts were recorded and made available via the (Universal College of Learning) UCOL library web site. The study collected quantitative data from staff and students and results demonstrated that there were differences found between the groups surveyed in perceptions and use of the library instructional podcasts. Findings revealed that students perceived the podcasts as being "very good". Findings go on to reveal the most helpful podcast topics, suggestions for future podcast topics, device ownership and required technologies, preferred times and places for listening to podcasts as well as their and disadvantages. However, participants suggested that it is necessary with future podcasts to ensure quality of recordings is satisfactory and that podcasts include visuals.

Walls et al. (2010) present a study which explored students' readiness and attitudes towards these two forms of podcasting to provide fundamental information for future researchers and educators. Results pointed towards students not being as ready or eager to use podcasting for recurring or additional educational purposes as much as educators think they are, although they could be convinced. The majority of students interviewed reported owning mobile devices and computers but used them for music rather than educational purposes, a finding consistent with that from previous work by Evans (2008) and Malan (2007). Following a semester of availability, students increased their podcasting familiarity, knowledge, and even subscription. Consequently, students' attitudes suggested that the technology contributed to their learning. One of the qualitative findings revealed fear around the negative effects of repetitive podcasting on student attendance. Nonetheless, there is no supporting literature to suggest correlation between podcast use and number of student absences.

Additionally, other studies reveal that students either preferred organized classroom lectures or expressed that podcasts ideal usage is only when mobile (Chandra, 2007; Evans, 2008; Malan, 2007).

Griffin et al. (2009) investigate the efficacy of audio–visual synchrony in podcasting and its possible pedagogical benefits. In their study, participants in two groups undertook two electronic lectures on two separate topics (the subject matter of neither was familiar to them beforehand). Each group was presented with a topic in which voice was synchronised with PowerPoint slides as well as PowerPoint slides and voice files presented separately. Each group therefore experienced both "synchronous" and "asynchronous" delivery after which they were then given an MCQ test that assessed five levels of Bloom's taxonomy (Buckley & Exton, 2003; Forehand, 2010 & Anderson and Sosniak, 1994). Consequently, there was no difference between the two groups although evidence supported the primary hypothesis that statistically significant higher test scores were seen when participants viewed a synchronous e-lecture; these scores were accounted for by subjects' performance at three of the five levels of Bloom's taxonomy. Qualitative 'attitude' survey results also indicated participant preference towards the synchronous over the asynchronous mode of delivery.

Malan (2007) reports on a study in which he podcasts Computer Science E-1 at Harvard's Extension School in both audio and video formats. His goals were to provide students with more portable access to educational content and to involve them in technology itself. To evaluate this experiment, researchers analyzed logs and student surveys. Results showed that students valued E-1's podcast more as a vehicle for review than as an alternative to attendance. Similarly, the study reveals that most students tended to listen to or watch lectures on their computers, with far fewer relying upon audio-only or video iPods. Logs suggested that E-1's podcasts that were available to students and the public (as of September 2006) received up to 10,000 subscribers from over 50 countries. Malan therefore argues that podcasting offers to extend universities' educational reach more than it offers to improve education itself.

Shim et al. (2007) provide an overview of podcasting and webcasting, and examine student preferences between the different delivery richness of communication media. They develop a conceptual model based on media richness theory which is used to explain student's perceptions.

In order to test the model, a survey is used to collect data based on the six factors related to future media use namely; personal focus, transmission of cues, immediacy of feedback, usability, functionality and ease of use. These factors are then represented as hypotheses which are tested using logistic regression analysis. The authors collected survey data in order to test the resulting hypotheses but results were inconclusive. This may have been due to the lack of user experience with podcasting. Some instructors have even adopted such techniques as their primary means (within or outside the classroom) of communicating to students. However, the selection of suitable communication media necessitates an understanding of perceptions, preferences and receptiveness of podcasting.

Lonn and Teasley (2009) explored the attitudes, perceptions, and use of podcasting at a large American midwestern university. Results focusing specifically on items related to teaching and learning were presented. Findings suggest that students used podcast materials largely for reviewing concepts and issues raised in lectures that they had previously attended. Although instructors and students agreed that podcasts were helpful, they were not sure whether they would improve instructors' teaching. It was argued that podcasts can help instructors transform face-to-face instruction into more constructivist learning practices. Additionally results confirmed that podcasting is being used primarily by tech-savvy faculty who capture their lectures via audio or video and post them on a near-weekly basis. Contrary to the instructors' commonly held expectation, students do not report that they skip class as a result of the available lecture recordings.

Edirisingha et al. (2007) report findings from research into the benefits of integrating podcasts into a first year undergraduate module on English Language and Communication at Kingston University. Six podcasts were developed to improve first year students' learning, study skills, provide advice on portfolio development and presentation skills. This study used two focus groups, personal interviews and an end of semester evaluation questionnaire (n=35). The findings led to development of a model for integrating podcasts in on-campus blended learning, and can have potential applications in distance learning contexts. The model identifies three key features of podcasting i.e. experience of peers conveyed in discussions; tacit knowledge; learner choice and flexibility and a sense of informality brought into formal learning. Consequently, researchers will be able to develop a transferable model and guidelines for developing podcasts that can be applicable in other contexts.

Tynan and Colbran (2006) present preliminary results of a podcasting trial in six law units involving 1244 students during semester one, 2006. The data revealed a rapid uptake and acceptance of podcasting with few difficulties and students perceiving podcasting as having excellent value. Podcasting altered study habits, with some students spending more time reading primary materials while others on transcribing podcasts. Additionally, participation on the WebCT discussion forums did not reduce as a result of introduction of podcasts. Podcasts were expected by students to be delivered within three days, and students were prepared to accept lengthier downloads with improved quality. The paper also discusses the main advantages and disadvantages of podcasting as revealed by student users. Furthermore, audio podcasting has now become an essential requirement for teaching tertiary students within the law units. The challenge is creating workflows to meet students' expectations of quality and service delivery.

Moss et al. (2010) examine the influence of psychosocial constructs, from a theory of planned behavior (TPB) perspective, to predict university students' use of enhanced podcasts. The specific behavior of interest was downloading and listening to a series of enhanced podcasts (of lectures) which were offered as a resource for students enrolled in an introductory university course. Students completed questionnaires at different points in time during the semester in order to assess the TPB predictors (attitude, subjective norm, perceived behavioral control) related to intended enhanced podcast use. This data was used to test the hypotheses that were also derived from the TPB predictors. Results suggest that attitudes revealed differences in intensions of use particularly for the perceived educational benefits of podcast use later in the semester. Generally, this study identified some of the determinants which should be considered by those aiming to encourage student use of podcasting.

In their article, Lee et al. (2009) describe how podcasting promoted collaborative knowledge building among the student-producers. Findings advocate that the collaborative development of audio learning objects and enabling the sharing of student conceptualizations is a powerful way of stimulating both individual and collective learning. Focus groups were conducted to elicit the views and experiences of the student producers, for the purpose of better understanding their knowledge-creation processes. Consequently, the study had a number of implications for teachers and instructional designers in diverse education settings where podcasting facilities can easily be established.

Firstly, students in the study found the task both challenging and motivating, as evidenced by the quality and intensity of their interaction and by the successful production of the podcasts. Secondly, students may not always realize that the actual processes of interactive dialogue and collective problem solving are essential to knowledge creation, and may become overly focused on the technology.

3.3.1 Empirical studies Discussion

Although many interesting findings have been presented, the researcher echoes the view of Traxler that there is still a lack of systematic empirical investigation in this area (Traxler, 2009). In fact, the majority of studies have been tool specific and are concerned with the different aspects of course management i.e. authoring adaptive tests, quizzes answered via SMS and general multimedia content. Additionally, the majority of the podcasting tools have been built in the developed world and in some cases only the tech-savvy academics use these tools. Another issue that illustrates the need for more studies in this area is the lack of empirical attention paid to different aspects of podcasting for instance how podcasting strategies may change over time. Therefore, in the later chapters, (i.e. Chapters 4 and 5), this thesis explores podcasting and the design of its tools using UCD techniques to support its activities. The next section discusses the second area of research contributions i.e. a review of podcasting prototypes.

3.4 Review of technology Prototypes

Mugwanya and Marsden (2010) in their analysis of Mobile Learning Content Authoring Tools, provide a framework for this section. In fact, many parts of the text in this section have appeared in researcher's article titled: *"Mobile Learning Content Authoring Tools (MLCATs): A systematic Review"* (Mugwanya and Marsden, 2010). This section reviews podcast authoring prototypes that have been proposed in the research domain, as well as highly innovative published commercial systems that are not in widespread use. This is an active area of design, and many systems have been proposed, both in the research domain and the commercial sector. Therefore, this section does not aim to be exhaustive, but instead provide a representative summary.

3.4.1 Podcasting systems

Learning demands from mobile devices are increasing thus presenting challenges for quality content creation (Kuo and Huang, 2009). Authoring tools are programs used by academics to create and distribute content in various domains (Virvou and Alepis, 2005). The use of podcasting tools by academics who wish to author electronic content is not a simple task (Hsiao et al., 2008; Tortora et al., 2002). This may be due to steep software learning curve(s), some academics being technology shy and resistant to change and inadequate institutional support.

Podcasting tools provide academics (even the recalcitrant ones) a means to easily author podcast lecture content for consumption on mobile devices thus providing anytime, anywhere learning. Over time, researchers have made efforts to design and implement podcast authoring systems thus the great diversity in both commercial and non-commercial tools (Li et al., 2005). These tools are developed with various goals and purposes in mind resulting in a variety of architectures. Some tools, for example, are used to author tests (Virvou and Alepis, 2005; Proske et al., 2002; Attewell, 2005; Metso et al., 2001); support content re-use (Kuo and Huang, 2009); support content authoring for integration with Learning Management Systems (LMS) (Martin and Carro, 2009; Proske et al., 2002; Tai and Ting, 2007) and present video lectures (Juang et al., 2004; Roesler et al., 2009; Rubegni et al., 2008; Wolf et al., 2007) among others.

Founded on work by Martin and Carro (2009) and a report by Taylor et al. (2005) on best practices for instructional design and m-learning, three broad dimensions to classify podcasting tools are identified namely: technology, pedagogy and usability. Bulterman and Hardman (2005) and Taylor et al. (2005) suggest that technology is a critical enabler for podcasting but the major challenges lie with content authoring, delivery strategy (Pedagogy), the need for a graphical user interface (GUI) and accessibility support (usability). The technology dimension is further sub-divided into smaller sub-dimensions while providing their corresponding acronyms as follows: system type (Sys Typ.), authoring techniques and technologies used (Techno.), tool availability (Av.), ICTD relation (ICTD), tool purpose and Multimedia support (MM). Pedagogical requirements comprise of standards (Stds.) and learning style (LS) support whereas usability requirements include existence of an intuitive graphical user interface (GUI) and accessibility (Acc.).

A systematic review of literature on podcasting tools distinguishes the following system types i.e. artificial intelligence tools (A), traditional authoring tools that use hypertext and multimedia features for content creation (T), video capture systems (V) and natural language speaking and handwriting tools (N). These system types represent requirements of users in the developed world where infrastructure, equipment, and high-speed connections are in place. Artificial intelligence tools enable academics to create intelligent tutoring systems in their domain of expertise through a graphical user interface. AI tools model student usage and offer personalized guidance during learning (Virvou and Alepis, 2005). Video capture tools record, encode and stream the instructors presentations for consumption on various devices whereas natural language speaking and handwriting tools use recognition software to convert speech and hand written material into editable objects (i.e. text, video, audio or graphics) which are authored for presentation on end devices (Valverde-Albacete et al., 2003; Luciano and Guisseppe, 2007).

The first sub-dimension gives an indication of whether a tool offers desktop authoring (DA), mobile authoring (MA), content distribution to mobile (DM), desktops (DD) or both (DMD) and use "??" as a placeholder for a lack of sub-dimension support. The second sub-dimension explores the authoring techniques and development environments used; for example, some tools use single authoring (S); a technique used to create a single version of content for adaptation to any given end device; Multiple authoring (M) which involves creation of several content versions for the different consumer devices and Flexible authoring (F) which involves the creation of both single and multiple authored content versions (Martin and Carro, 2009). The development environments include: J2ME, eXtensible Markup Language (XML), .NET framework and Synchronized Multimedia Integration Language (SMIL) among others.

In the third sub-dimension, tools are classified based on their availability e.g. are they Web based (w); do they have a downloadable version available (d); can they be purchased (p) or are they client based (c). The fourth sub-dimension classifies tools based on whether they are developed within a developing country (ICTD) context. The fifth and sixth sub-dimensions classify tools based on their purpose and the multimedia supported respectively. The purpose(s) of tools explored are to: create learning content; multiple choice quizzes; tests and podcasts among others whereas the multimedia elements supported includes video (v), text (t), audio (a) and images (i).

Within the pedagogical dimension, standards and learning styles are explored as the seventh and eighth sub-dimensions respectively. There are various standards including but not limited to the Sharable Content Object Reference Model (SCORM). Moreover, support for learning style and activity of learners should be taken into account during content authoring for podcasting. Therefore, tools are classified based on their support for standards and learning styles. Lastly, in the ninth and tenth sub-dimensions, tools are classified based on whether they have an intuitive graphical user interface and/or support accessibility (for people with disabilities). A total of 26 tools were classified as illustrated in Table 3-1 revealing some interesting observations.

Table 3-1: Classification Matrix showing podcasting tools Vs dimensions provisioning

Dimensions	**Technology**						**Pedagogy**		**Usability**	
Tool Authors	**Sys. type**	**Auth. Tech & Techno.**	**AV.**	**ICTD**	**Tool purpose**	**MM**	**Stds.**	**LS**	**GUI**	**Acc.**
Kuo & Huang (2009)	T,DA, DMD	F, XML, XSLT	w	No	learning content and tests	t, i, a, v	Yes	No	Yes	No
Romero et al., (2006)	T,DA, DMD	S, Java and XML	w	No	adaptive tests	t, i	No	No	No	No
Virvou & Alepis (2005)	A, MA, DA, DMD	S, ASP.NET, VB.NET, Windows Server 2000+, IIS, RDBMS	w	No	adaptive content and tests	t, i	No	Yes (intelligence)	No	No
Martin & Carro (2009)	A,DA, DMD	?, Java, XML	w	No	Learning content	t, i	No	Yes	Yes	No
Simon et al., (2005)	T, DA, DMD	S, XML, XHTML, CSS	c	No	Learning content	t, i, a	No	No	Yes	No
Luciano & Guisseppe (2007)	N,DA, DMD	??, hand writing, screen capture., video streaming software	??	Yes	Learning content	t, i, v	No	No	No	No
Juang et al., (2004)	??, DA,DMD	??, XML	??	No	Learning content	t, i, v	No	Yes (learning activity)	??	No
Li et al., (2005)	T,MA, DM	F, Visual C++, Pocket PC2003 OS	??	No	Learning content	t, i, v	No	No	??	No
SourceForge.Net	T, D,DA, DMD	??, XHTML, XML	d	No	Learning content	t, i, v	Yes	Yes	??	No
Attewell (2005)	T, DA, DM	??, SMS	c	No	quizzes answered through SMS	t, i	No	No	No	No
Attewell (2005)	T, DA, DM	??, Palmtop, e-mail, MMS	w	No	interactive learning tasks for learner groups	t, i.a	No	Yes	??	No
Attewell (2005)	T, DA, DM	??, PocketPC	c	No	Multiple choice quizzes	t, i	No	No	??	No
Smith (2006)	T, D, DA, DMD	??, Java, XML, XHTML	w	No	Learning content	t, i, v	No	No	Yes	No

Table 3-1: Classification Matrix showing mobile learning content authoring tools Vs dimensions provisioning

Dimensions	**Technology**						**Pedagogy**		**Usability**	
Tool Authors	**Sys. type**	**Auth. Tech & Techno.**	**AV.**	**ICTD**	**Tool purpose**	**MM**	**Stds.**	**LS**	**GUI**	**Acc.**
Broll et al., (2007)	T, DA, DMD	??, XML, RFID, GPS	w	No	Learning content	t, i, a	No	No	Yes	No
Proske et al., (2002)	T, D,DA, DMD	??, XML	w	No	exercises of different types	t, i	No	Yes	No	No
Gugerbauer (2004)	T, D, DA, DMD	??, C sharp, XML	??	No	Learning content	t, i	No	Yes	??	No
Kravcik & Specht (2004)	A, DA, D	??,XML, HTML, CSS	c	No	Learning content	t, i , a, v, hyperlinks	Yes	No	Yes	No
Wolf et al., (2007)	V, DMD	??, Streaming Server, SMIL, MPEG-4	p	No	Learning content	Video podcasts, t, i, a	Yes	No	No	No
Bulterman & Hardman (2005)	T, DA, DMD	??, SMIL	w	Yes	multimedia content	t, i, a, v	??	No	Yes	No
Rubegni et al., (2008)	V, DA, DMD	??, ??	??	No	Instant multimedia content	t, i, a	??	No	Yes	No
Valverde-Albacete et al., (2003)	??, DA, DD	??, XML, XSLT Style Sheets, XHTML	w	No	multimedia content	t, i, a	??	No	??	No
Hsiao et al. (2008)	??, DA, MA, DMD	??, Java	w	No	examples	t, i, v	No	No	Yes	No
Sa & Carrico (2006)	??, DA, MA, DMD	??, Java	w	No	Tests, assessment, collaborative activities	t, i, a	??	No	Yes	No
Jiang et al., (2009)	V, DMD	??, Java 2D, Java Media Frameworks	c	No	Creating video centered educational spaces	t, i,v	No	No	??	??
De et al., (2008)	??, HTTP, WAP, Web Services	??	w	No	multimedia content	t, i, a, v	No	No	??	No
Roesler et al., (2009)	??, H.264, MPEG-4	??	??	No	multimedia content	t, i, a, v	No	No	No	No

From a technology perspective, the biggest number of podcasting tools are traditional tools in a sense that they use hypertext and multimedia features for content creation (Attewell, 2005; Broll et al., 2007; Bulterman and Hardman, 2005); followed by video recording tools (Jiang et al., 2009; Roesler et al., 2009; Rubegni et al., 2008; Wolf et al., 2007); artificial intelligence tools (Martın, and Carro, 2009; Kravcik and Specht, 2004; Virvou and Alepis, 2005) and natural language processing tools (Attewell, 2005). Additionally, the LMS concept has been successful in many HEIs. Consequently, the majority of the tools are developed with the goal of being integrated into Learning Management Systems. For example, the tool presented by Proske et al. (2002) is designed for integration into the AHA system; the one presented by Tai and Ting (2007) into Moodle and lastly, the one developed by Martin and Carro (2009) is developed for integration with the Context-based adaptive Mobile Learning Environment (CoMoLE).

Additionally, many of the tools have been developed for desktop authoring, with some also providing for mobile authoring and others distribution of content for access on both mobile devices and computers (Li et al., 2005; Virvou and Alepis, 2005). Herzog et al. (2006) argue that video content is not mandatory in most learning environments due to limitations such as the need for constant Internet bandwidth availability. For that reason, it is a challenge to implement video recording within LMS architectures. Other video recording implementations have emerged that allow video lectures to be recorded and delivered to iPods (Wolf et al., 2007). These processes represent single authoring since the recordings cannot be later changed. The majority of tools in our review use this authoring approach with a few offering flexible authoring (Kuo and Huang, 2009; Li et al., 2005).

Nevertheless, a vast number of articles (cited in table 3.1) do not give an indication of the authoring techniques used, hence the use of '??' in the respective cells. The natural language processing tools use hand-writing software, screen capture software and video streaming for content delivery and the matrix also reveals that majority of the tools are either web-based or client tools with only Tai and Ting (2007) having a demonstration version available whereas only one tool can be purchased (Wolf et al., 2007). The developing world is characterized by inadequate infrastructure, intermittent Internet connectivity, unreliable or intermittent electricity and limited user expertise among others. Thus the developing world requires ICTD relevant tools since the majority of tools published are developed for user contexts in the developed world and consequently do not represent the needs of academics and learners in the developing world.

For instance, in much of sub-Saharan Africa, despite the huge investments by universities on LMSs such as WebCT and Blackboard, the impact of their use has not been significant.

Several programmes have been offered through distance education but still heavily rely on print and face-to-face lectures (Ngugi et al., 2007). The majority of tools generate various combinations of multimedia elements i.e. text and images (Martın and Carro, 2009; Proske et al., 2002; Virvou and Alepis, 2005), text, images and video (Jiang et al., 2009; Low, 2002; Luciano and Guisseppe, 2007). The pedagogical dimension explored support for standards and learning styles as they greatly impact on content creation. The review shows that some tools offer support for standards such as the sharable content reference model (SCORM) or the Question and Test Interoperability (QTI) (Kuo and Huang, 2009; Kravcik and Specht, 2004; Tai and Ting, 2007; Wolf et al., 2007) whereas others offer support for learning styles (Attewell, 2005; Juang et al., 2004; Proske et al., 2002; Tai and Ting, 2007; Virvou and Alepis, 2005).

Finally, the usability dimension explores the availability of an intuitive graphical user interface (GUI) and accessibility support for people with learning disabilities to utilize the tools. Some mobile learning content authoring tools have GUIs built in (Broll et al., 2007; Bulterman and Hardman, 2005; Hsiao et al., 2008; Kuo and Huang 2009; Martın and Carro, 2008; Simon et al., 2005) whereas none of the tools offer support for accessibility. The framework offers some general development considerations for mobile learning content authoring tools and offers a classification of the various tools. The researchers are conscious of the need for tools developed within their intended user contexts for successful adoption. Many of the podcast content authoring tools explored do not use design approaches that involve real system users in context.

Therefore, there is a need to develop tools that represent the needs of users and empower them to author content for use in mobile environments. Furthermore, the varieties of tool implementations explored are mainly technology driven. In order for systems to satisfy their intended needs and facilitate the learning process, tool implementations should follow an integrated approach that takes into account usability and pedagogical aspects. It is believed that this will lead to better design, increased use and adoption of mobile learning content authoring tools.

3.4.2 Discussion of Technological Contributions

Section 3.4 presented many interesting prototypes indicating technological contributions in the area. However, interesting design in itself does not necessarily correspond to a solid contribution to the knowledge base of HCI or mobile learning research. The Human Centred Design Process for Interactive Systems consists of four steps namely: understand and specify the context of use; specify user and organisational requirements; produce more than one candidate design solution and evaluate designs against requirements (ISO, 1999: 13407). In this section, it is argued that the tools presented are lacking in their exposition on the stages used to develop human-centered interactive systems thus fail to make a substantial contribution to HCI and mobile learning research knowledge-base. The following sub-sections expound on this in more detail below.

3.4.2.1 The need for contextual tool design and evaluation

The primary criticism that can be directed at much of this work concerns a lack of contextual tool design and evaluation techniques. The majority of podcasting tools are developed in developed countries and exported to developing countries and due to skills shortages, cost and infrastructural challenges, there is low adoption and failure of these technologies (Ssekakubo et al., 2011 and Mugwanya et al., 2012). Evaluation is critical to validate designers' claims regarding the strengths and weaknesses of their designs. Otherwise the HCI community cannot be sure if a designed artifact is "better or just different".

It has been argued that long-term, in-situ studies that employ a triangulation of methodologies are important for evaluating mobile learning environments (Mackay and Fayard, 1997). The implications for new design may not be fully clear until it has been used over time, meaning that evaluation is a difficult, expensive undertaking. A key reason for the limited evaluation studies may be the lack of accepted methodology. This also means that it is difficult to compare designs that have been evaluated in different ways. Therefore, we hypothesize that there is need to develop new design and evaluation models for mobile learning environments based on UCD (Beyer & Holtzblatt, 1997) and Personal Construct Theory (PCT) approaches (Hinkle, 1965).

3.4.2.2 The Need for Empirical or Theoretical Grounding

Research prototypes aim to provide improved support for user needs. Consequently, they depend on a solid understanding of user needs to ensure that design is directed towards generating appropriate solutions to important problems. However, it is not clear whether many of the podcasting tools covered in this section are grounded in a firm understanding of user problems, for instance (Wolf et al., 2007 and Chandra, 2007). Low-level results from controlled studies may not necessarily apply in the real-world contexts in which the tools are to be used.

In addition, many systems are rooted in theoretical critiques and generally, have been technologically rather than empirically motivated. It can be argued that much of the work has been based on designer intuition regarding appropriate technology to apply to the mobile learning domain. However, as noted above, it is particularly important in such cases for designs to be tested through extensive user evaluation using triangulation. The fact that it has not been performed is problematic. Similarly, most technology prototype studies have been tool-specific, thus section 3.5 highlights the analysis of key research gaps in terms of relative lack of empirical support for contextual podcasting tool design.

3.5 Review of Theory

In this section, the researcher surveys theories of mobile learning. Firstly, Rogers (2004) presents four aims of theory namely: to describe interactive phenomena, to explain interactive phenomena, to make predictions of the output of a design (e.g. in terms of user performance) and to generate new routes for design. Parsons et al. (2007) propose a conceptual framework for mobile learning applications that provides systematic support for mobile learning experience design. It is based on a combination of the game metaphor and several other studies of mobile learning contexts. Figure 3-1 shows how the four M-learning design requirements namely; generic mobile environment design issues, learning objectives, learning experience and M-learning contexts interact. For instance, consider M-learning for dynamic complex situations such as rescue services or intensive care. It is important that the collective learning objectives are identified for example developing team skills in our case.

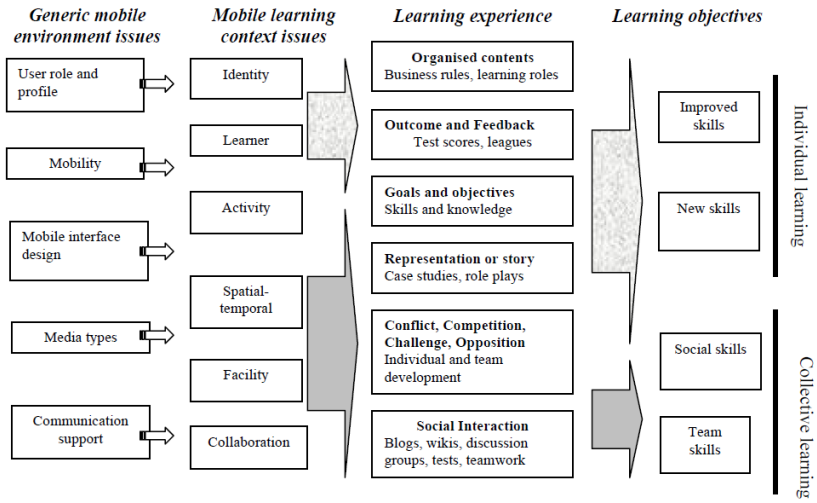


Figure 3-1: A framework for M-learning design requirements

Source: Parsons et al. (2007)

This learning objectives are supported by the learning experiences and m-learning contexts which in turn would map (in a context specific way) to the generic mobile design requirements. In order to validate the framework, it was applied to four successful M-learning environments that had differing characteristics namely; Ambient Wood (Rogers et al., 2004), Thinking Tags (Colella et al., 1998), Uniwap mobile teacher training (Seppälä and Alamäki, 2003) and Mobile Learning Organizer (Ryu et al., 2007). In the first three examples, the framework is used for a post-hoc analysis of mobile learning experiences whereas for the last example the framework is used in the analysis of new mobile learning system requirements. This framework is used both as an analysis tool to help understand the critical success factors in previous mobile learning applications, and as a design tool for developing new systems.

Wingkvist & Ericsson (2009) bring forth a framework which illustrates the evolution of a mobile learning initiative based on an empirical study using Action Research. They describe how empirical data gathered mainly during a podcast initiative was used to abstract a theoretical framework that models the development process. The framework shows how development of a mobile learning initiative happens in stages, from Idea, to Trial, to Project, to Release. The activities within each of these stages address four areas of concern namely: Technology, Learning, Social, and Organization.

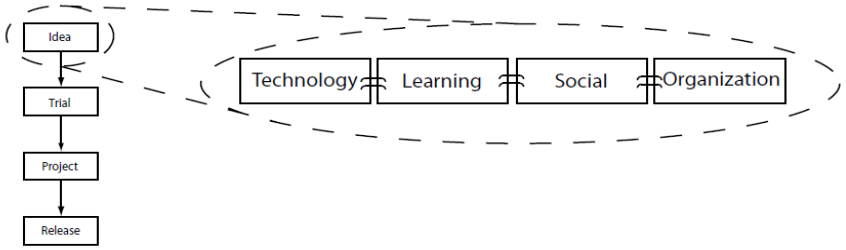


Figure 3-2: The Areas of Concern

Source: Wingkvist & Ericsson (2009)

The areas of concern are linked; affect each other and the specific focus on one area of concern is applied as a means to reduce the complexity of the setting. The framework uses stages to model the development process and areas of concern to model the situation. The framework was created using the process of iterative cycles of the Action Research approach and provides key concepts that show the development process in a way suitable for the intended audience and practitioners involved in mobile learning initiatives. These key concepts can help the practitioners reflect upon the development process in many ways for instance map activities happening within the initiative to concepts in the framework; reason about these and then translate the findings back to the activities. Another use is to arrange the setup of new initiatives according to the framework. Additionally, using this framework to guide evaluation would also be an interesting path to follow.

Barker et al. (2005) investigate the use of wireless technologies in education with particular reference to the potential for m-learning in developing countries. They present a theoretical model for m-learning adoption for a developing country which emphasizes the importance of taking a systems view of all the elements i.e. stakeholders, infrastructure, mobile devices, etc. This model embraces the key issues with regard to m-learning as well as the critical success factors that are essential in ensuring successful adoption. The model offers guidelines and principles to guarantee the involvement of stakeholders and designing the devices with the end user in mind. They report on a number of current m-learning projects from which the perceived benefits of using wireless technologies in education and potential barriers to their use are derived. Benefits are perceived to outweigh the difficulties (i.e. limitations of the devices, pedagogical issues, training, support and cost) encountered when integrating wireless technologies in education.

Uden (2007) specifically suggests that Activity Theory is an ideal theoretical framework to design mobile learning environments as it focuses on understanding the human activity and work practices. The principles and components of Activity Theory have been used as analytical tools for many different subjects such as: HCI, Information Systems (Bødker, 1991), Interface Design, Communities of Practice and Education (Engeström, 1987). Figure 3-3 shows Engeström's model of an activity system.

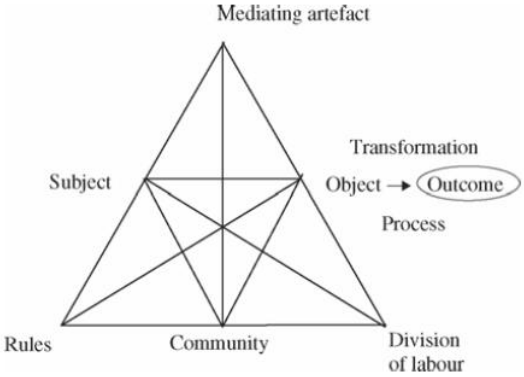


Figure 3-3: Activity Theory model

Source: Uden (2007)

An activity consists of a subject and an object, mediated by a tool. A subject can be an individual or a group engaged in an activity. An activity is undertaken by a subject using tools to achieve an object (objective), thus transforming it into an outcome. Tools can be physical or psychological such as ways of thinking. Computers are considered as special kinds of tools (mediating tools). An object is less tangible (i.e. a plan) or totally intangible (i.e. a common idea) as long as it can be shared by the activity participants (Kaptelinin, 1996).

Activity Theory also includes collective activity, community, rules and division of labor that denote the situated social context within which collective activities are carried out. Community is made up of one or more people sharing the same object with the subject whereas rules control actions and interactions with an activity. Division of labor informs how tasks are divided horizontally between community members as well as any vertical division of power and status. Activities always take place in a certain situation with a specific context (Engeström, 1987). Activity Theory provides an ideal theoretical framework for describing the structure, development, human work and activity in context.

To make Activity Theory more practical, Kaptelinin et al. (1999) have developed an artifact – the activity checklist. The checklist makes concrete the conceptual system of Activity Theory for design. It is intended to elucidate the most important contextual factors of human–computer interaction. Activity Theory provides a powerful vehicle for developing mobile learning. Firstly, it can be used as a lens to analyze learning processes and outcomes for the design of mobile learning. Secondly, it provides us the design of context-aware applications that are crucial for mobile technologies. The theory helps structure analysis, but does not prescribe what to look for. It does not offer ready-made technologies and procedures for research (Engeström, 1987).

Uden then shows how the principles of Activity Theory are used to design a mobile learning environment. The case study used is based on the design of a mobile learning environment for students to construct a knowledge management system for the construction industry. Students working as team were expected to solve the problem. Each student was given a handheld PDA to use for collaborative work. Principles from Activity Theory are used to design the learning environment and the context of use. The methodology consists of steps and sub-steps as follows: Clarify purpose of the activity and deal with interface design; analyze the context for learning and use; clarify the relevant context within which activities occur; analyze the activity system using Engeström's activity diagram and externalization/internalization.

Motiwalla (2007) discusses and demonstrates how learning can be extended to wireless/hand-held devices. His approach was to first understand the capability of mobile technology for learning and leverage it with successful learning models and approaches to develop a generic m-learning framework which can be adapted to varying m-learning requirements. The requirements generated from the framework led to the development of a prototype application. This application was evaluated with students from both online and on-campus classroom environments to explore m-learning feasibility and get valuable feedback. Results demonstrate that most learning pedagogies from constructive learning and conversation theories can be adapted for a mobile learning environment. The key is to understand the strengths and weakness of a particular technology, while deploying good pedagogical practices to achieve specific learning goals. Beyond looking at system decisions, a look back at learning pedagogies helps the overall m-learning strategy. The differences between a classroom using mobile devices (or m-learning) with a classroom using computers (or e-learning) to supplement their learning activities are in the tools but the pedagogies remain similar.

Although it seems inevitable that m-learning will soon be an essential extension of e-learning, this transition will not occur over night. The promise of instant access to learning anytime and anywhere is an enormous benefit, but will be restricted until the technology of wireless data access matures and educators learn how to apply appropriate pedagogies from both social constructive and conversational theories. A major bottleneck from the student's point of view for our current application was the user-interface. This constitutes serious problems in the design of podcasting and other interactive systems.

Sharples (2000) argues that learning has become more ubiquitous, learner-centered, situated, collaborative and continuing and so has the ICTs. This parallel progress offers the possibility for m-learning to support both the social constructivist theory of learning (Palincsar, 1998; Sivan, 1986) and the conversational theory (Pask, 1976a & Pask 1976b). Sharples further presents a framework (see Figure 3-4), that integrates the ideas from mobile connectivity and e-learning into application requirements for mobile learning. For example, the mobile connectivity research suggests the content delivery is more effective when a combination of push and pull mechanisms are used.

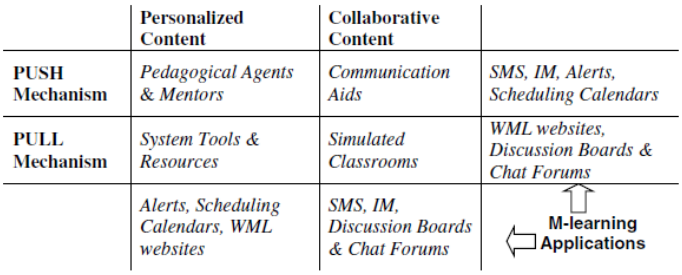


Figure 3-4: A Mobile learning framework

Source: Sharples (2000)

Similarly, the content delivered is more useful when it is personalized (i.e., when students can control or filter the content) and collaborative (i.e., when students can reflect and react to the information that they receive), as suggested by the constructive and conversational learning models. The framework utilizes these pedagogical approaches to extend learning in a mobile environment and supports concepts outlined for the e-learning environment such as a delivery system for submitting assignments, development of a 24-7 learning community as well as an interactive forum among others.

In other related work, Sharples et al. (2005) developed an analysis of learning as conversation in context, drawing on Dewey's pragmatic technology philosophy (reproduced in Hickman, 1990) and Pask's conversation theory (Pask, 1976). They use these theories as groundwork on which to build an account of the m-learning processes. Sharples et al. describe an application of cultural-historical Activity Theory to analyze the activity system of mobile learning. They describe the dialectical relationship between technology and learning through an adapted version of Engeström's expansive activity model (Engeström, 1987).

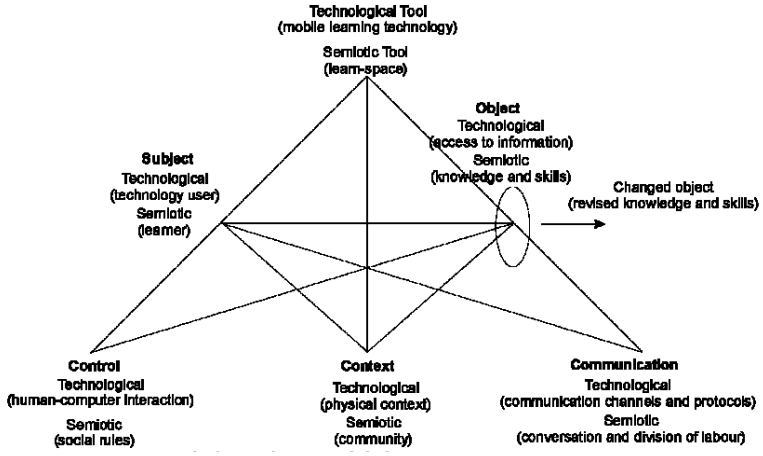


Figure 3-5: Framework for analyzing mobile learning

Source: Sharples et al. (2005)

In the tradition of Activity Theory, Sharples and colleagues analyze learning as a cultural-historical activity system that is mediated by tools which constrain and support learners in transforming their knowledge and skills. Analyzing the activity of mobile learning helped to separate two perspectives, or layers, of tool-mediated activity i.e. the semiotic layer which describes learning as a semiotic system in which the learner's object-oriented actions (i.e. actions to promote an objective) are mediated by cultural tools and signs. The technological layer corresponds to learning as an engagement with tools such as computers and mobile phones operating as interactive agents in the process of coming to know, mediating agreements between learners; creating a human-technology system to communicate and to aid recall and reflection.

These layers can be prized apart to provide: either a semiotic framework, promote discussion with educational theorists, analyze learning in the mobile age, or a technological framework for the design and evaluation of new mobile learning systems.

There is need to clarify that this framework neither proposes the separation of the semiotic and the technological, nor the fusing of the two. Rather, the framework proposes a continual dynamic in which the technological and the semiotic can be moved together and apart, thus enabling the analysis of mobile learning (Engeström, 1987). These have been adapted in Engeström's framework to show the dialectical relationship between technology and semiotics and have been renamed with the terms – Control, Context and Communication – that could be adopted either by learning theorists or by technology designers. Of course, these terms may be interpreted differently or lead to misunderstanding therefore Sharples et al. (2005) attempt to clarify their meaning.

Sharples (2002) describes theory aimed at the design and development of software, hardware and communications for a handheld learning resource known as HandLeR. The theory supports children to capture daily events such as images, notes and sounds and relate them to web-based learning resources; organize them into a visual knowledge map and share them with other learners and teachers. In this paper, Sharples (2002) describes the design and evaluation of a prototype for children aged 9–11. The project followed a methodology of socio-cognitive engineering which aims to analyze the complex interactions between people and computer-based technology and then transform this analysis into usable, useful and desirable socio-technical systems (technology in its social context). This is similar to the work presented by Taylor et al. (2006) where socio-cognitive engineering has been successfully applied to the design of a broad range of human centred technologies. Sharple's (2002) aim was to design human-centred systems based on a sound understanding of how people think, learn, perceive, work, communicate and interact. Figure 3-6 below shows an overview of the design process.

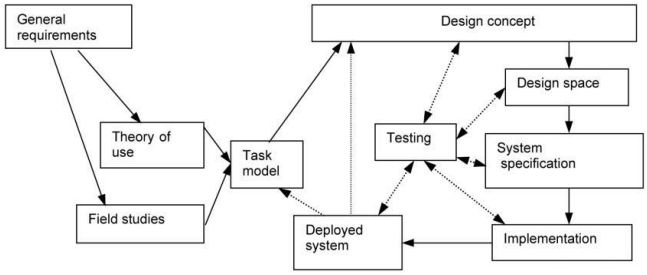


Figure 3-6: Overview of the flow and main products of the m-learning design process.
Source: Sharples (2002)

It starts by specifying the general requirements and constraints for the system to be designed. It sets out the type of activities to be supported by the new technology (such as learning and knowledge management), the domain (personal contextual learning) and any general constraints (such as time and budget available for the system design). This provides parameters for two parallel studies namely: an analysis into how specified activities are currently performed in context and exploration of the underlying cognitive and social structures and processes. The outcomes of these two studies are synthesized into a Task model whose aim is to describe the activity system (Engeström, 1987). The model provides the bridge to a cycle of iterative design that includes: specifying a design concept; generating a space of possible system designs; specifying the functional and non-functional aspects of the system; implementing and deploying the system. Although this cycle is based on a conventional process of interactive systems design, it gives equal emphasis to cognitive and organizational factors as well as task and software specifications with the end product being the technology intervention and guidelines for its use.

Brown (2005) shares the results regarding a m-learning project in Africa and proposes a model for the implementation of m-learning in higher education in developing countries. The model is presented in the form of guidelines and analyzes a number of factors for instance high student enrolment numbers and cell phone prevalence; reviews current successes of cell phone usage and lessons learned from recent developing world mobile learning projects. Brown then models the situation for 2003 and 2005 and postulates that by 2010 or further, the m-learning model will be different.

3.5.1 Discussion of Theoretical Contributions

Many of the articles point towards using Activity Theory as an analytical framework. Conceptual frameworks such as those described in the previous sub-section have made some progress in providing principled advice and guiding design, although there is clearly much more to be done. In the context of mobile learning, cognitive theories of human memory and classification may not be applicable to the modeling natural real-world classification decisions in a chaotic work environment.

Other theory is very high-level, such as the conceptual frameworks offered by Sharples et al., (2002). One route may be to develop new theory or combine theories which focus on different levels of analysis. Secondly, theory must be applicable. The challenge for theorists is to develop models that can be useful in a design context. It is not clear how much of the theoretical work is of practical help to the practical needs of designers.

While a number of theoretical contributions to handle the socio-technical nature of mobile learning exist, research is yet to produce initiatives with any lasting outcomes. To further investigate this, sub-section 3.6.1 addresses the methodological considerations and the methods utilized in this thesis. In this thesis, the author extends the work of Litchfield et al. (2007), Kim (2009) who report on the need for investigation into strategies for low-cost m-learning using an Action Research approach. Moreover, the author partly utilizes the work of Vavoula and Sharples (2009) to provide an evaluation framework for MLCAT (detailed in Chapter 5) at the micro (concerned with usability) and macro (concerned with integration within existing educational and organisational contexts) levels. The meso level (concerned with the learning experience) is outside the scope of this thesis. This framework has been used to guide data collection in mobile learning evaluation projects.

3.6 Critical Analysis of Previous Research

In this chapter, three main engines of research progress have been identified: empirical studies, technology design and theory. However, despite the body of previous works in each area, analysis reveals that podcasting has not received the attention it merits as a fundamental mobile learning activity. In terms of empirical studies, Section 3.3 highlighted a lack of attention to evaluation of mobile learning. The studies reviewed mostly explore the effectiveness of podcasts; analyze podcast usage; experiences of incorporating podcasts into HEI courses; usefulness, feelings and perceptions and student delivery preferences. Accordingly, some studies predominantly use any one of the methods i.e. questionnaires (Hurst et al., 2007) in isolation whereas others use a combination of techniques (i.e. McGrath, 2009). Consequently, the articles reveal subjective results for example podcasts were well received (this is common with most new technologies); podcasts were mostly useful when students are mobile (Bhaskar and Govindarajulu, 2008); presented important lessons learned from usage (i.e. podcasts should be short, linked to course material, etc.), suggested positive attitudes; implied that podcasts were very good; revealed higher scores for students who used podcasts versus those who traditional class material; and promoted collaborative knowledge building.

On the contrary, other results disclosed that students preferred traditional class lectures to podcasts and preferred sections of recordings (Chandra, 2007); valued podcasts only as a vehicle for revision and that residential HEI students watched from their PCs and not mobile devices (Malan, 2007); and that in some cases students were not ready and eager to use podcasts for educational purposes. Despite the fact that the studies provide interesting results, this insufficient empirical grounding has contributed to the inadequate guidance on usage and sequencing of design and evaluation methods for innovative podcasting technologies. Section 3.4 surveyed previous research which presents podcasting prototypes. The review provides literature on the use of podcasting tools and offers insights to researchers and practitioners for the design and choice of tool adoption. Clearly, there is a need for tools to be developed within the contexts of the users in order for successful adoption of these technologies. Many of the mobile content authoring tools explored do not use design approaches that involve real system users in context.

Moreover, the varieties of tool implementations explored are mainly technology driven. In order for tools to satisfy intended user needs, such as authoring legible podcast content, they should follow an integrated approach that takes into account usability and pedagogical aspects as this leads to better design, likelihood of use and adoption. Much of this body of work can be criticized in terms of making a strong contribution to the mobile education knowledge base due to: (1) a lack of grounding in empirical requirements, (2) limited exposition on the design approaches used and (3) evaluation methods. The reasons for this poor epistemic state are: Firstly, there is over reliance on Western tools in developing HEIs and subsequent low adoption rates. Secondly, traditional measures of usability may be inappropriate for evaluating interfaces that support podcasting activities. Thirdly, mobile learning is a multi-faceted, ongoing, and highly idiosyncratic activity, and may be seen as too challenging an area.

Chepken et al. (2012) present a survey of ICTD technology interventions and reveal that education and health related technology interventions dominated ICT4D research in the last decade. In addition, applied research stood out as the most employed method across the different areas, particularly in education. Applied research is similar to prototyping and is based on a trial-and-error practice relying on the expertise and reasoning of the researcher's capabilities through intuition, experience, deduction, and induction. Applied research is relevant for mobile learning in relation to design and implementation of systems, interfaces and techniques, which meet certain requirements for performance, user interaction and user satisfaction. This was consistently followed by field studies over the same time period.

Field studies normally take place in natural settings, allowing the researcher a flexible stance in respect to variables. Using a range of qualitative and quantitative approaches, data is collected often through observations and interviews, supporting the study of complex situated interactions and processes (Klein & Myers, 1999).

Action Research, case studies and basic research did not appeal to researchers during this period. However, Wingkvist and Ericsson (2009) review the field of mobile learning and present a classification framework of articles based on purpose and methods used. They affirm the notion that mobile learning is an interdisciplinary field with ties to Computer Science – something that might explain the emphasis on applied research and data gathering. Mobile learning researchers could learn from other disciplines that have struggled with the study of similar phenomena often depending on the degree of involvement from the researcher.

3.6.1 Selection of Methodology

The selection of appropriate research methodology is a classic HCI dilemma. As an interdisciplinary research field, HCI offers many research approaches and methodologies (Rogers, 2004). The methodology employed in this thesis is heavily influenced by the UCD research paradigm. This is in line with development agencies such as bridges.org that advocate people-centric approaches to creating appropriate solutions (bridges.org, 2003). They hypothesize that centering design activities on users needs in context will lead to the most meaningful and appropriate technological systems. As a result, UCD methodology should be evident in any ICT4D design initiative. Formally, the international standard ISO 13407: Human Centred Design Process for Interactive Systems describes four principles of Human-Centered Design namely: active involvement of users; appropriate allocation of function to system and to user; iteration of design solutions and multi-disciplinary design. The standard further presents the following four Human-Centred Design Activities:

1. Understand and specify the context of use
2. Specify user and organisational requirements
3. Produce more than one candidate design solution
4. Evaluate designs against requirements

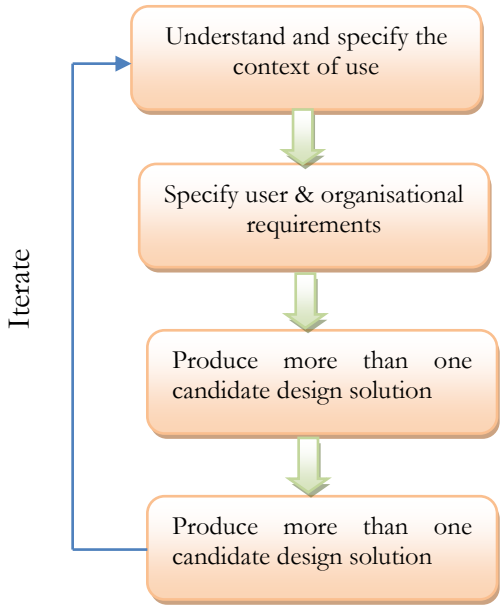


Figure 3-7: ISO 13407: Human Centred Design Process

Firstly, practitioners are required to undertake contextual analysis in order to understand and specify context. The next phase, according to the UCD model, is to transform the contextual data into a detailed requirements specification. Designers usually immerse themselves within the target context, and attempt to separate and describe user and organizational requirements from their own perspective. Thirdly, this would typically progress into a prototype design followed by an evaluative phase where the user experiences the prototype. The designer then gathers the users' reactive feedback and uses it to inform their initial analysis and understanding of the usage context before proceeding to the next design iteration.

3.6.2 Participatory Design

Participatory design is part of phase one in the ISO 13407: Human Centred Design Process. It considers potential users of the proposed system as equal partners or co-designers in the systems' development process (Schuler & Namioka, 1993). Consequently, users have equal status, roles and responsibilities within the systems development process as other stakeholders. PD attempts to capture complex and messy issues within a given context so as to improve the computer system that supports these activities. The underlying premise is to maximize user involvement in the systems design by giving users equal responsibilities and treating them as equal participants in the systems development process. Therefore, this approach makes users equally accountable for the design decisions made about the system being built.

However, critics of the participatory design method have questioned the merits of treating users as equal partners in the design process. They argue that users do not know enough to be equal partners, but they can instead be informants (Scaife and Rogers, 1999) in the design process, to be consulted as and when required. Druin (1999) has also voiced her concerns about the idea of treating users as equal partners in the design process. For example, in discussions of designing software for children, Druin points to differences in power structures within the design team as one disadvantage of treating users as equal participants. She further explains that some of the ideas that users (especially if they are children) come up with may not be workable in computational terms. Therefore even though users may come up with several smart ideas about the design of a software product, it is the systems developer who makes the final decision as to what gets implemented into the system and what gets left out.

What participatory design methods do give is a design process to benefit from the expertise and experience of workers in the intended application domain. However, it is difficult to find users who are willing to give full-time commitment to a design project, since users tend to have other duties to carry out. Additionally, the idea of training may also place a lot of intellectual demands on users as participants in the design team. In addition, participatory design methods require users to sketch out their ideas during brainstorming sessions. This design activity may prove to be intellectually taxing for some participants (Mugwanya and Marsden, 2011).

Participatory design methods therefore physically or mentally take the users out of the social context of their normal work situation because most design projects are carried out at the system developer's workplace, in laboratory settings. Suchman (1987) reveals that excluding people from their normal work environments alters their behavior patterns. Suchman illustrates that taking a worker away from the workplace changes the very nature of the worker's actions. Real action is situated action; which occurs in interactions with the materials or tools (e.g. computers) and people of the workplace (social aspects).

3.6.3 Generating and evaluating the design solution

The methods available to cross-cultural researchers in cultural data collection include academic research, observation, focus groups, questionnaires and interviews. According to Sharples (2009), mobile learning differs from learning in the classroom or on a desktop computer in its support for education across contexts and life transitions. This makes evaluation challenging particularly if context is not pre-determined and the activity spans various settings.

Sharples presents a framework used to evaluate usability, effectiveness and satisfaction and illustrates these with case studies of evaluation for three major mobile learning projects. The Mobile Learning Organizer project used diary and interview methods to investigate students' use whereas MyArtSpace used critical incident analysis to reveal breakthroughs and breakdowns in the use of mobile technology for inquiry science learning. According to Traxler (2007), what is not always accepted is that there are no *a priori* attributes of a 'good' evaluation of learning. In an earlier work, he tried to outline some tentative candidate attributes of a 'good' evaluation namely: it should be rigorous, efficient, ethical, appropriate, consistent and authentic among others (Traxler, 2002).

Vavoula and Sharples (2009) summarize six challenges in evaluating mobile learning i.e. capturing and analyzing learning in context and across contexts; measuring the processes and outcomes of mobile learning; respecting learner/participant privacy; assessing mobile technology utility and usability; considering the wider organisational and socio-cultural context of learning; and assessing in/formality. Vavoula and Sharples go on to propose an evaluation framework with three levels i.e. micro (concerned with usability), meso (concerned with the learning experience) and macro (concerned with integration within existing educational and organisational contexts). This framework has been used to guide data collection in mobile learning evaluation projects.

3.7 The Challenge

The major challenge for designers of m-education applications is getting to grips with the physical, social and cultural environment. In the remainder of this thesis, the researcher explores strategies for designing locally relevant podcasting systems. Firstly, the researcher presents a familiar UCD approach where the designer attempts to understand users' needs and then uses their skills and experience to design an appropriate technology solution. Using pragmatic design (Marsden, 2008) within the wider UCD, designers are able not to look very far for solutions but rather utilize technologies that are already in the hands of users to devise new innovative applications. The ultimate goal is that the artifact will resonate at a local level and the designer will be able to re-use the participatory data into the design process in order to generate the appropriate solution. Evaluation also provides an opportunity for further empirical discovery (understanding of the world).

The approach is highly compatible with the author's desire to produce a novel podcast authoring tool, whilst also supporting the exploration of user behavior, and theory development. Moreover, it was envisaged that by experiencing design issues first hand, the author was more likely to produce findings in a form of relevance to practitioners.

Chapter 4 now moves on to report the Participatory Action Research methodology employed to design a podcast authoring tool (referred to as MLCAT in this thesis). This chapter also reports on a number of evaluation studies conducted during each of the design and use cycles.

Chapter 4 Designing MLCAT

4.1 Introduction

This chapter describes the design of a podcast prototype called MLCAT based on the unsuccessful adoption of Western systems in their goal of being domesticated by faculty in developing HEI contexts. The researcher's article titled: *"Using a participatory action research approach to design a lecture podcasting system"* provides a framework for this chapter as well as much of the text (Mugwanya et al., 2012). It begins by examining why the tools failed and the methodology used by the researchers to design MLCAT. Findings highlighted several weaknesses with the adoption of Western tools and accordingly, researchers opted for a more user-centric approach grounded in HCI best practice.

Consequently, this chapter makes two main contributions to the thesis namely:

1. The design and implementation of the MLCAT prototype – this chapter presents a podcasting information ecology model and framework which aids in the design and implementation of the MLCAT prototype. As well as being a novel podcasting system, MLCAT acted as a research vehicle to enable the investigation of general issues relating to podcasting.

2. The results from the initial formative evaluation of MLCAT confirmed the value of pursuing a more in-depth evaluation. Chapter five presents a follow-up prototype evaluation of the modified version of MLCAT which incorporates suggestions from the initial evaluations.

Moreover, the design component of this thesis had two high-level objectives, each relating to a limitation of previous design work in this area:

- To propose a podcasting tool design that better meets user needs – chapter three criticizes a number of previous research prototypes in this area for a lack of empirical grounding. Instead, many have been founded on designer intuition. To avoid similar critique, the author set out to ground design efforts in findings presented in this chapter.

- To implement the design with an aim of performing an evaluation – any implementation has to be sufficiently robust to sustain long-term usage in real-world conditions.

4.2 Design Approach

In contrast to most previous work in this area, the researcher opted for a design approach that utilized PD in combination with AR. The purpose is related to the role of each method in the overall design process. PD ensures that the target users are actively involved in the design process and their insights and feedback are captured to help shape and refine the final solution. AR on the other hand operates at a higher level. It encourages designers to engage with the target community in identifying locally relevant problems without placing any emphasis on technology aspects. This approach is aimed at extending, rather than replacing existing technology. This is in contrast to the criticism of previous work presented in chapter three that there has been an over-focus on revolutionary design - the innovation of radical alternatives to current tools. Although many interesting designs have been proposed, such radical inventions do not necessarily bring about a strong contribution to HCI knowledge, especially if no evaluation has been performed. In response, a number of researchers have emphasized the need for iterative, incremental design (Rogers, 2004; Carroll, 2000).

In the context of this thesis, an AR approach was chosen for the following reasons:

1. To enable effective evaluation – as noted above, a key aim of the research reported in this chapter was to enable effective evaluation. One downside of radical invention is that it is difficult to measure specific improvements as so many interface aspects may change.

2. To promote user familiarity – if the proposed design builds on familiar concepts and tools, then this promotes familiarity, given users have less to learn.

3. To promote system up-take – building on current tools implicitly implies compatibility with previous data formats. It was envisaged that this would make long term evaluation more straight forward, since a tool that can be easily integrated into users' existing tool set(s) is more likely to be used.

4. To realize an achievable design goal – a key concern was that the design and implementation needed to be achievable in the context of the limited time and man-power resources available. Furthermore, the design also needed to be robust enough to enable real-world evaluation studies.

Therefore, this chapter describes the execution of the design strategy in detail while drawing specific attention to the operation of Participatory Action Research (PAR), which resulted in the generation of the MLCAT prototype. An AR approach was employed to investigate the possible effects of various affordances for the MLCAT podcasting model. Chetty et al. (2004) advocate that PD (Muller, 1991), AR (Kim, 2008) and iterative participatory cyclical approaches have been reported to provide an ideal framework for introducing ICTs and bridging the technology gap. These approaches have also been recommended by ICT4D researchers Blake and Tucker (2006); used by Chetty et al. (2004) for the design of locally relevant technologies and therefore worth discussing in this chapter.

4.2.1 Action Research (AR)

According to Baskerville (1999), AR manages better than conventional methods to remain relevant to the real world. However, some AR can lack discipline and lead to context bound solutions. These problems are overcome by ensuring that AR interventions have good theoretical foundations, where all phases are well documented and the outcomes have restricted generalization. Thus AR and particularly its most typical variant PAR is a well-suited methodology for the project being undertaken. PAR's philosophical context is contained in strongly post-positivist assumptions such as idiographic and interpretive research ideals. The designers opted for a design approach that utilized PD in combination with AR and the rationale behind the decision was related to the role of each method in the overall design process.

PD ensures that the users are actively involved in the design process and that their insights and feedback are captured to help shape and refine the final solution. The AR approach on the other hand operates at a higher level and encourages designers to engage with the target community (while including them as participants). The process of participation requires that activities be used only in identifying locally relevant problems without placing any emphasis on technology aspects (Maunder et al., 2007; Bidwell et al., 2010).

The difference between a typical AR approach and one that emphasizes participation is that AR requires the designer to collaborate with the target community whereas the participatory variant requires both the designer and the community to be in agreement as to: what the problems are (analysis, fact finding and conceptualization); which problems will be addressed (action planning); how they will be addressed (action implementation) and what the criteria for success might be (evaluation).

4.2.2 The Participatory Action Research (PAR) Process

The PAR cycle has four phases as highlighted in the previous sub-section and they operate within the context and environment within which the research is conducted. These cycles are repeated and the PAR loop is exited if project time is up, project funding is exhausted or no new knowledge being discovered (Baskerville and Myers, 2004). The researcher should contribute to the practical concerns of people in a situation, which means taking action and evaluating the action at the same time, both to be carried out between the researcher and the population concerned. As the word action implies, the researcher is engaged actively, which profits both the organization and the researcher, in combining practice and theory. This is in line with the ideas of Baskerville and Myers (2004), who argue that the goal of AR is to solve a problem in a real setting and also to make a knowledge contribution.

The researcher is an active participant and the empirical observations and materials gathering are performed while acknowledging the prior theoretical standpoints. A researcher needs to be able to balance this heavy involvement as well as the strengths and weaknesses that follow. AR is particularly suited for use in real or natural settings and studying social and cultural phenomena. Baskerville and Myers (2004) argue that the researcher actively participates in solving a problem while at the same time evaluating the results and making a knowledge contribution at large. For example, it allows for the introduction, transformation, evaluation, and extraction of theories. The advantage of being so engaged in the activity facilitates first-hand understanding and supports the learning process for all those involved. Conversely, the disadvantage is that it can be very time consuming, and since the researcher takes part in the phenomenon being studied, remaining critical may be challenging.

On the other hand, this unique position of in-house work allows the researcher to produce highly relevant results while informing theory simultaneously (Baskerville, 1999, Baskerville and Myers, 2004). Even though the outcome is attached uniquely to the research conducted, it does offer a degree of external validity, since others can interpret the theoretical contribution made. Nevertheless it can still be difficult to generalize from. In relation to mobile learning, Action Research provides an opportunity for a researcher to jointly collaborate with the "team". Further, AR has been recognized in the information systems research community and entered into journals as well as conference proceedings (Avison and Myers, 2002).

The iterative AR cycle supports the analysis of an application or problem area and has been utilized for the overall research. It is a cyclic process involving four linked phases as illustrated in Figure 4-1. It is envisaged that the theoretical contribution will emerge through iterations of Action Research cycles (Baskerville, 1999). To further explain the overall research process, field studies, document analyses, interviews, focus groups and survey research have been planned, ongoing action and observations made and in turn gathering of the empirical data is accompanied by constant reflecting, specifically through construction of theoretical connections.

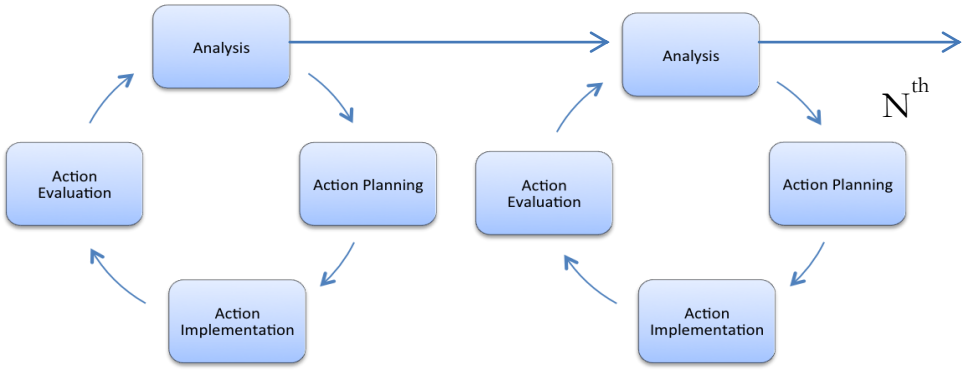


Figure 4-1: The Iterative Cycles of Action Research

A mixture of research methods, i.e. triangulation, is advocated by Mingers (2003) on the grounds that the target and the research processes are complex and multidimensional, requiring a range of different data collection approaches to produce richer and more reliable results. Additionally, it emphasizes the use of multiple sources of evidence thus imposing a great burden on the researcher, who is required to have mastery of data gathering techniques and analysis of the extensive data these techniques produce. Yin (2003) presents four types of triangulation namely:

1. Data sources i.e. data triangulation
2. Among different researchers i.e. investigators triangulation
3. Perspectives to the same data sources i.e. theory triangulation and
4. Methods i.e. methods triangulation.

In this thesis, the researcher uses a triangulation of methods in the design and evaluation of MLCAT. In fact, not only is triangulation taken into account but also the sequencing of methods. In chapter six, the researcher proposes a practical framework for evaluating mobile learning software that shows how methods from Personal Construct Theory are triangulated and sequenced.

4.3 Design of the MLCAT system

4.3.1 Background

Action Research is appropriate as the project started out with the researcher observing his role as a student and later on as a lecturer at a developing HEI. The researcher wanted to take action in the hope that they would change the environment. Therefore, in the paragraph that follows, the researcher begins with a personal reflection and motivation for doing the research as the first part of phase one of the Action Research cycle.

The research topic emerged from the researcher's work as a lecturer at a developing HEI. The researcher completed a first degree in 2001 and during this time all lectures were delivered through faculty writing material on a Chalkboard (for the highly mathematical/practical content); dictation of notes for the more theoretical content and a combination of the two approaches where appropriate. In other instances, faculty typed out notes and made a single hard copy version available to students in A4 print. The class notes were housed at a commercial photocopy area (just outside the department building) where students would make copies at a fee.

In 2004, while the researcher was at the University of Liverpool, faculty delivered lecture content and class assignments in digital form (mostly as PowerPoint slides). Additionally, a LMS called LearnWise was used for content delivery with mostly undergraduate students, and in rare instances graduate students, to collaborate on assignments through forums. In 2006, the author then returned to Makerere University as an assistant lecturer in the department of Information Technology. All lectures in the department were presented and delivered in digital form using PowerPoint and e-mailed to students through the various mailing lists. No use of LMSs was noted although the University had procured BlackBoard and is currently in the process of trialing an open source LMS called Moodle. During this time, there were very few computers compared to the growth in student numbers, Internet access very intermittent and load shedding (random power outages) very prevalent despite majority of the students owning a mobile device. In 2008, while at the University of Cape Town (UCT), the author found that, in spite of South Africa being more developed than Uganda (based on Gross Development Product figures), similar problems persisted i.e. a limited number of computers, relatively slow Internet access and divisions amongst students in terms of access to ICTs.

One thing they had in common was the high prevalence of mobile devices, particularly cell phones among students, the use of Power Point to deliver content and a more widespread use of LMSs (i.e. Vula – a Sakai based LMS) for delivery and access to content.

By 2008, there were some implementations of lecture recordings/podcasting at UCT (Ng`ambi, 2008a; 2008b) normally undertaken by enthusiastic academics albeit with a number of challenges. Consequently, in order to appreciate the organizational context, environment, define the problem domain and select a design direction for the rest of the process, an AR-PD approach was undertaken as detailed in the subsections that follow.

4.3.2 The first AR-PD cycle (Analysis, Fact-finding and Conceptualization)

The researcher's article titled "Podcasting in developing HEIs: a South African case" provides a framework for this sub-section (Mugwanya et al., 2011). The overall aim of this baseline (also denoted as study A) was to understand the current working environment of the lecturers, prior to any new technology being introduced. This phase of the AR cycle is comparable to contextual analysis in user-centered design (UCD) (Beyer & Holtzblatt, 1997). The primary data collection tools were interviews (conducted individually with each taking about 45 - 60 minutes) with eight participants who were lead users (Von Hippel, 1986) of podcasting technology and a survey with UCT students between July and October 2009. They consisted of six academics, a technician and a content/curriculum developer mainly from the UCT and one from Witwatersrand University.

Generally, one would expect that the technologically oriented faculties are early adopters of ICTs in HEIs. This was found not to be the case. For instance, at the UCT, only the faculty of Commerce had an instance of podcasting amongst all the science faculties/departments. Table 4-1 gives an indication of where podcasting instances were evident. A tick represents existence whereas a cross (x) non-existence. The other university studied in Uganda, Makerere University, had no instances of podcasting; whereas Witwatersrand University was undertaking small-scale trials managed by their content/curriculum developers.

Table 4-1: Podcasting usage across faculties at UCT

Faculty	Podcast usage
Science	X
Health Sciences	X
Engineering and the Built Environment	X
Commerce	✓

In order to study how podcasting took place and how tools support this activity, the researcher conducted a two-part study. Since this was an initial exploratory study, the first part involved qualitative interviews with academics to find out current practices and challenges of podcasting lectures. This approach was used because it is particularly useful for studying phenomenon or events. The academics had been lecturing for at least three years and were very enthusiastic about lecture recordings whereas the content/curriculum developers were providing support to lecturers who were trialing podcasting. Sample questions from our qualitative interviews included but were not limited to the following: how did you set up podcasting infrastructure? Which tools do you use? What are the challenges? Is there anything you would love to see changed? If you were to take part in the design an educational content authoring and presentation tool, what would it look like? Can you describe how students access the generated content?

These questions were derived from Gaffney (2001) and their purpose was to obtain an account of podcasting experiences by faculty and students at two South African Higher Education Institutions (HEIs), identify issues, limitations and discuss implications for the design of future tools. Consequently, the researcher completed six in-depth semi-structured interviews with academics and a content/curriculum developer. They were selected based on the fact that they had experimented with podcasting. The interviews were conducted in lecturers' offices, meeting rooms and one on Skype – all chosen at their convenience. All interviews were tape recorded and transcribed to typed format for analysis.

The second part of this study constituted a quantitative study with first-year students in the faculty of commerce undertaking an introductory Information Systems (IS) course. This is because podcasting was being piloted with this group of students. Questionnaires were given to 132 first-year students and they consisted of a background section and mixture of closed and open-ended questions to allow for the respondents to express their perceptions on podcast use.

Of the 132 that were administered, seven were discarded because they were left blank, leaving us with 125. Responses were voluntary and treated with strict confidentiality. Moreover, there was no need for advertising to recruit participants as the questionnaires were administered during a tutorial session.

Qualitative data was collected from both academics and students to provide an expanded understanding of how they perceived the podcasts, their suggestions for enhancements, production and potential future usage within developing HEI contexts. As with most studies, a number of limitations exist; for instance, the sample group was small because the experimentation with podcasting is not a university-wide undertaking and only pursued by enthusiastic faculty; limitations are posed on the stratification and generalization of results. Additionally, potential bias may also exist resulting from the different mindsets of our respondents with some answering in groups of about two or three. These preliminary studies revealed majority of our respondents had various improvisations. The technologies used are as highlighted below:

- A microphone connected to the pre-installed public lecture address system.
- A desktop presentation computer installed with Windows operating system.
- A Mac book connected to a video camera on a tripod stand pointing towards the presentation machine. The Mac book has factory pre-installed software such as iMovie and Garage Band for recording, editing and compressing the videos.
- .Vula LMS which was intended to host the recordings.

Other scenarios involved the use of a stand-alone audio recorder or the one in-built into a laptop/personal computer to capture the lecturers' voice and the use of Audacity to edit the MP3 files for manual upload onto Vula LMS. In order to illustrate the extent of diffusion of podcasting at UCT, the researcher compared the data from the concurrent mixed methods studies (study A) against the five innovation characteristics from Rogers' theory on diffusion of innovations (Rogers, 2003) to come up with the following contextual observations.

4.3.2.1 Contextual observations

The contextual observations derived from the concurrent mixed studies are as described below:

A. Show relative advantage

This is the degree to which an innovation is perceived as better than the idea it supersedes by a particular group of users (Rogers, 2003). Respondents revealed that podcasting is viewed as supplementary to existing e-learning approaches such as the use of LMSs and not compared in such a way as to determine which is better as seen from the following quotes: *"benefits of these Podcasts include the issue of flexibility because it means that people do not physically have to come to one place at that particular moment [. . .]. The second one is that of re-usability for subsequent classes [. . .] broader access to resources, e.g. you could really have leading, internationally re-known speakers in your class room without them physically being present".*

B. Be compatible with existing values and experiences

Refers to the degree to which an innovation is perceived as being consistent with values, past experiences and needs of potential adopters. In fact, academics and students make use of the already-existing platforms such as LMSs for storage, access to recordings and other course resources. For instance, one of the respondents reported the following:

"[. . .] What we have done is we just use Vula – an LMS and we very simply recorded MP3 and just posted it onto Vula and the guys would just download it off Vula [. . .] We compress it, break it/split it into smaller chunks and currently we are putting it onto Vula or the lecturers are putting it onto Vula".

C. Have simple complexity

This is the degree to which an innovation is perceived as difficult to understand and use. Overall, respondents seemed to like the idea of podcasting but of the 125 students interviewed, only seven had listened to the lecture recordings at least once whereas only 4.8 % (six) had downloaded them at least once per week.

Table 4-2: Download frequency of podcast lectures by UCT students.

	Frequency	%	Valid %	Cumulative %
Valid				
Never	64	51.2	58.7	58.7
Once or twice this semester	45	36	41.3	100.0
Total	109	87.2	100.0	
Missing				
System	16	12.8		
Total	125	100.0		

Source: extracted from SPSS analysis results

These respondents reported that they found the recordings useful and the qualitative interviews with the lecturers' validated this assertion. For instance, the lecturers revealed that some students on a number of occasions reported back saying the podcasts were useful. However, 51.2 percent (64) had never downloaded the lectures. This is contrary to the works of Evans (2008) in which the students claimed to learn better with podcasts compared to their own notes. The predominant reasons for this low usage as reported verbatim are:

"[. . .] Sometimes the formats do not work [. . .] I have not needed extra lessons [. . .] I am at par with the course [. . .] Sometimes they cannot be found [. . .] they take forever to download [. . .] I am not that patient and I never knew they existed among others".

D. Be trial-able

This is the degree to which an innovation can be experimented with on a limited basis. 19 students who listened to lecture recordings at least once used a laptop or desktop computer as the primary access tools. The reasons for this are the fact that a great number of students interviewed primarily use university-provided infrastructure – which is normally inadequate given the large student populace. The majority of the students did not have access to devices off-campus – a challenge echoed by many of the lecturers interviewed. For instance, one of our respondents revealed that while podcast lectures may help increase access channels to content, educators need to be wary or aware of the access devices their students' possess – considering the fact that the majority of students in developing world HEIs are from disadvantaged backgrounds.

Moreover, given the resultant size of recordings i.e. 100MB, the preferred access devices were PCs or laptops over Ethernet. Therefore, there is need to explore the inclusion of access devices such as cell phones since almost all students owned at least one (Hürst et al., 2007). The students encountered a number of challenges during access, e.g. off-campus access issues, incompatible formats, lecture podcast upload delays and a limited ownership of personal computers by students. It is normally very difficult to access university resources off-campus as students have different connection speeds and access devices. As a result a number of themes were generated with supporting verbatim quotes from respondents as described below:

- **Content appropriateness and availability**

The IS academics from UCT argue that content type and appropriateness is of paramount importance when using podcast lectures as this greatly influences use. For instance, one of the lecturers identified that their students are more visual, hence the need for content that fits that requirement. One of the academics suggested that it would be appropriate to have both PowerPoint slides with audio as illustrated in the verbatim quote that follows:

"[…] they have slides and can also hear and (Access audio). I tell them for instance to go to slide number 5, and slides and audio work together. For me it is for students to revise but I doubt if they use them for that [. . .] ummh revision is the best way. For instance you get students who will always be asking you to do this so if you can refer them to podcast X it would force them to go back and review them/listen to them".

- **Content transformation or processing**

As mentioned earlier, there is a need to have an automated way of transforming and processing the content into formats that are easily consumable without the need for client software. In the current state, our interaction with the academics reveals a manual and time-consuming approach as indicated in this verbatim quote:

"[. . .] there has to be a way of formatting the podcasts such that the noise is out [. . .] I know I can or should be able to start formatting the podcasts but I do not have the time, that is extra work and do not have the time to go over what I have already said [. . .] But now we have to use a manual method of recording and transforming files [. . .]".

- **Distribution mechanism**

During our interaction with lecturers, they did not know what happened to the recordings once they were captured. The problem arose from the fact that the post processing was done by technicians and yet they had the ultimate responsibility of transferring the media files from the shared volume into their course folders in Vula for students to access. This created a breakdown in the podcast production information ecology as it was common to take from 48 hours to several days before lecture content was uploaded to a shared drive or Vula.

Additionally, the academics interviewed did not know where the manually compressed and edited video recordings were stored and yet despite the possibilities availed by mobile devices, content distribution and adequate application scenarios have to be considered. The challenge is how the media can be offered to the students in such a way that no expert knowledge or additional software (which in most cases they cannot afford) is required (Ketterl et al., 2006) as quoted verbatim in the following text:

"[. . .] and then may be if there could be a way to distribute files much better – that would be great [. . .] One of the major challenges is the distribution of files. They have gotten to a point where recordings are being made but distribution of the files to the students is a major problem [. . .]".

- **Awareness of availability and accessibility**

A survey with students revealed that they were not aware of the availability of video lecture recordings and how to access them – a concern also shared by the academics. In addition, the academics did not know where the recordings were stored and had never downloaded them. The recordings were also made available in QuickTime format, which the majority of the students and academics did not have installed on their computers. This could have resulted from the fact that despite the ways in which the lectures were recorded and made available, a lot of the work to accomplish this task was delegated to the technicians. Hence there is need for academics to own the process through easy-to-use tools and also to incorporate the use of lecture recordings within the curriculum (Baker et al., 2008). The quote below gives an illustration of the above issues:

"[. . .] If we are looking at a 2 hr lecture, we have to split that file into 2 because we obviously do not want to make it a huge file so that people stand for 3-4 hrs downloading a file. [. . .] I do not know how students get access to content and that is one big problem [. . .] you will find that many of the students are not aware of the availability of podcasts".

- **Intrusiveness and organizational issues**

One of the lecturers expressed the issue of intrusiveness during the recordings and the added pressure to perform. They felt that this in some ways affected the way they interacted with their students because lectures normally incorporate telling jokes, stories and real-life examples outside the scope of the class content as indicated in this quote:

"[. . .] there is need for lecturers to be made aware of the eventual purpose of the audio content that results from the lectures, e.g. have to be careful of the words I use [. . .] lecturer feels there is added pressure into being more explicit with explanations since students are going to listen to content afterwards [. . .] it needed a whole lot of organization and management because we had to fight to secure the labs and it was not easy at all [. . .]".

- **Student and system interaction**

The academics also mentioned that they had difficulty interacting with the system and students as indicated in this verbatim quote:

"[. . .] It is difficult in terms of interaction that I struggle a bit with because when I am lecturing, I like to be able to see students, interact with them, and ask questions [. . .] podcasting should not have as much user interaction as it is currently. It should be a fairly fluid system [. . .] the process of switching between screens is annoying [. . .] If everything was synchronized so that it could be done easier [. . .] During recording, lecturer has to be in one place and it is difficult [. . .] They are sitting all around me and some are seated in other smaller labs within the general lab area [. . .] It is difficult in terms of interaction [. . .]".

In parallel, an analysis of system manuals and related research articles was undertaken as well as informal observations in the classrooms where the technologies were used. The document analysis provided an objective snapshot of the systems and gave context to the other data collection initiatives. In 2009, one of the lecturers in the department of Computer Science at UCT introduced OpenEyA (Enhance your Audio), a system that facilitated archiving (in Flash format) and sharing (via web, zip) of traditional scientific lectures carried out using chalkboards in classrooms and/or modern presentations (PPT, PDF, animations, etc.) (http://www.openeya.org/). OpenEyA is developed for Linux (Ubuntu) and can run on a low-cost Netbook with just one click in order to synchronize:

- Video in Flash format (to see whatever happens in front of a classroom),
- High resolution digital photos or VGA screen captures (to zoom specific areas of the Classroom podium, blackboard and projector screen, if any) and
- Classroom audio (without the need to wear a microphone).

One of the lecturers proposed the use of OpenEyA to record lunch-time presentations done by students and visiting academics. The idea was immediately discarded because the workshops coordinator thought it would intrude on the privacy of the presenters. Therefore, the researcher decided to trial the system through conducting informal presentations; reading system documentation and research papers on OpenEyA in order to gain an in-depth understanding of the tool.

During the same period, the department of Information Systems at UCT was in the process of trialing Apple's Podcast Producer server. Just as with the OpenEyA system, despite its sophistication, the resulting recordings are only accessible on iPhones which are not very common with students in developing HEIs; the implementation and costs were prohibitive, in addition to the setup and administration being complex. In order to gain an in-depth understanding of the workings of Podcast Producer server, the researcher attended one day training with Project3, a company that re-distributes Apple products in South Africa.

Project3 provided the researcher with a copy of Podcast Producer server software to deploy a stand-alone implementation of the system at Makerere University. During December of 2009, the researcher presented the software to the then Faculty of Computing and Information Technology at Makerere University. However, the setup and configuration of the system proved complex even for advanced users i.e. the system administrators were not familiar with the administration, setup and configuration as they mostly use Windows and Linux systems for server-side computing. With almost no Apple distributors to provide support, coupled with limited training, this initiative was immediately discarded.

Consequently, the designers settled on the design path that tackled the problem of a labor-intensive podcasting process. Typically, our analysis revealed that the lecturers were not using any standard architecture or model for authoring lecture podcasts as some had their own piece-meal improvisations. The lecturers and designers were in agreement that the process of authoring digital lecture content was a time consuming one. Implementation cost was an issue, inadequate funding and skills required to set up and configure the systems. Access to podcasts in QuickTime, Flash or as a Zip file was not ideal. Despite the fact that these file formats seem fairly easily understandable, the resultant videos should be in formats that do not require downloading additional software, and have the requisite access devices i.e. PCs or laptops for easy access.

In developing HEI contexts, there exist divisions amongst students in terms of access to ICTs. For instance, students encountered a number of challenges during off-campus access i.e. incompatible media formats, lecture podcast upload delays and limited ownership of personal computers by students. It is normally very difficult to access university resources off-campus as some student's primarily access PC Internet on campus.

The size of the resultant recordings was an issue as well, for instance a one-hour video ranges from 230 – 350 MB which may be impossible to download at a developing HEI where the bandwidth and cost of Internet access is still prohibitive. Moreover, during this time, the University of Cape Town undergraduate students had a 300MB monthly Internet cap. The designers believe that by addressing the challenges presented above, they would improve the quality of the podcast production process.

4.3.2.2 The Podcast Ecology Model

In order to better understand the podcasting processes, this sub-section attempts to model the podcasting ecology. According to and Nardi and O'Day (1999, pg. 49), *"information ecology refers to a system of people, practices, values and technologies in a particular local environment"*. They further state that *"the spot light is not on the technology but the human activities that are served by the technology"*. Perhaps more importantly, they argue that information ecologies are "designed" and that it is the "responsibility and privilege of people in the local information ecology to shape new technologies and practices" (Nardi and O'Day, 1999, pg. 182). Chapter two presented an abstract podcasting model for developing HEIs consisting of four sub-activities namely: content organization, podcast authoring mechanism, podcast delivery mechanism and access mechanism. This was based on the researcher's conceptual framing of the abstract podcasting processes from a review and analysis of literature sources.

In this sub-section, the researcher proposes that an ecological perspective on podcasting in developing HEIs may be useful for providing insight into the integrity and efficacy of such environments. In particular, it offers a way of viewing podcasting environments that considers more than just the technological features available in higher educational environments. Such considerations tend to reinforce the potentially dangerous notion that human interaction in authoring content with technology should simply be ordered around the parameters and capabilities of the most readily available technologies.

Therefore, we attempt to situate the information ecology attributes within the context of podcast production based on the baseline studies presented in sub-section 4.3.2. As a result, we explain which people are involved including their role(s); how they go about doing their work i.e. work practices; what aspects within their work practices are of value to them in terms of accomplishing tasks easily and what technologies are available to them in order to accomplish their work within a particular environment.

People – the people immediately involved in podcasting in HEIs are readily identifiable i.e. instructors and students. The teaching and learning activities mediated by such environments are a primary concern for these people; consequently, access and appeal of the environment should be closely tied to these primary participants. A second group of people is the administrators. While members of this second group are less concerned about the mundane activities that occur in the podcast environment, they should not be completely neglected by those designing podcasting systems.

Values – are the typically un-voiced emotional, social, and intellectual investments that guide people's choices (for instance principles, standards, morals, ethics, ideals, etc.). Many of the high-level values present during podcasting shared by the primary people involved include: effective communication, cooperative behavior and success in academic achievement. At another level, values can vary between students and instructors. Whereas an instructor may value sophisticated theoretical understanding and exploration of connections between ideas, some students may value skills that are immediately marketable and ease of information acquisition. At an individual level, of course, values vary considerably.

Work Practices – refer to the processes related to the creation, distribution, acquisition and use of podcasts (the content life cycle) and forms the underlying structure of which podcast content authoring is a part. The model organizes podcasting processes into four major categories: organizing content, authoring, distribution and access. These processes must be supported in podcasting information ecologies.

Tools and Technology – Tools are the most readily identifiable features of podcast environments including authoring tools, servers and such mediating provisions as audio and video supplements.

Learning management systems (LMSs) as virtual environments are complemented by a more material set of tools, such as the computers, cell phones and keyboards used by students and instructors.

Local Environment – Podcast production takes place in an environment composed of resources, tools and their affordances, Law and policy, appropriation, curricula, cultures (of use), ethics, communication. This environment sets the context (time, spaces, institutional support, and infrastructure), expectations, and implementation goals.

Figure 4-3 models podcasting in developing HEIs and shows the dysfunction in the information ecology. During the course of our observations, the researcher encountered a growing concern of disjointed processes as indicated in the dotted boxes also giving an indication of the need for interventions. When we look at the technology from the point of view of the academics, they were not empowered in any way to take charge of the podcasting process. Therefore, the information ecology reveals that the authoring process was rather manual, academics were not in charge and as a result, interventions that provide for more automation needed to be built into this ecology. After the technology had been in use for some weeks, a number of concerns were raised namely:

- The time it took to accomplish a podcasting task and for students to access the end product would take several weeks.
- Post processing of the podcasts in order to deliver them in small manageable chunks was challenging.
- The use of various tools to accomplish the podcasting process
- Copyright issues.
- Complex system set-up.

The tensions over the systems and its functioning created a dislocation in the information ecology. Unlike a biological ecology, information ecologies are designed: thus the podcasting system is not a blind fact of natural selection but rather a product of the human head, hand and heart. As such, it is the responsibility and privilege of the people in the local ecology to shape new technologies and practices. In developing HEIs, the dysfunction in the ecology came about for two reasons, which could have been anticipated and dealt with earlier. Firstly, there was no systematic and thorough way for academics to arrive at the end product: i.e. podcasts.

As such, there was a need for automation as processes were manual and involved technicians to accomplish the system set-up, recording, post processing and upload processes. Although this might seem ideal, there were always delays in accomplishing task(s) as technicians felt that they were undertaking extra work. Therefore, it was not clear to academics as to what happened after podcast recordings, if they were uploaded onto the LMS and whether or not students accessed them. Secondly, there were privacy safeguards with respect to recording faces, the feeling of added pressure to "perform" during recordings as well as copyright issues. Therefore, as shown in the dotted lines, the breakdown in the ecology necessitated interventions to improve on the working processes.

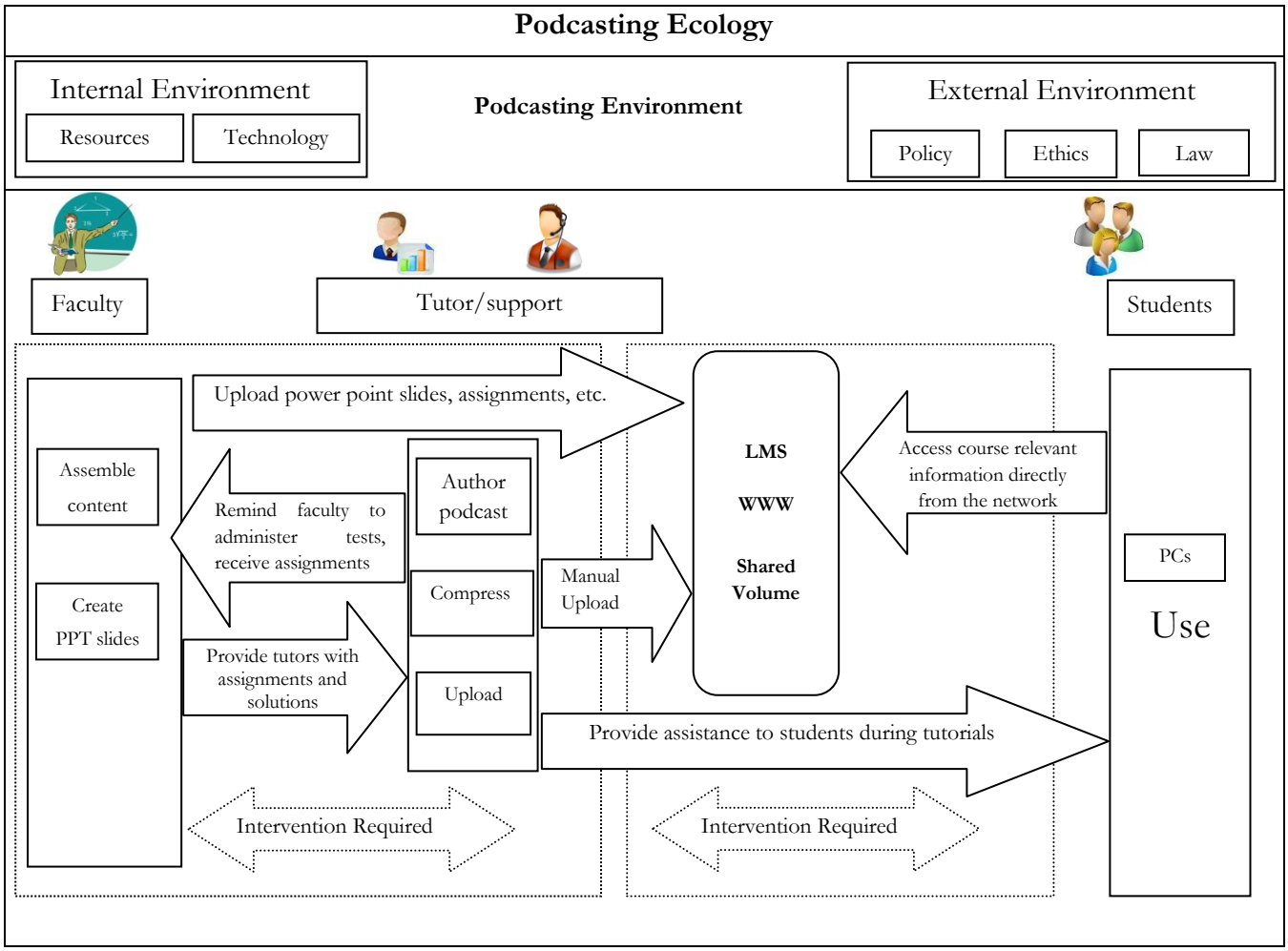


Figure 4-3: The original podcast ecology

4.3.3 Action Planning: MLCAT Requirements

The implementations described earlier were problematic and ultimately unsuccessful. In most cases, technicians undertook all podcast production activities such as equipment setup (as the lecture theatres do not have integrated infrastructure); the manual post-production process (i.e., compressing and breaking down of video into smaller chunks); uploading to the LMS, server or shared volume and lastly access by students. The design team chose this problem because lecturers had experimented with podcasting systems and that developing a contextual solution would have a positive impact on its users. Moreover, utilizing tools such as mobile devices already in the possession of students in HEIs and relieving the pressure on HEI infrastructure through the use of a simple, easy to use desktop application would save HEIs and academics alike valuable time, effort and resources. The designers then began to address the problems by initiating an AR – PD design process based on an evaluation of the existing ICT systems. As a result, the researcher scheduled PD workshops at UCT and Makerere University (MAK) with a purpose of refining requirements for the proposed tool.

4.3.4 Action Implementation – The Participatory Design of MLCAT

The designers facilitated a PD process in order to develop a new version of a podcast authoring tool. The goal was to empower lecturers to take charge of the entire podcasting process. Consequently, three PD workshops (study B) were conducted on different days at UCT and MAK. Seven participants were selected from Computer Science and Information Systems departments at these universities. This number is ideal because industrial environments typically use from seven participants and more during PD sessions (Boehner et al., 2007). Participants were divided into three groups (one with three participants and the others with two each) in which the researcher acted as the facilitator. Two participants who had initially volunteered to take part did not turn up hence the two groups with two members each. Figure 4-4 shows examples from our PD workshops.

Figure 4-4: PD workshops with lecturers

During these workshops, participants were briefed about the overall objectives of the sessions; goals to be accomplished; then introduced to the paper prototyping technique (Bailey et al., 2008; Snyder, 2003).

4.3.5 Evaluation – The Paper Prototype

The researcher's article titled: *"Using paper prototyping as a rapid participatory design technique in the design of MLCAT – A lecture podcasting tool"* formed the framework for this sub-section (Mugwanya and Marsden, 2011). Design solutions were generated from the paper prototyping workshops in the form of low-fidelity prototypes. This study was never intended to follow PD in the strictest sense (as that would require longer multiple sessions to work towards a final agreed design) but rather to keep participants informed and facilitate opening up of the design space so as to uncover crucial requirements. At this stage, our goal was not to come up with a complete tool design as each participant only afforded us two to three incomplete screens, though the ideas were well received. Nonetheless, several issues were identified during the paper prototyping process (denoted as study C) between January and February 2010, such as: incomplete interfaces and missing links, failure to generate tasks and the reluctance from some of the participants to sketch solutions. Figure 4-5 shows examples of the low fidelity prototype screen elements.

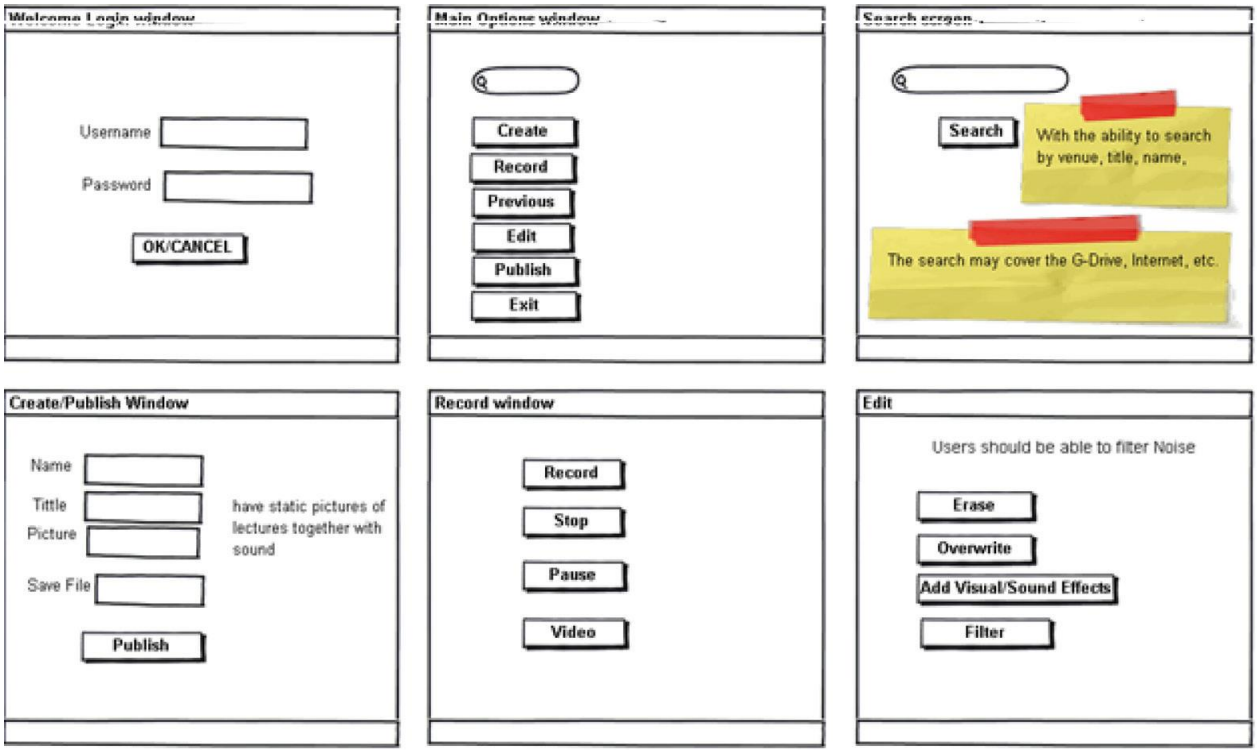


Figure 4-5: Sample paper prototype screen elements

Evaluation results indicated that the prototype was successful in revealing usability issues. The primary goal of formative evaluation was to collect information about the perceptions on learning effectiveness, users' satisfaction and identify any usability issues early in design (Boehner et al., 2007; Mäkelä, 2001). In order to achieve this, the researcher used five of the participants who took part in the PD sessions individually to act as users. The reason for individual sessions lay in the difficulty in getting all participants together (given their busy schedules) to take part in a group formative evaluation. The participants were given an introductory briefing about the low-high fidelity prototype, user goals and requirements derived from the PD sessions. In terms of users' perceived learning gain, the majority of participants reported that the tool is easy to learn and in terms of users' satisfaction, users were enthusiastic to use the tool. The positive results of the formative evaluation confirm that the user-centered design process allows for designing and implementing usable software. However, a number of issues were pointed out as described below:

Layout

- The prototype had two preview buttons which was confusing. The preview after recording and preview to edit. The two were eliminated and instead ended up with only "preview" functionality.

Functionality

- One user suggested a reduction in the number of steps required to produce the end product.
- The users insisted on the need for the tool to offer support for fault tolerance.
- Participants also expressed the need for the tool to be as non-intrusive as possible and more intuitive.

Navigation

- Two of the users suggested that the navigation needed to be improved and that the tool should provide meaningful alerts and prompts.

Terminology

- Some terminology had to be re-thought, for instance some users did not understand what "publish" or "upload" meant – they preferred to use *"distribute"*.

The screen designs produced during the design activity revealed a trend towards simplicity. There was a need to strike a balance between functionality; the number of steps required to accomplish a lecture podcasting task and the tasks that users minimally expected on a podcasting tool namely; record, encode, preview and upload. The result was that the ideas captured in the prototype sessions were perpetuated into the second action research cycle where a high fidelity prototype was to be generated.

4.3.6 Reflections from cycle one

The results from the first AR cycle are used as input for the second cycle. While faculty found podcasting valuable, they made clear their concerns about the amount of time the process takes as technicians had to set up recording equipment, manually compress recordings, break them into smaller chunks and then later on upload them onto the LMS. Another major challenge was the distribution of lectures. Since the technicians manually did this, it would normally take several weeks before files were distributed to the LMS. Additionally the issue of re-usability of lectures was of paramount importance. At UCT, re-usability was in the context of using the same content for the same class in a new academic year thus saving time whereas at MAK, since many of the academics teach at many Universities, they viewed podcasts as a substitute for the lecture in case they failed to be present at the lecture. The academics from UCT also expressed the view that there was need for proper management and organization to secure lecture rooms and computer laboratories and also having the requisite infrastructure in place.

In addition, the academics had experimented with audio only podcasts therefore they expressed the need for audio-visual content and that they viewed podcasts more as a revision tool that students make reference to.

Furthermore, academics expressed the need to incorporate podcasts into day-to-day student work, for instance through asking students to make reference to a given podcast to answer an assignment – that this would encourage use/usage. The academics also expressed the issues of intrusiveness particularly if the podcast includes their faces as they present lectures. They were concerned that they would be under added pressure to put up a performance during lectures. On the other hand, students preferred that podcasts were presented to them in the following ways:

- ✓ "It would be nice to access them as video presentations on Vula with notifications saying a new lecture recording has been uploaded [. . .] where notifications work like face book notifications."
- ✓ "Bluetooth" – students are used to sharing media such as music, video and image files using Bluetooth which is free (as cost of access is a major limitation to the diffusion of technologies in the developing world). Therefore, developing content in formats that are consumable on mobile devices and sharable via Bluetooth presents various possibilities.
- ✓ "Make listening to the recorded lectures part of the tutorial [. . .] if all classes had them and listening to them would count towards attendance."
- ✓ "Put it on a common folder so that students do not have to download it because it takes long."
- ✓ "On a CD or flash drive."
- ✓ "Use formats that can be played by majority of players."

These results were then incorporated into the second AR-PD cycle as described below.

4.4 THE SECOND AR-PD CYCLE

4.4.1 Analysis, Fact Finding and Conceptualization

In this cycle the designers analyzed the users and their context from a technical standpoint based on the findings from the previous cycle.

For example, the need for more automation (reduction in the steps required to create a podcast/vodcast); integration of podcasting activities with already existing systems and the design of a tool that is intuitive (requires limited training). The results were then used to generate a detailed requirements specification and produce a high fidelity prototype.

4.4.1.1 Contextual Observations

The researcher attended ten meetings, usually in the afternoon, for periods of one to two hours each over a two month period between June and August 2011 with three academics at TSiBA – a private HEI in Cape Town, South Africa. The reason for the shift in testing site was because UCT was in the process of trialing another podcasting solution called Opencast. During meetings, the researcher would review his notes and discuss observations with the academics at TSiBA, confirming and verifying impressions.

In fact, some of the observations at UCT were similar to those from TSiBA for example the importance of Bluetooth for access and sharing of podcast files. The revised podcast ecology model echoes these findings as illustrated in figure 4-6 below. The researcher also observed that it was important for academics to break their content into small manageable chunks before hand for easy authoring and subsequent access as well as reducing students' cognitive load. The podcast ecology was modified to include the authoring and upload processes within the client application and the inclusion of the Bluetooth server to offer student access to podcasts via Bluetooth.

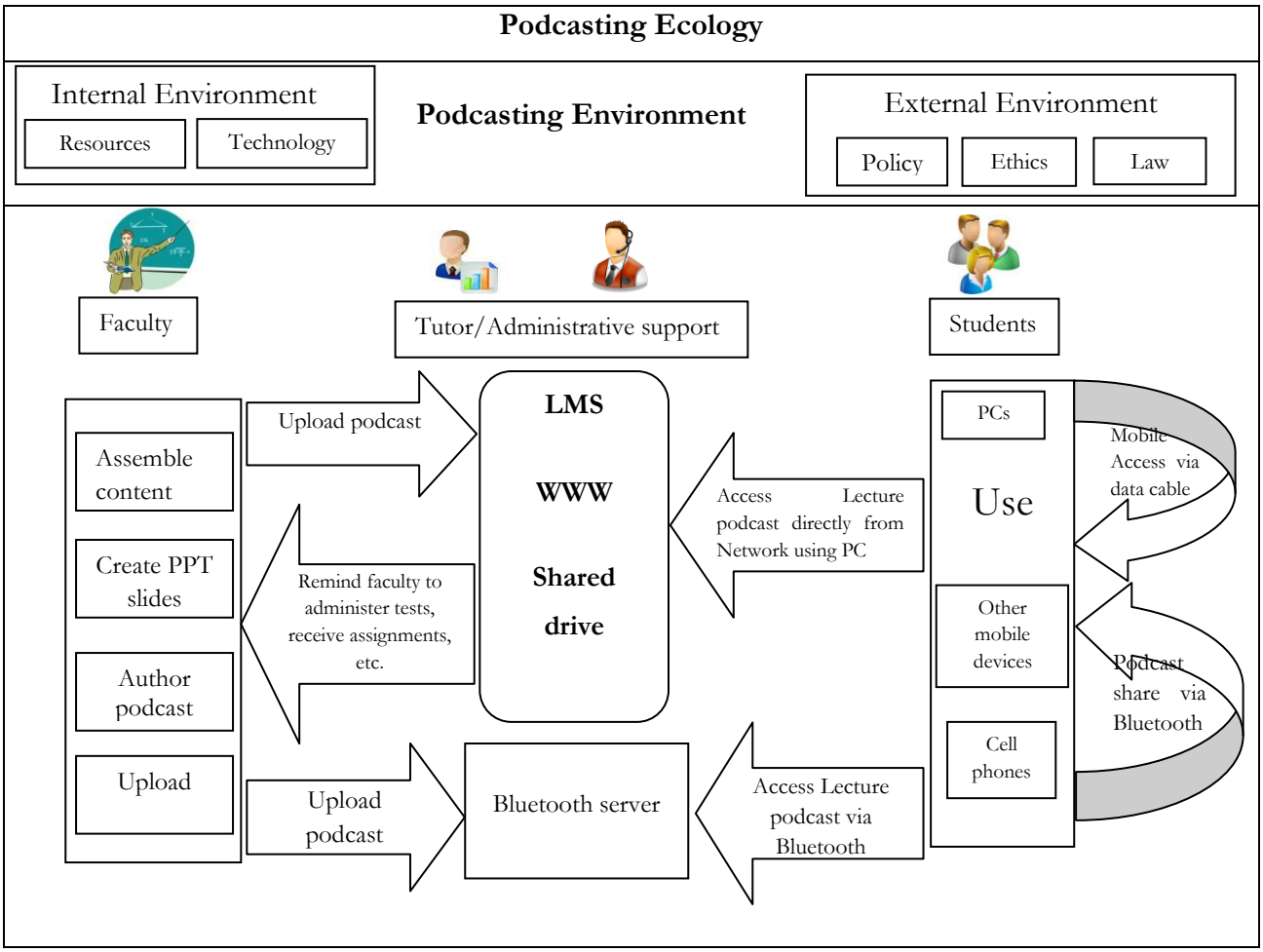


Figure 4-6: Revised podcast ecology model

Based on these results, the researcher set out to develop a real and practical podcast production framework for this and similar developing countries HEI applications. Given the corresponding increase in mobile phone ownership in many developing countries and the vast use of Microsoft Windows and Office applications (particularly in Africa), PowerPoint became an obvious choice for the client device. The next section illustrates our design framework onto which the MLCAT is built.

4.4.1.2 The MLCAT Framework

The MLCAT framework comprises client-server architecture for authoring podcasts in developing HEIs. The client side application, which runs on a Windows OS PC or laptop pre-installed with Microsoft Office Suite 2007, comprises the authoring and distribution mechanisms whereas the server side stores podcasts and services user requests for content. Figure 4-7 presents the MLCAT architecture's overall structure.

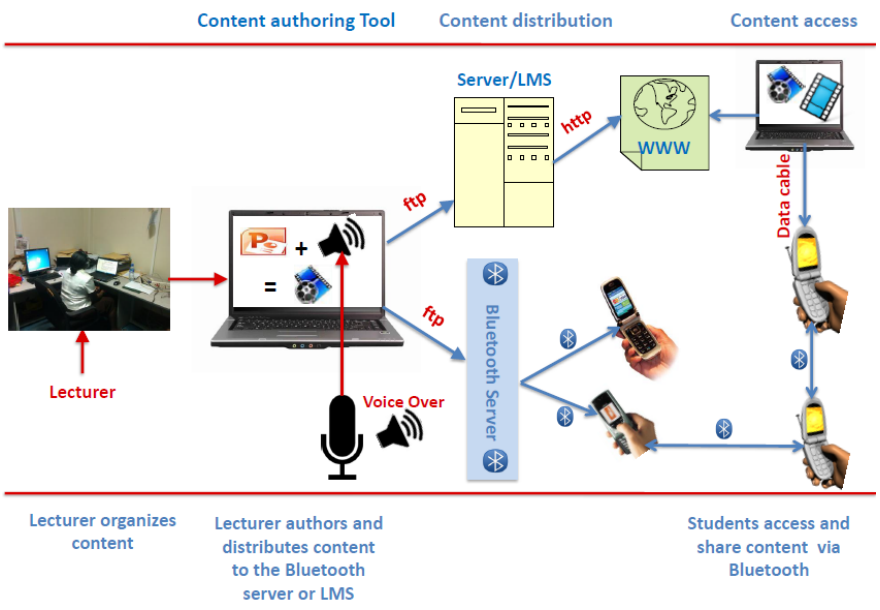


Figure 4-7: The MLCAT Framework

4.4.2 Action Planning–System Requirements

Based on results from the baseline studies presented in the previous sub-sections, it became apparent that a tool with the ability to offer the following advantages was needed:

- Reduce lecturer involvement through automation to a high degree.
- Reduce the pressure on the university infrastructure.
- An all in one tool that would utilize already familiar applications as opposed to the use of various tools (i.e., iMovie, Windows Movie Maker and Audacity) to achieve the end product.
- Integration with other existing tools for example LMSs or the SnapAndGrab system.

4.4.3 Action Planning–The User Requirements

The MLCAT design listed the following as the features required to successfully accomplish a podcasting task, i.e. "start recording"; "control recording"; "aggregate recordings"; "encode media," and "upload recording".

4.4.4 Action Implementation–The MLCAT Design

This sub-section describes the implementation of the MLCAT high fidelity prototype. At this point, users had begun to draw inspiration from already familiar tools such as PowerPoint to provide the prototype functionality. Moreover, the popular Microsoft's Windows operating system was selected so as to provide access to the largest possible number of potential users.

Development was carried out using Windows operating system and Microsoft's Visual C#. The researcher used the .NET environment as it offers the ability to develop extensions or plug-ins for Microsoft Office applications. Figures 4-8 and 4-9 illustrate the client architecture and system activity flow respectively.

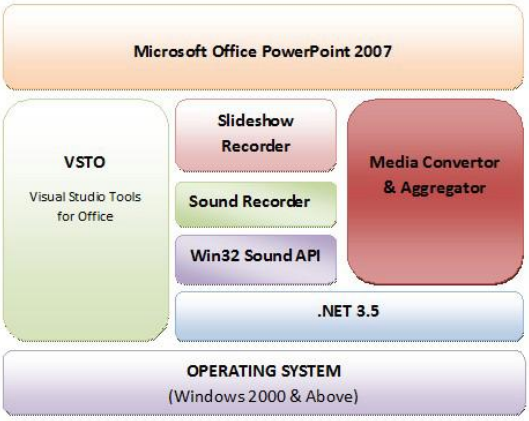


Figure 4-8: Office plug-in client architecture

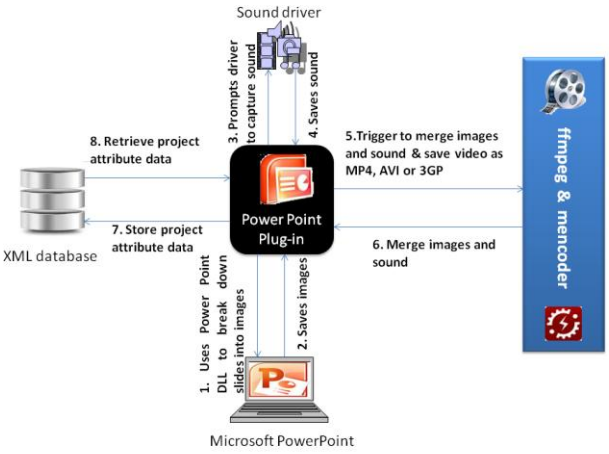
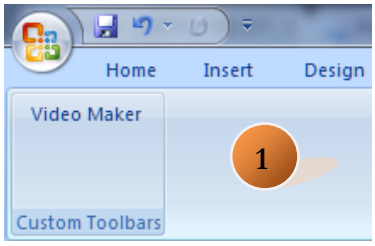
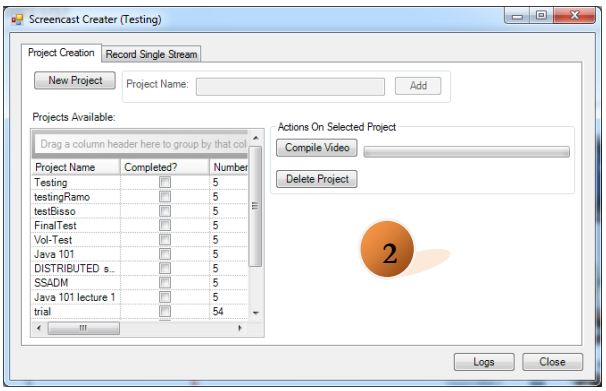


Figure 4-9: Office plug-in activity flow

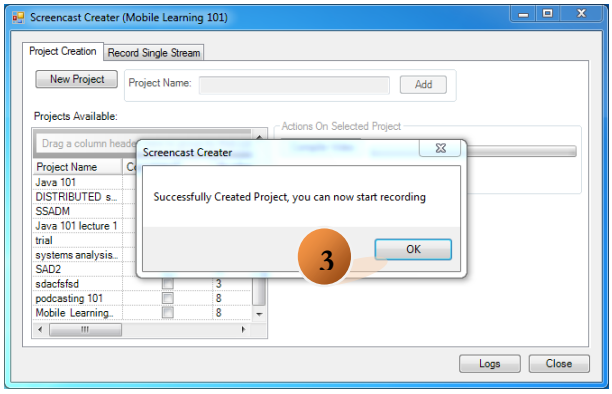
The client application uses PowerPoint's dynamic link library to convert PowerPoint lectures slides into images (in .JPEG format) and saves them. The application then prompts the sound driver to capture and save the presenters' audio after which the media aggregator and converter merges images with sound and converts the resultant files into either .avi, .3gp or .mp4 formats respectively. Figure 4-10 illustrates the form flow interaction of the MLCAT application.



The user clicks video maker

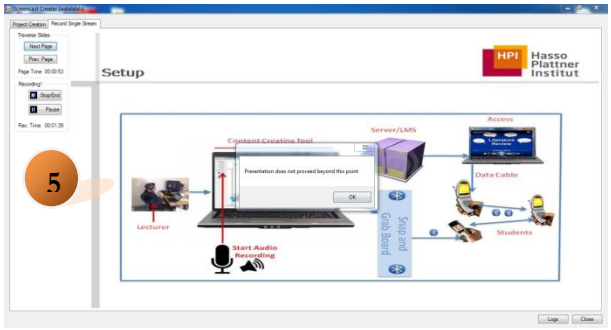


A form appears onto which the user is required to create and add a new project

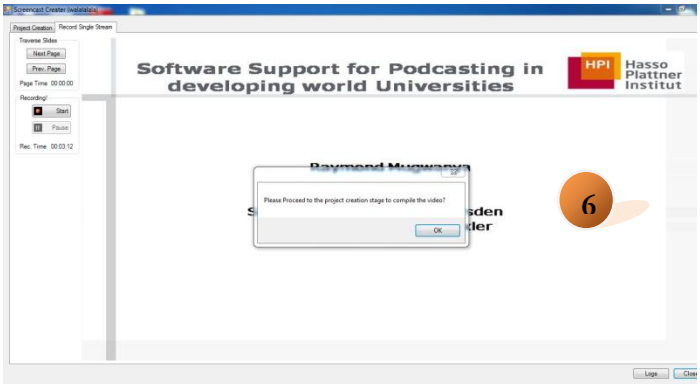


The PowerPoint slides are Converted into images after which the user is then prompted to start recording

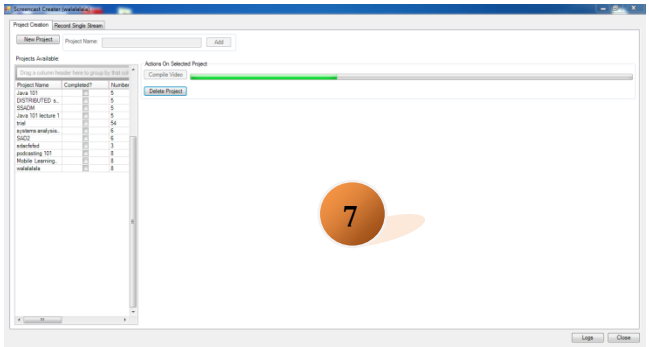
At this point, the PowerPoint slides are visible in a form and the user can start recording and navigate the slides



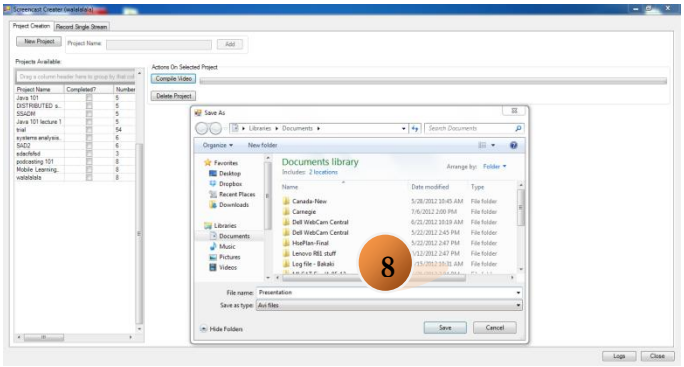
The user is notified about the end of the presentation



The user is then prompted to compile video files



Compilation in progress as indicated by the progress bar



At this point, the authoring system mashes up the PowerPoint slide page videos into a single .avi, .mp4 or .3gp file and saved

Figure 4-10: Example MLCAT interaction/Form flow

Once the user is satisfied with their recording, it is manually uploaded to the SnapAndGrab system, an application used for sharing files using Bluetooth (Maunder & Marsden, 2008); LMS or shared volume. The authoring system is able to produce video lectures and their associated XML descriptors as illustrated in the figure 4-11.


```
<? Xml version="1.0" standalone="true"?>
-<DocumentElement> -<Project_details> <project_name>Test</project_name> <status>true</status>
<video_format>avi</video_format>
<video_path>C:\Users\raymugwanya\Desktop\Presentation0ther.avi</video_path>
<no_of_pages>2</no_of_pages> <Has_single_stream>true</Has_single_stream>
<stream_xml_data><NewDataSet> <xs:schema id="NewDataSet" xmlns=""
xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns:msdata="urn:schemas-microsoft-com:xml-
msdata"> <xs:element name="NewDataSet" msdata:IsDataSet="true"
msdata:MainDataTable="stream_details" msdata:UseCurrentLocale="true"> <xs:complexType> <xs:choice
minOccurs="0" maxOccurs="unbounded"> <xs:element name="stream_details"> <xs:complexType>
<xs:sequence> <xs:element name="record_no" type="xs:int" minOccurs="0" /> <xs:element
name="length_in_seconds" type="xs:int" minOccurs="0" /> <xs:element name="current_page" type="xs:int"
minOccurs="0" /> </xs:sequence> </xs:complexType> </xs:element> </xs:choice> </xs:complexType>
</xs:element> </xs:schema> <stream_details> <record_no>1</record_no>
<length_in_seconds>41</length_in_seconds> <current_page>1</current_page> </stream_details>
<stream_details> <record_no>2</record_no> <length_in_seconds>37</length_in_seconds>
<current_page>2</current_page> </stream_details> </NewDataSet></stream_xml_data>
<stream_schema><?xml version="1.0" encoding="utf-16"?> <xs:schema id="NewDataSet" xmlns=""
xmlns:xs="http://www.w3.org/2001/XMLSchema" xmlns:msdata="urn:schemas-microsoft-com:xml-
msdata"> <xs:element name="NewDataSet" msdata:IsDataSet="true"
msdata:MainDataTable="stream_details" msdata:UseCurrentLocale="true"> <xs:complexType> <xs:choice
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minOccurs="0" /> </xs:sequence> </xs:complexType> </xs:element> </xs:choice> </xs:complexType>
</xs:element> </xs:schema></stream_schema>
</Project_details>
</DocumentElement>
```


Figure 4-11: Media package representing .avi podcast

Figures 4-12 and 4-13 show how podcast content appears both on Nokia N95 and Nokia 6120. Participants verified the clarity of content particularly from the Nokia 6120 small screen.

Figure 4-12: podcast lecture on Nokia N95

Figure 4-13: podcast lecture on Nokia 6120

4.4.5 Action Evaluation– Formative Evaluation of MLCAT

In order to evaluate our high-fidelity prototype, it was deployed at TSiBA – a private HEI based in South Africa. This change in test site resulted from the fact that UCT had moved on from using Podcast Producer server to Opencast and therefore introducing another system to them was not appealing.

However, through contact with the Extra Mural studies department, the researcher was brought into contact with a technology champion – the executive director who identified and introduced the researcher to three lecturers who took part in our trial. The three lecturers were teaching undergraduate courses in business namely; Strategic management, a foundations course in economics and applied financial management.

At this point the goal was not to impose on participants how MLCAT should be used but to find out interesting ways in which they appropriate it and later on identify opportunities for further improvements. This is analogous to Hutchinson et al.'s (2003) Technology Probes which involve installing a technology into a real context, while watching its use over time and reflecting on this use to gather information about users and inspire ideas for designing new technologies. Informal interactions with the lecturers provided rich qualitative data revealing interesting results as described under four key themes below (see figure 4-14). Our assumption was that lecturers would record entire lectures as the MLCAT requirements arose from the unsuccessful adoption of Podcast Producer, OpenEyA and the use of pre-installed recording software on the Macintosh and Windows machines i.e. iMovie and Windows Moviemaker respectively. Participants were trained on how to use the MLCAT system (using the researcher's laptop) after which they were given an opportunity to make test recordings. Two of the participants had their own laptops onto which the system was installed whereas the other utilized a computer in the library currently used by a part-time student librarian.

This computer required the researcher to have administrative rights (in order to install software); housed some of the librarian's applications and thus she had reservations regarding installation of additional software. We then resorted to installing the application on a laptop that was provided by the systems administrator at TSiBA. The results from the informal qualitative interviews are as summarized under the following four themes:

Themes	Notes
Do recording when it suits me/in my free time	*"[...] it would be useful to install on my work computer so that when there are no people around, I can try to get this thing going but to make this thing happen, I would have to find a place that is quiet or to use this [...]"*
Breaking down content into smaller chunks	*"[...] identify hypothetically 50 key lessons for the course. These lessons also appear in the course text books and other resources and create say 50 clips of the same material for students to reference [....]"*
Integrating assembling content into the application ecology	"[…] *in finance, we use Excel quite a lot...we can have it in excel and paste it into Power Point. Easier to use excel because i can change numbers i.e. what happens if the profit in year 2 was not 300 but 400? How does it affect our average, standard deviation, coefficient of returns? How will the analyst/ Investor perceive this investment?* [...] *one can achieve that by replicating this in Power Point* [….]"
Privacy	*"[…] I do not want them to see me in the recording […]"* thus validating our initial assumption that recoding the presenter may not be necessary

Figure 4-14: Themes from informal interviews with academics at TSiBA

Student Survey Summary

The survey sample was self-selecting as we focused on students who were undertaking courses taught by our participants. The purpose of this informal survey was to get ideas of who the students were, the devices they interacted with, their knowledge of podcast lectures and any challenges they face. As a result, the researcher interviewed fifteen students who were undertaking the foundation economics course with no incentive for participation. A snapshot of the questions asked and responses are presented below.

What technologies do you own?	Flash drives, a few Personal computers, two with no technology at all and the 22 owning a cell phone as their only technological device.
Which Cell Phone Brands do you own?	Nokia Express music 53C, Nokia C3, black berry curve 2GB, Sony Eriksson 4GB, nokia Music express 5130C, Samsung star, Samsung E250, Samsung B3210, E250i, Vodafone 543, BlackBerry curve 8520 4GB, Sony Ericsson W 395, Nokia 5230.
Which technology do you use at Home?	The most dominant technology used at home is the cell phone which validates the existence of a high mobile phone penetration in the developing world. Some instances of usage of Television, Digital Video Disk (DVD) and personal computers were reported to be used at home.
How do you access digital lectures?	A personal computer at School (through download from Moodle - LMS), School network, Khan Academy (http://www.khanacademy.org/), Cami Maths (http://www.camiweb.com/), Internet/online, Maths lessons Online, You Tube, personal computer and download it to external hard drive.
What are the Challenges during access?	*"[...] takes long to respond, internet is offline, slow network sometimes, cannot ask questions directly, slow internet, scarcity of personal computers, do not have a personal computer, mobile cannot read office documents, Difficult to download work and software on campus and home is not the same [....]"*
How would you like podcast lectures presented/delivered to you?	Visual, video, via cell phone, Bluetooth – for sharing, audio and slide shows, available anytime you logon, sms, e-mail, Phone or any other way possible other than MXit (http://mxit.com/), Face book because I would rarely do anything, via Bluetooth every after lecture. Fun and not long, clear and straight to the point e.g. You Tube videos.
What is your understanding of digital lectures?	- Lectures that take place on a PC like Khan Academy - Lectures we have using computers and projectors - Being lectured in the video way – using You Tube and Khan Academy

Figure 4-15: TSiBA student survey summary

4.4.6 Reflections from cycle two

Our preliminary experiences with podcasting show that it is feasible and fruitful to employ a pragmatic design approach to design for podcasting at developing HEIs. Using easy-to-use software tools for authoring, it is possible for instructors to develop podcasts themselves (Dalsgaard et al., 2008). The tool is not geared to develop "professionally" produced recordings, but rather short video podcasts. The initial assumption that the system was directed towards recording entire lectures was quashed. Instead, there is a potential for short videos – such as demonstrations, summaries of course sections, presentations, model descriptions, solutions to frequently asked questions and topics that call for visual representation (Walls, 2009). The pedagogical idea behind short introductory videos is to provide them as resources for students' problem-oriented work and revision. The short introductory videos are in many cases easy to author using our solution. The technical solution, both with regards to authoring tools, LMS and Bluetooth Server – is in every way cheap and easy to administer and support.

The MLCAT prototype meets many of the podcast needs of HEIs despite the fact that there is room for refinements. The next AR cycle will explore extended user evaluations and prototype improvements. At this point, no new design seemed to be coming out of the interactions with participants, thus this finding validates the original design – the researcher deployed the prototype based on the co-design data and only system improvements arose from participant interactions.

The students from UCT and TSiBA also encountered a number of challenges namely: off-campus access issues, incompatible formats, lecture podcast upload delays and a limited ownership of personal computers by students. It is normally very difficult to access university resources off-campus as students have different connection speeds and access devices. An interesting revelation that resulted from studies with students in developing HEIs is the need to access and share podcast lectures amongst fellow students via Bluetooth. These results were incorporated into the third AR cycle as illustrated below.

4.5 The third AR – PD cycle

4.5.1 Analysis, Fact Finding and Conceptualization

Given the positive results from the previous cycle, it became apparent that the client authoring system required improvements in the way that users interacted with it. From the previous implementation, 'start recording' would trigger a dialog which enables users to create a new project. At this point, the PowerPoint slides would appear inside the form with the navigation controls. This did not seem very natural as normally when PowerPoint is launched for presentation purposes, full screen view is normally preferred. Therefore, the client application had to be modified for the final deployment. Similarly, there was need to automate the upload of media packs in the form of podcasts from the client application as well as re-design of the Web-Based SnapAndGrab system.

4.5.2 Action Planning – System Requirements

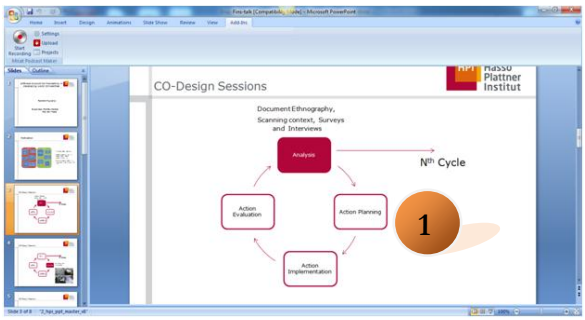
The following requirements arose from the reflections in the previous AR cycle:

- Re-design the client side authoring system to allow for a more natural interaction process.
- Automate the upload of media packs to the Bluetooth server.

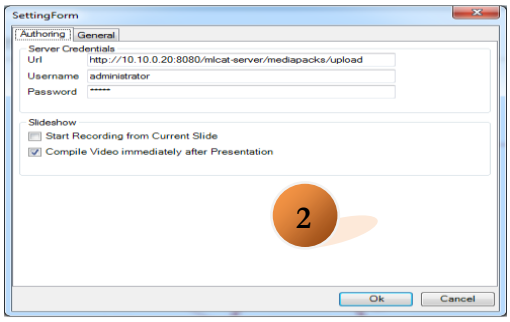
– Re-design the Web-based SnapAndGrab to enable automatic upload of media packs from the client authoring application.

4.5.3 Action Implementation–The MLCAT Design

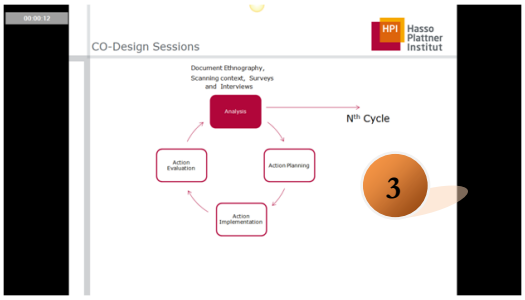
This sub-section describes the improvements made to the implementation of the MLCAT high fidelity prototype. The figures below illustrate the client system interaction flow and the Web-based SnapAndGrab System respectively.



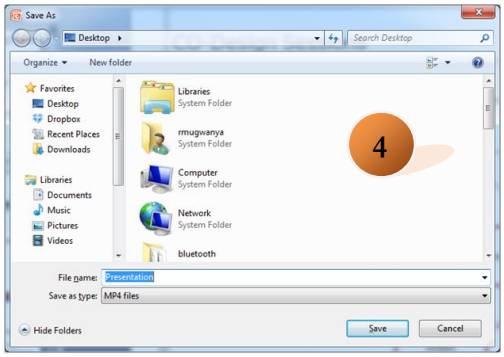
User starts recording



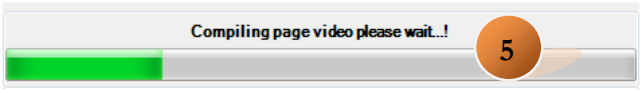
User modifies server upload and presentation settings



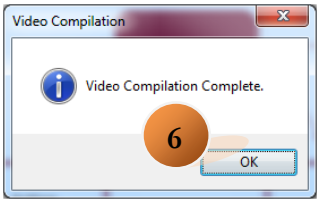
Full screen presentation view with recording timer



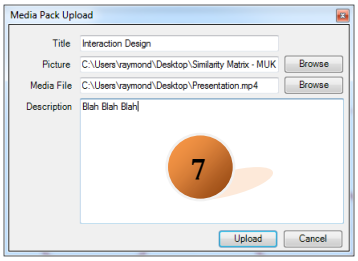
On completion of recording, user then saves in desired format



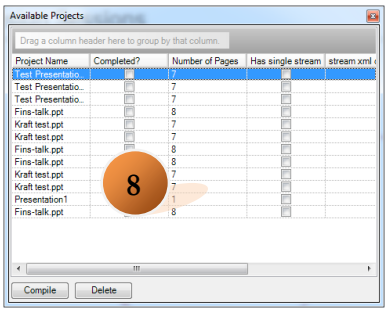
Saving initiates the podcast mash up process of slide images and sound as indicated in the progress bar



Podcast authoring complete notification



The media pack upload form



The form that shows previously recorded projects

Figure 4-16: MLCAT form flow

After upload, the system then creates a media pack on the server as illustrated in figure 4-17.

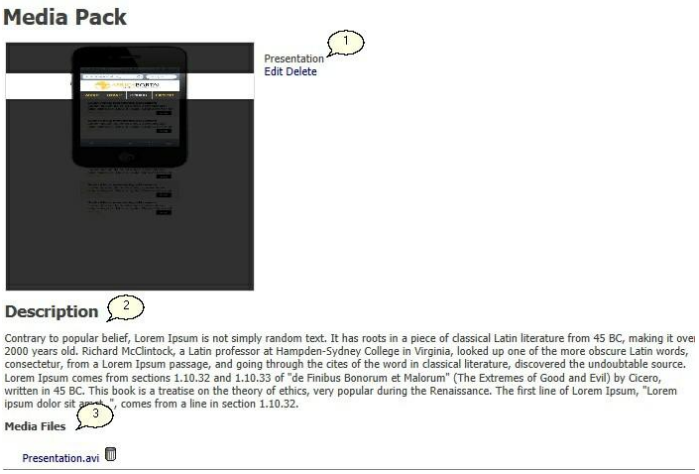


Figure 4-17: MLCAT Client system upload form

Server-side application

Figure 4-18 illustrates the MLCAT Server Architecture and setup respectively whereas figures 4-19 and 4-20 show the various interface elements.

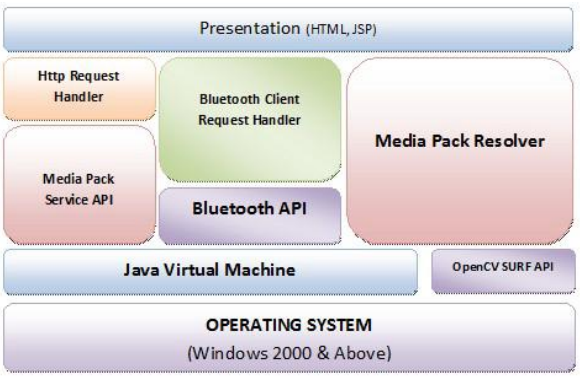


Figure 4-18: MLCAT Server Architecture

Initially, users are required to provide a user name and password to log-in to the server side application after which the home page appears. The home page contains links which give quick access to all of MLCAT's functions i.e. create media packs; create different user profiles; create various display boards – for instance in case of a university wide deployment, faculty may create boards for different departments and perform various other tasks.

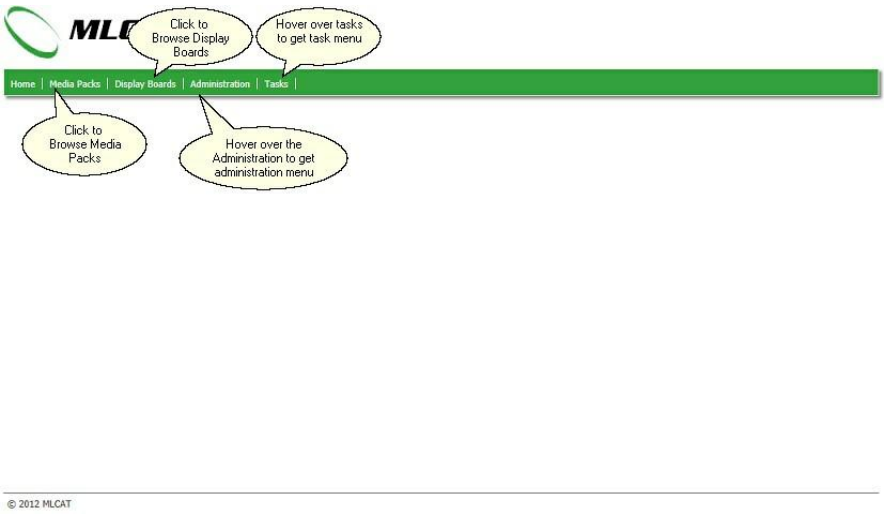


Figure 4-19: MLCAT Server application Main form

Figure 4-20 shows the display board form, description and the display order of the different media packs. The display board can be edited and media packs removed or re-organized. The board can also be changed to full screen view – the preferred mode for student interaction with the Bluetooth system.

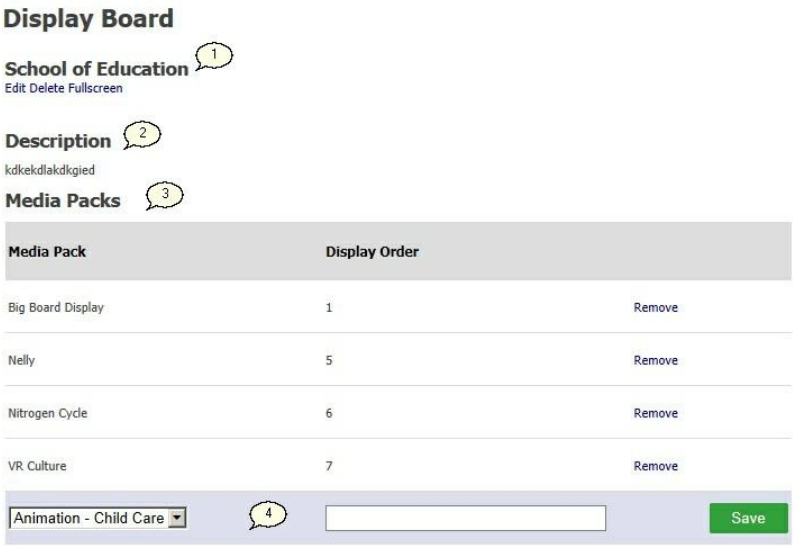


Figure 4-20: MLCAT server display board form

4.5.4 Action Evaluation

After alterations had been made to both the client and server systems, they were deployed in Uganda using MAK lecturers who were also lecturing at the International University of East Africa (IUEA). The evaluation results are presented in chapter five. In this section, the researcher lists some lessons synthesized from this study.

Key Strengths

The main strength of the PAR approach lies in the design, development and deployment of prototype systems in the real world. It enables designers to iteratively prototype systems, observe actual usage over extended periods of time, while providing participants with concrete examples of a novel technology being used in their environment. The system was initially deployed at TSiBA. In our deployment meetings, users were certain of the role the tool would play in their institution and how they intended to use it in their environment.

Finding Participation

As our approach relies heavily on participation of lecturers and students, their feedback and usage of the prototype system, one of the first tasks was acquiring willing participants. During our baseline studies, we used participants at UCT and MAK in order to understand their work environments and later on build relevant prototypes. By the time our first working prototype was developed, some of our initial participants had since moved on to using other technology to record lectures. In addition, UCT was in the process of introducing another system called Opencast. As a result, the initial baseline study participants were confused by the number of tools that had been introduced thus far, making the researchers re-think their deployment strategy.

Moreover, our deployments came at a time when end of semester exams were almost underway. Typically, lecturers and students were so busy and there was normally no active teaching going on in order to conduct trials. Consequently, the researchers contacted the Extra Mural Studies department, the distance learning division at UCT, but they were only due to undertake courses in August 2011. They, however, linked us to one of the directors at TSiBA who was very enthusiastic about mobile learning. We then had initial contact and identified three lecturers and a librarian to take part in the deployment trials at the start of semester in 2011.

The influence of the Director at TSiBA – a technology champion (Heeks, 1998) – aided in finding participation for trials considerably. During this time, further deployments at Makerere University in Uganda with willing participants were being planned.

Selection of Methods

As noted previously, the selection of techniques used in making observations, gathering feedback and designing with participants remained flexible. Naturally, suitable techniques varied between settings and participants, and thus the choice of techniques was a matter of past experience, expert knowledge and a certain amount of trial and error made possible by the iterative nature of the approach. For instance, academics had heavy workloads and tight schedules therefore conducting design sessions with busy professionals demanded preparation, improvisation, and clarity of purpose. We needed techniques to gather and engage them within a short time frame. As a result paper prototyping, Participatory Design, focus groups, qualitative and quantitative studies were used. In fact, these techniques were in many instances triangulated. Hence, they formed an essential part of eliciting requirements and evaluating design ideas for interactive systems. It was often the most simple of approaches that yielded the most success, including largely unstructured discussions to gather on-the-spot feedback from casual conversation rather than structured investigation, where respondents seemed less comfortable and vocal.

Expecting the Unexpected

Throughout the project, flexibility had been a necessity; rarely had an arranged meeting proceeded in a way the author had planned. At various meetings, it was realized that the purpose of some sessions may have been mis-communicated, participants may have had more pressing issues to discuss, or may simply have been uncomfortable with the material we had prepared. In each of these cases, rather than enforcing original plans, the author chose instead to adapt them and focus on the participants' concerns, while gently guiding them towards the original questions set out by the author. Although occasionally frustrating, each of these sessions proved fruitful despite the change in plans. Indeed, participants seemed most vocal when sessions had been steered in a direction they felt was interesting or important, whereas they often fell silent when presented with a task with which they were not comfortable. For instance the unsuccessful attempt at user interface sketching, prioritizing scenarios and not having any idea of anticipated design. The researcher therefore decided to consolidate the ideas from the workshops to create low – high fidelity prototype which the participants evaluated formatively.

Influence of the Technology Champion

It is imperative not to overstate the significance of the role played by the technology champion as illustrated in sub-section 4.4.5 (Heeks, 1998). Her help was vital in communicating with the lecturers, initiating contact with key personnel and securing participants as well as offering advisory support. Without her input, it was unlikely that the researcher would have maintained productive relationship with the lecturers. That said, the researcher often felt that her strong views in relation to technology and assertive personality had the potential to distort feedback from the lecturers and direct the flow of discussion groups in directions that were not always helpful. Often, she seemed anxious for the participants to use the technology, although it was clear that some participants might not have been interested. This may be a trade-off that must be accepted and negotiated in exchange for the benefits brought by the champion; as it were these very same characteristics that made her an ideal contact and spread the word of the project around the community.

Influence of Researchers

The technology champion was certainly not alone in attempting to influence the direction of the deployment. As researchers, it is difficult particularly when involved deeply in a project for a long period of time, to remain free of preconceived ideas and wishes for the development of the system. Certainly, it was expected that researchers bring their own expertise to the process and guide participation, but they must be aware of this influence and be willing to embrace alternate ideas in response to feedback received from participants (Montero, 2000). Based on earlier feedback, the researcher thought that participants would want to record entire live lectures during class yet it became apparent that they only wished to record different aspects of their courses. For instance, one participant expressed the need to record podcasts of only the models that are covered in their strategic management course as opposed to the theoretical aspects.

Reliability

From a more technical perspective, it was important to ensure that prototypes remained reliable, despite being developed and deployed rapidly. The use of off-the-shelf components to build prototypes rather than a bespoke solution helped to ensure the reliability of the hardware, whereas the relative simplicity of the system limited software problems. Interestingly, we eliminated the need for students to download content directly onto their cell phones using mobile Internet because of the cost involved.

Therefore, once recordings were uploaded, they would either be downloaded from Moodle using PC Internet at TSiBA (transferred to cell phones via data cables) or directly from the SnapAndGrab system via Bluetooth.

Generalization

Finally, it is important to consider the ability to generalize any research conducted using this approach. Since the researcher positioned the research work as a means of learning about a community and its use of novel technologies, generalization was certainly a concern. Baskerville and Wood-Harper (1996) recognized this same issue in their analysis of action research, but also noted that it applied to much of social science research generally. Additionally, there is also the difficulty of generalizing results from action research (McKay & Marshall, 2001). Meyer (2000, p. 8) observes that action research *"is often written up as a case study and it is important to note that generalization is therefore different from the more traditional forms of research".*

Further, he argues that case study and action research are *"means by which theoretical explanations of phenomena can be generated using analytic induction" which are "rich in conceptual detail" and "readers are invited to judge the relevance of the findings to their own practice situation"* (Meyer, 2000, p. 8). Coghlan (2002, p. 63) claims *"action research is fundamentally about telling a story as it happens."* In sum, the transparency of research processes in action research can be improved by articulating and discussing (a) the framework of ideas brought into the study and (b) analytical generalization of findings.

Ethical Dilemmas

According to Attewell and Savill-Smith (2005), ethics influence mobile learning at two different stages. The first is that evaluating mobile learning requires ethical consideration. The second is that mobile learning has an ethical dimension which needs to be identified and explored as mobile learning evolves. In the first instance the responsibility is of the evaluator or researcher for the research participants. In the second, it is of the teacher for the learner. In both, the idea of ethics encompasses a spectrum from statutory issues to cultural issues, from what is defined as legally acceptable to what is defined as socially acceptable. Ethics is a significant issue because evaluation and provision that do not conform to explicit ethical guidelines may be:

- ✓ seen as improper or immoral
- ✓ breaking laws or regulations

- ✓ unacceptable to the research community.

While the collaboration and close contact between researchers and lecturers (or other research subjects) yielded many benefits, this contact may often lead to some challenges. For instance some lecturers had concerns about re-distributing copyrighted material to students in digital form. However, the researchers cleared this with the lecturers and management by assuring them that as long as they do not re-distribute the content at a fee, they will not in breach of any laws. The other challenges in attempting to develop ethical guidance for mobile learning are:

- ✓ Online learning, including mobile learning, could take place in several different countries and consequently across different legal jurisdictions.
- ✓ Online learning, including mobile learning, might be working with participants whose ages are near the legal age of majority (and this age may vary from country to country).

4.6 Summary

This chapter has presented some of the designers' initial experiences in designing podcasting systems for developing countries HEIs. Through this, the researcher developed a better understanding of users' work processes, abilities and interaction preferences. One consistent result obtained during these studies was the importance of authoring small content chunks and the use of Bluetooth as a podcast access mechanism. Having experience using Information Systems and software applications such as LMSs, Microsoft Office applications made it easy for academics and students alike to handle the use of our podcast production prototype without too much training. In the next chapter, the researcher describes an evaluation of MLCAT.

Chapter 5 Evaluating the MLCAT Prototype

5.1 Introduction

This chapter reports a prototype evaluation in which five academics and twenty six students' use of MLCAT and podcasts respectively were tracked for approximately eight weeks. The evaluation acted as a dual-purpose research vehicle to satisfy two high-level objectives:

1. To evaluate the MLCAT prototype presented in Chapter four.

2. To build on the "pilot" findings reported in chapter four by investigating podcasting over an eight week period.

In terms of both objectives, the study makes important progress over previous work. Firstly, published literature (see chapter three) indicates that there exists challenges such as limited guidance on the methods used to evaluate podcasting and the sequencing of these methods. The next two sub-sections discuss each objective in turn.

5.1.1 Objective 1: MLCAT Prototype Evaluation

Robson (2001) defines evaluation as an attempt to assess the worth of an innovation or intervention. The evaluation of interactive designs is an essential component of HCI research, since an interactive artifact, however innovative, does not in itself constitute substantial contribution to HCI knowledge without some assessment of its worth (Dix et al., 1997; Carroll, 2000). However, much of the body of podcasting design-based research is limited in this regard. In fact, chapter three highlights the challenges of evaluating podcasting designs. Traxler and Kukulska-Hulme (2005) reveal that the last decade has seen a dramatic increase in the number and the variety of pilots and trials involving m-learning. This increase is reflected in, and supported by, submissions to mobile learning conference series. The growing pedagogic and technological sophistication of mobile learning pilots and trials is evident, although sustained deployment will depend on the quality of analysis and evaluations (Traxler and Kukulska-Hulme, 2005).

Evaluation and analysis are essential to the sustainability of podcasting because firstly, they inform the outside world about the effectiveness of pilots and trials with respect to objectives set out initially. Secondly, evaluations provide funders with insights on the cost-effectiveness and utility of pilot projects. In other instances, evaluation determines whether pilots can be extended into longer term Institution-wide projects thus creating sustainability (Traxler and Kukulska-Hulme, 2005).

Therefore, a starting aim was to avoid such limitations by evaluating the design presented in chapter four using a triangulation of methods. MLCAT is a podcasting application which allows a user to author and distribute lectures for download and sharing via Bluetooth. A PAR incremental design approach was used to enable undemanding incorporation of core podcasting processes into a prototype. Chapter four concluded with an initial assessment of the workability of MLCAT based on results from usage by faculty and students at TSiBA – a private HEI in Cape Town, South Africa. Based on the positive feedback from the three academics and twenty one students (i.e. study D), it was decided that the design was feasible, albeit with some minor improvements in functionality i.e. re-designing the client system; automating the distribution of recordings and re-designing the Web-based SnapAndGrab system (see chapter four, sub-section 4.5.3). In effect, no new designs were evident at this point thus validating the original MLCAT design. Consequently, further evaluation was pursued after these alterations had been implemented. The deployment and evaluation had two sub-objectives:

1. To facilitate the formative redesign of MLCAT.

2. To explore appropriate methods for designing and evaluating podcasting tools.

The first sub-objective was to assess the usability of MLCAT and identify ways for its improvement. The specific areas investigated included the following:

- Usefulness: do users value the ability to author podcasts in an automated way?

- Learnability: how easy is it for users to understand or learn and use MLCAT?

- How do users respond to MLCAT? – The exploratory study in chapter four identified a wide range of user profiles. A key interest was to examine how users react to MLCAT (e.g. *what they choose to record, how students appropriate recordings, etc.*).

Secondly, as well as assessing the MLCAT design specifically, it was also hoped that the evaluation would allow the derivation of general design recommendations for podcasting systems. Finally, it was envisaged that lessons learned during the study would provide insights regarding appropriate methods for the evaluation of podcasting tools.

5.1.2 Objective 2: Empirical MLCAT Evaluation Study

As well as evaluating MLCAT, the study also offered the opportunity for further empirical investigation of podcasting. In the context of the thesis, the MLCAT field study provided an opportunity to build on the "snapshot" exploratory studies reported in chapter four. It was envisaged that collecting evaluation data would provide insight into the following issues:

- How is podcast content/media used by students? What are lecturers' and students' perceptions of podcasts/podcasting?

During "pilot" studies, participants provide subjective reports of how they perform such sporadic tasks. It was hoped that the field trial would enable the collection of more objective data on these aspects of podcasting.

5.1.3 Contributions

The contribution of this chapter towards the thesis is two-fold, based on the dual-purpose nature of the study:

- Firstly, the chapter offers results from the formative evaluation of MLCAT. In addition, the chapter provides empirical ground-work for deriving general guidelines for the design and evaluation of podcasting tools. These are discussed in chapter six, along with methodological recommendations for designing and evaluating podcasting tools based on the experience gained in evaluating MLCAT.

- Secondly, the chapter offers insights into the nature and use of podcasting.

Section 5.2 describes the study timelines and methods; section 5.3 presents findings while section 5.4 presents a discussion.

5.2 Study Timelines and Methods

This section presents findings on the use of MLCAT at IUEA by Makerere University academics in Uganda. Data was collected in 2012, as part of ongoing prototype evaluation studies. The studies included a usability evaluation (i.e. study F), semi-structured interviews (study G), student survey (study H) and focus group discussions (study I) to begin looking at podcasting and the use of MLCAT at IUEA. The studies provided foundational insights into users' present day perceptions of podcasting. This chapter also presents how data in studies, G, H and I (described in the next sub-sections) was incorporated into a card sorting task (Study J); and subsequently into laddering sessions (Study K). This chapter will then conclude by presenting the findings and discussions.

5.2.1 Participants

Recruiting participants for this study provided a greater challenge than anticipated because MLCAT was ready for deployment at the time when Makerere University holidays had begun (i.e. June through to August 2012). The researcher however found out from the Dean – School of Computing at Makerere University that some MAK lecturers were lecturing on a part-time basis at the International University of East Africa (IUEA), a private university in Uganda.

Consequently, participants were selected via snowball sampling approach and participant I led us to participants II and III, who in turn lead us to participants IV and V. Thus, this is how the five academics for the study were selected. Four (4) men and one (1) woman aged from 25 to 35 years participated in this study. Table 5-1 below provides a summary of the demographics for academics used in this study.

Table 5-1: MAK Lecturer Demographics

SN	Demographic	Characteristics
1	Average Age	25 – 35
2	Gender	4 Male, 1 Female
3	Position	Ass. Lecturer
4	Average years of teaching	3+ Yrs
5	Experience with computers	Advanced
6	Highest Academic Qualification	3 MSc., 1 MSc Finalist and 1 PhD Finalist
7	Causes Taught	User Interface Design, System Analysis and Design, Software Engineering, Discrete Mathematics, Social Computing, Subsidiary ICT (A Level Students), Introduction to IT (BIT), Cryptology & Coding Theory, Data Communications & Computer Networks, Maths for IT, Statistics, Computer Systems

It is from the academic participants that student participants were recruited. The academics used in this study were lecturing various courses namely: User Interface Design, System Analysis and Design, Software Engineering, Discrete Mathematics, Subsidiary ICT (A Level Students), Introduction to IT (BIT) and Maths for IT among others. The twenty six students who participated in this study were recruited from the classes that were being taught by the five academics.

The use of colleagues as participants is justified as follows. Firstly, it was hoped that the study would leverage the existing trust basis between the researcher and his colleagues – avoiding possible privacy problems of working with strangers' personal data. Secondly, they were all technologically aware and ready to work with beta software. A third reason was pragmatic: it was easy to meet with them to carry out interviews, and install software on their personal computers. This is analogous to Appreciative Inquiry which deals with the art and practice of asking questions that strengthen a system's capacity to apprehend, anticipate, and heighten positive potential. This in turn inspires discovery, dream, and design (Cooperrider and Srivastva, 1987).

However, two methodological problems might result from such a set of participants. Firstly, since they already knew the researcher, there is the possibility of potential bias in favour of, or against, the MLCAT prototype.

Furthermore, the small number of participants meant that the results are unlikely to be applicable to the wider population of computer users. However, the intention was to produce interesting, indicative results, and to highlight routes for follow-up future research.

5.3 Methods

5.3.1 Usability Evaluation with MAK Academics (Study F)

In order to deploy MLCAT at MAK, the researcher undertook a usability evaluation to ensure that users understood the functioning of the system. The use of usability evaluation methods to evaluate podcasting tools is fundamental for validating them against potential users. Currently, the most common usability definition can be found in the international standard ISO/IEC 9126-1, where six guidelines are described for the creation of any kind of telematic application. They are functionality, reliability, usability, efficiency, maintainability and portability.

Usability is also described as the quality of an application to be understood, learned, used and attractive by/to the user, when employed under specified conditions or in context of use conditions (Magal-Royo et al., 2007). The evaluation criteria related with usability is mostly concentrated in the assessment of the efficiency with which the user is able to manage the tool, and its effectiveness when performing a certain task. In order to conduct a usability evaluation of MLCAT, the researcher used the Questionnaire for User Interaction Satisfaction abbreviated, QUIS (Harper & Norman, 1993). The QUIS consists of usability statements that are rated by users against a 10-point Likert Scale.

5.3.2 Semi-structured Interviews with MAK Academics (Study G)

The interviews were semi-structured, and lasted about an hour on average. Most were held one-on-one and often led to rich discussions. Interviews with academics took place at the author's office at Makerere University (as it was more private) and the language of mediation was English. Without controlling for gender, four of our participants ended up being male with only one female. This arose from the small number of women academics in computing discipline where the researcher sought for participation.

5.3.3 IUEA Student Survey (Study H)

Our quantitative study involved first-year computing students studying at the IUEA. IUEA has three intakes in a year and the class sizes were ranging from four to seven students. In June 2012, the author requested each of the five lecturers for permission to administer the survey questionnaire with students immediately after their lectures. The author interviewed all the students given that the class sizes were very small. As a result, 26 students participated in the survey with no incentives or bonus points issued to students for participation. The questionnaires consisted of a background section and mixture of closed and open-ended questions to allow for the respondents to express their perceptions on podcasting.

Moreover, all twenty six questionnaires were filled completely immediately after lecture sessions indicating one hundred percent (100%) response rate. The respondents were made aware that their responses are voluntary and would be treated with strict confidentiality. Additionally, the author did not need to do any advertising for the survey. Since the majority of the students were freshmen, many of them were in the age range 18-21 years old. Qualitative data were collected from both academics and students to provide an expanded understanding of how they perceived podcasts, their suggestions for enhancements, production and potential future usage within developing countries HEI contexts.

5.3.4 IUEA Student focus groups (Study I)

According to Kitzinger (1995), focus groups are a form of group interview that capitalizes on communication between research participants in order to generate data. Although group interviews are often used simply as a quick and convenient way to collect data from several people simultaneously, focus groups explicitly use group interaction as part of the method. Three focus group discussions with six students each were conducted in order to get a more in-depth understanding of their podcast use. These focus groups were conducted at the IUEA university compound

5.3.5 Card Sorts (Study J)

The small sample size for this study (i.e. three of the five academics) has a potential impact on the conclusions that can be drawn and to what extent they can be seen as an accurate representation of a larger group or population.

However, using card sorts to investigate perceptions and use of podcasting elicits rich data from small numbers of respondents; a conclusion also established in this study. The work of Nielsen and Landauer (1993) in the related field of usability testing, also suggests that observational overlap will occur with 3 – 5 users.

The types of cards used vary, for instance, Rugg and McGeorge (1997) discuss three techniques; (1) card sorts (traditionally word cards), (2) picture sorts, and (3) item sorts (e.g., physical objects). The dataset from studies F - I were rich in qualitative data which provided a number of keywords/phrases used to form word cards. Many of these were established during the analysis of what the students first said when they were asked about their understanding and experience with podcasting. Other keywords came from the dataset as a whole and consisted of words, expressions, phrases, and metaphors that the academics used to explain ideas of podcasting.

During card sorting, a number of themed cards were given to the five academics (individually) to sort and categorize, enabling the researcher to make inferences about the way that the participants 'construct' their world view. Therefore, Academics did the sorting, and provided the names of the groups and the criterion for sorting. If the respondent appeared to be genuinely stuck, then the facilitator took for instance two cards at random and asked the respondent to tell the main single difference between them; this usually provides the necessary inspiration. However, there is often a 'drying up' point where the respondent cannot bring any more criteria to mind. Thus, the method depends on participants 'appropriating' ambiguous words and/or images into this world view, thus revealing something of that world view to the researcher.

Although some of the terms could be fitted into a number of different categories, the aim is not to get mutually exclusive terms, but a rough sense of the range of issues covered together with a simple classification. Card Sorting is a technique which has been adopted within the fields of knowledge acquisition and knowledge elicitation (Rugg and McGeorge, 1997). Card sorts offer the following advantages namely: simplicity of use; focus on participants' terminology; and ability to elicit semi-tacit knowledge. In the study of podcasting, card sorting seems appropriate given its focus on terminology as this may uncover, in more depth, how it is constructed by academics and students during their different snapshots of use. Although card sorting is generally used in systems design, the general theory of card sorting could be adopted within product evaluation. Therefore, it seems logical to suggest that this method could be adopted in this research to understand how users organize and categorize their knowledge.

5.3.6 Laddering (Study K)

Laddering is a method originally developed by Hinkle in the context of personal construct theory (Hinkle, 1965). Hinkle's work built on that of George Kelly's on the way that individuals construct meaning. Hinkle developed a method which elicits meaning systems that start from the concrete and work towards the abstract. Grunert and Bech-Larsen (2005, p229) explain the method; *"Starting at the most concrete level, respondents reveal the first bipolar personal meaning construct (e.g., I like lean meat as opposed to fat meat – which becomes the bottom of a ladder). The interviewer then asks 'Why' or 'why do you prefer lean meat', and the respondent then generates a second, more concrete construct such as in order to be healthy as opposed to being unhealthy. The second construct is followed up by a 'Why' question and the process continues until the ladder has reached a level of abstractness from where it is impossible to continue".*

In order to elicit data about the use of MLCAT and determine academics' and students' opinions on the role and value of podcast lecture content, card sorts and laddering were conducted in the same session with each of the five academics. The main input into the laddering approach was the construct grouping from the card sort results. The constructs identified by participants during the card sorts formed the basis for the laddering interviews. As a result the card sort data provided the researcher with relevant 'contextual clues' to formulate adequate questions, interpret the answers correctly and prompt the participants without evoking socially desirable answers. There was no point during the laddering interviews when participants or the researcher felt that the questioning was either personal or intrusive as may sometimes be the case.

Once the most important consequences are revealed, one can determine the underlying values. The analysis explains the process of deploying MLCAT as well as the opportunities and challenges encountered. For instance, one participant mentioned that one of the challenges faced by students during the pilot trial is "noise from the recordings". The subsequent why question led the lecturer to respond as follows: if recordings are noisy then the end user will have problems. The lecturer was then asked why they thought this was important, they responded that there is a need to appreciate end-user problems. The lecturer was asked why it is important to appreciate end user issues and their response was 'in order to improve the technology'. This is further illustrated in example below:

Laddering Example

Interviewer: 'Please tell me why noise from recordings is an important problem encountered by students?'

Faculty: 'If recordings are noisy, students have problems listening'.

Interviewer: 'Why is students having a problem listening an important problem?'

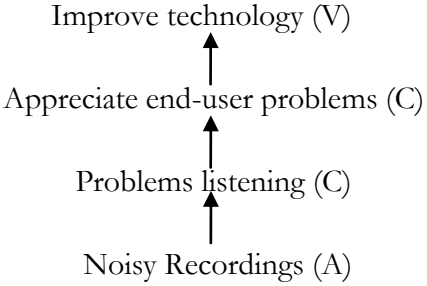
Faculty: 'Because, there is a need to appreciate end-user problems'

Interviewer: 'Why is it important to appreciate end-user problems?'

Faculty: 'So as to improve the technology'

The labels for the attributes, consequences and values should correspond to the actual responses of the interviewees. According to Gutman (1982); Olson and Reynolds (2001) and reproduced in Zaman (2008), the laddering method is based on the means-end theory. This theory helps to understand and describe how participants within a given domain perceive products by revealing the core underlying values that motivate them to desire certain product consequences. According to this theory, people unconsciously categorize incoming stimuli into a hierarchical chain of beliefs, referred to as the means-end chain which consists of attributes, consequences and values (Zaman, 2008). The responses in the example described above i.e. 'If recordings are noisy, students have problems listening' was broken down into two labels 'noisy recordings' and 'problems listening'; 'because there is a need to appreciate end-user problems' under the label "appreciate end-user problems" whereas 'So as to improve the technology' was coded under the label 'improve technology'.

The combination of the card sort session and the laddering interviews was a great help to label the values together with the interpretation of contextual clues. The laddering interviews gave an opportunity for the researcher to probe faculty for more elaborate answers than during the card sort session. The contextual clues gained during the test made it easier to correctly analyze the answers.



5.4 Findings

All studies were conducted and transcribed in English by the researcher. The researcher then performed several iterations of coding to distill themes of interest during the analysis and interpretation of data. Sub-section 5.4.1 presents the emerging themes that arose from studies F – I. Sub-sections 5.4.2 and 5.4.3 then present findings from the card sort study and laddering sessions respectively.

5.4.1 Emerging Themes

The researcher transcribed all the interviews, focus groups discussions and other qualitative data and performed several iterations of coding in order to distill the themes described below:

Usability Evaluation

For the usability evaluation, an overall score was calculated by simply averaging all of the ratings on the questionnaire that was used. (All scales had been coded internally so that the "better" end corresponded to higher numbers.) The scores were converted into percentages by dividing each score by the maximum score possible on that scale. So, for example, a rating of 9 on the Questionnaire for User Interaction Satisfaction (QUIS) was converted to a percentage by dividing that by 10 (the maximum score for QUIS), giving a percentage of 90% (Shneiderman, 1992). Table 5-2 below provides a summary of the usability evaluation results.

Table 5-2: Usability Evaluation results

Participants **Usability Statements**	A	B	C	D	E	Average %ages
Terminology relates to task domain	90%	80%	100%	60%	80%	82%
Instructions describing tasks	90%	100%	100%	100%	100%	98%
Instructions are consistent	80%	90%	100%	80%	100%	90%
Operations relate to tasks	90%	100%	80%	70%	100%	88%
Informative feedback	80%	90%	100%	50%	80%	80%
Display layouts simplify tasks	90%	90%	80%	100%	90%	90%
Sequence of displays	90%	90%	100%	80%	100%	92%
Error messages are helpful	X	100%	NA	90%	100%	58%
Error Correction	90%	50%	NA	30%	NA	34%
Learning the operation	80%	100%	100%	100%	100%	96%
Human memory limitations	80%	90%	NA	50%	100%	64%
Exploration of features	X	90%	80%	100%	100%	74%
Overall Reactions to the System						
Wonderful	80%	100%	100%	NA	80%	72%
Satisfying	90%	90%	100%	NA	90%	74%
Interesting	90%	100%	100%	NA	90%	76%
Stimulating	90%	100%	100%	100%	70%	92%
Easy	90%	90%	100%	NA	100%	76%

Generally respondents received MLCAT well and their overall reaction was that they found it stimulating, easy and interesting as represented by average scores greater than 75%. In addition, a number of positive attributes were noted as follows: Respondents found instructions describing system tasks as being clear (with the highest score of 98%) as well as always consistent (90%), display layouts always simplifying tasks (90%) and learning the operation as being easy (96%). The lowest score was for error correction as the errors received were system ones that would force Power Point to stop, shut down and restart. As a result, it was not clear whether error messages were helpful as shown by the low 58% average score. These results validated the assertion that MLCAT was robust enough for deployment.

Themes from Studies G, H and I

The semi-structured interview data with academics needed to be systematically analyzed. Therefore, studies G and I were subjected to a three-stage analysis method, i.e. data reduction, data display and conclusion drawing. Data reduction involves selecting, focusing, simplifying, abstracting and transforming the data as the researcher elicits meanings and insights from the words of the respondents. The researcher listened to each audio recorded interview, transcribed it and then read transcripts several times in order to familiarize himself with the data.

In the initial stages of data reduction, each line of interview transcript was numbered according to the question number it related to in the interview schedule. Once coded, all the interview transcripts were cut up into relevant question sections and then filed into the appropriate question folder. This meant that all the lecturers' responses to the questions were assembled together. The researcher also kept an original copy of each transcript so that he could refer any passages back to the original section in the transcript to ensure that all comments were being analyzed in context. Through this analytical process, the researcher developed a familiarity with the data that guided and focused their questioning, so that linkages and potential hunches could be followed up and checked with the questionnaire data.

Data display involved presenting qualitative data in the form of narrative text, supported by excerpts from the data. Results and discussion were combined and the data display reflected the emergence of six descriptive themes and was further enhanced by descriptive text. Reliability and validity involved asking respondents identical questions at different times to check for consistency of responses during a single interview and used respondent validation to ensure stability. In addition, qualitative research tends to espouse a constructivist ontological view of the world. As a result, they are focused less on generalizability (or external validity) and more on reliability (the degree to which the data accurately represents the population being studied). Rather than establishing universal truths about the world, a qualitative study is about gaining an understanding of how respondents talk about their experiences and the meanings they associate with particular events, actions and claims. In this section, the following themes were derived from studies G, H and I as summarized below:

- **Capturing interactions with students during lectures**

Overall, our respondents seemed to like the idea of podcasting but of the five academics interviewed, three wanted to capture classroom interactions with students during lectures as indicated in the verbatim quote below:

"{…} record activity in the class – as I am explaining concepts, asking questions and students answering them – so that even those who are slow can be in position to capture that audio, it would benefit slow learners and those who did not attend class {…} the use of MLCAT should be like being at a party where, if you recorded events, you are able to playback much of the activity that took place. Is it possible to capture students' contributions during lectures? {…} the classes are small and very quiet, if a student is asking or answering a question, the environment should be able to favor recording of students' voice".

According to Edirisingha et al. (2007), although students have access to their peers' tacit knowledge and experience through informal conversations, podcasts provided an additional resource that can capture such knowledge in a formal and re-usable way. The usefulness can be even more relevant to distance learning students. Tynan and Colbran (2006) also suggest that it is advantageous to capture questions and comments from on campus students.

- **Ability to re-use lectures**

According to Hurst and Waizenegger (2006), a useful usage scenario is for students who may want to revise a lecture before meeting with friends to solve a course assignment but does not have enough time to go through the whole lecture. This can be done while reviewing sections of the lecture during a taxi ride to the university. Additionally, the podcasts can be used for reference purposes. On the other hand, lecturers may also want to re-use lecturers for other classes as shown in the verbatim quote:

"{…} some participants identified the fact that they moonlight (or teach at other Universities) and that in case they missed lectures, they could still give them to students through recordings".

Moreover, Murphy and Wolff (2009) also reveal that struggling students can replay videos as needed; while more advanced students can skip them altogether.

Finally, using videos to prepare for lab assignments can help to ensure that all students have adequately covered the prerequisite topics.

Capturing external content and reduction of noise from Podcasts

Murphy and Wolff (2009) reveal that integration of podcasts with other aspects of classroom/course activity is important for example labs and exam review as shown in the verbatim quote:

"{…} ability to capture writing/illustration done on say a chalk board especially with subjects like Mathematics/Programming, reduce the noise of the recordings {…}Capturing Video of the lecturer, capture demo of mathematics concept on a white/back board".

Additionally, Barker et al. (2008) reveals that the responses to the qualitative questionnaire indicate that background music in the supplemental podcasting materials causes distractions and should be reduced in volume before implementing future podcasts.

- **Length of recordings and choice of lecture sections to podcast**

According to Cebeci and Tekdal (2006), the length of a podcast is influenced by purpose and content although they recommend not longer than 15 minutes. Lee and Chan (2007) recommend 3 – 5 minutes of podcast recording whereas in the IMPALA project (Salmon et al., 2007), majority of the podcasts lasted 10 minutes. Chan et al. (2006, p.118) also advises to *"keep podcasts short, lively and entertaining"*. The verbatim quote from the participants interviewed echoed the same as shown below:

"{…} picked out important parts for their choice of recordings and omitted definitions, background and recorded more of the application areas {…}Others recorded only the assignments and explanations on how to answer the questions…".

Carvalho and Aguiar (2009) argue that full-length lecture recording should not be the emphasis but instead maximizing interest, appeal and ease of listening to students. Moreover, Carvalho et al. (2008) also echo the same opinions. However, this is contrary to what some of our respondents reported as shown in this verbatim quote:

"{…} I would use this for recording assignments and their instructions/slides and/or diagrams where I am less elaborate {…}Use tool to record entire lecture but be able to pause and resume during breaks/interactions/moving out {….} 38 Power Point slides for 1 hr 10minutes and 18 slides for 1 hour {…} The recordings were 90 minutes long for 15 Power Point slides, 60 minutes long recording over 10 slides, 45 minutes recording over 10 slides and lastly 20 minutes over 8 slides {…} picked out important parts for their choice of recordings and omitted definitions, background and recorded more of the application areas".

- **Breaking recordings into smaller chunks**

One of the findings was that three of the five academics wanted to capture podcasts during the lectures but be able to generate smaller chunks of recordings at different time intervals of say 10 minutes as per the verbatim quote below:

"{…} generating particular output as you record and for instance package lectures into 10 or 15 minute recordings".

In order to find out what access devices IUEA students had and their perceptions towards podcast use, an analysis of survey results with twenty six students was undertaken. A summary of the questions they were asked and a snap shot of responses is as shown in the paragraphs that follow. Sample questions from our survey included but were not limited to the following: What technologies do you own? Which Cell Phone Brands do you own? Which technology do you use at Home? What is your understanding of digital lectures? How do you access digital lectures? What are the Challenges during access? How would you like podcast lectures presented/delivered to you?

Responses were varied and overall, each of the twenty six students interviewed owned a PC/laptop. The students are given discounted laptops on payment of 50% of the tuition fees and only one student had no cell phone. Twenty five out of the twenty six students interviewed had access to phones with a camera, Bluetooth and storage ranging from BlackBerry 8900, Nokia E6 to Samsung SGH 490 and Nokia 1700. However, the most dominant technology that is used at home for all the twenty six students is the PC/laptop. All the twenty six students understood podcasting to mean a program used to record audio, make an interview, and listen to music /a form of audio streaming over the Internet /a device electronic that helps us to listen to audio music, radio.

Podcasts also allow for capturing pictures (depending on capacity, number of megapixels)/podcasting is a way in which people can communicate with others through radio…(record information)/Helping listen to music or to see video/ Podcast provides users the ability to record voices and play them or listen to them when required.

Additionally, twenty out of twenty six students preferred to access podcasts via Bluetooth whereas six preferred to use WIFI/Internet as indicated in the verbatim quote:

Students from IUEA suggested the possibility of using WIFI provided by the University infrastructure for podcast access as opposed to using flash drives to access usually from lecturers' laptops and share files amongst themselves – as was done currently

The survey was followed by three focus group discussions with six students each in order to get a more in-depth understanding of their podcast use. A summary of the themes and their respective verbatim quotes to support them are presented below.

- **Length of recordings and Sound Quality**

There was also general consensus amongst all the students that 1 minute or less was adequate lecture narration time for each presentation slide. *"{…} it's important that lecturers are on point during recordings, precise and concise because if they are not, I would not be going through that for the exam". The recordings should also not be too thin on explanations".*

Additionally, the issue of podcast quality is of paramount importance to students as indicated by the verbatim quote:

"While playing back the videos on the phone, the sound is so bad even with ear phones {…} there was a lot of static noise i.e. the .mp4 sound was really low and the .avi was the better sounding version although it had a lot of static noise… the sound is not good but you could hear the explanations{…} ". In fact, one of the students had to connect a sub woofer to their laptop to amplify the sound more.

- **Capturing external content**

This presented a pertinent concern with students particularly for courses where lecturers needed to give additional illustrations outside of the PowerPoint lecture presentation as indicated in the verbatim quote:

"What would you do if you had a subject like Mathematics because many times, lecturers write on the board or draw illustrations in order to explain in-depth their content. Have you thought about being able to capture that content".

- **Capturing interactions during class**

Additionally, students expressed the importance of being able to capture classroom interactions between students and the lecturer. These interactions may sometimes represent content that may not be captured in the lecturers' presentations hence providing useful information to students as indicated in the quote:

"{…} also, the thing with the video is that you cannot put up your hand to ask a question. Therefore, whether you put up your hand, you have to re-wind and hopefully you {…}". Also, when you put up your hand, it might be explained in another dimension so that you understand better unlike with the recording.

5.4.2 Card Sort Findings

The themes generated from studies F – I offered a variety of discussion points in relation to podcasting. This, combined with their flexibility of interpretation, helped to evolve the themes into a card set. Consequently, there were 30 word cards developed to represent these issues (see Table 5-3).

Table 5-3: List of word cards generated from the Studies F - I dataset

Sound quality of recordings	Corrupted recordings	Recordings should be shorter	The use of WIFI to publish/deliver recordings	Student access to recordings
Break down recordings into smaller chunks	Package recordings into smaller chunks	Student access devices/technologies	Length of lecture recordings	Noise from recordings/ Unclear sound
Clear terminology used	Capture content external to Power Point	Different usage /Lecture recordings scenarios	Backup of lectures	Capture student interactions
Delivery method for the recordings	Lecture recordings re-use	Attitude towards technology	Off-line production of recordings	Lack of integrated lecture room infrastructure
Recording sections of the entire course content	Copyright issues with recordings	Lack of requisite equipment to capture recordings	Accessing lecture recordings over WIFI/Bluetooth	Recording entire lectures
Ease with which recordings are made	Easy to Perceive, understand, navigate and interact with the system to record	Slow Internet connection	The System is intuitive/works in the way we think it should	Accuracy and completeness with which recordings are made

All cards measured 5 inches x 3 inches and were presented in landscape formats. Word cards adopted Arial Black as a font style, with a point size of 26 on a white background. The cards included three blank cards and all cards were assigned numbers rather than names as this saves a lot of recording time and can reduce the risk of cueing respondents towards a particular type of response. The blank cards would allow participants flexibility to discuss any podcasting issues not integrated into the text cards. This study uses all in one sorts – where one sort is performed that includes all the cards.

Figure 5-1: Sample cards

This type of sort can vary as it may involve a matrix sort with axes, or sorting cards into clusters based on criteria such as 'similarities between them'. Rugg and McGeorge (1997) suggest that there are problems with the 'all in one sorts' due to the fact that they often do not elicit individual attributes and that statistical analyses may have to be used to identify underlying factors. However, this may not present itself as a problem if the card sorting is interested in qualitative data, as this research is. The next section details how the card sorting task evolved and was evaluated.

The card sorting task was aimed at getting academics to group the cards in relation to how they perceive podcasting. Participant 1 sorted the cards into nine categories namely: 1) Problems encountered by students; 2) Problems encountered by teacher; 3) Recommendations to come up with quality recordings; 4) Solutions to problems encountered during recording by teachers and access by students; 5) Advantages/Good points about the technology; 6) Problems that could be encountered during distribution of lectures; 7) Solutions to problems during distribution of lectures; 8) Lecturing the same course content to different groups and 9) Avoiding Plagiarism. This participant felt that the text groupings best represented their working role as an academic and they were worried about all these issues. The opportunity to add cards, using the blank cards was an option.

Participant 2 also used existing cards in the pack as categories for the card sorting exercise and created five groups namely; (1) Usability/Use, (2) Application/Usage, (3) Quality, (4) Content Delivery, and (5) Problems/Errors. Participant 3 sorted the cards into four groups i.e. (1) Attributes associated with tool design, (2) Attributes of tool during listening by students, 3) Attributes associated with tool usage, and 4) General qualities of the tool. The remaining two participants did not take part in this study.

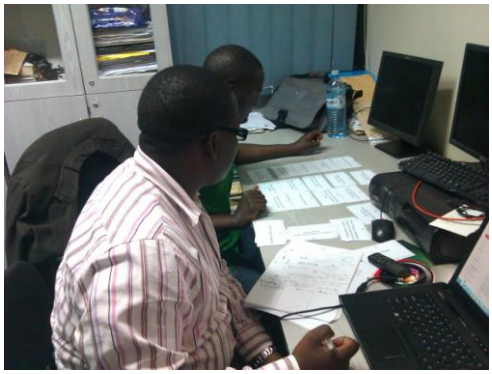


Figure 5-2: Card sorting exercise

Some of the names that participants allocated to the categorization of the cards were based on the cards in that category whereas the other participants offered more abstract groupings and were less reliant on using the word cards in the groupings to generate the group names. The card sort analysis demonstrated some key findings:

- Participants had no problems grouping the word cards and defining the names of their categories.

- Participants tended to take the cards very literally, not expanding on what they saw, but merely describing the items on the cards and then placing them. It had been hoped that the cards would be understood in a more abstract way and that the participants would go further than grouping cards based on what was literally on the cards.

There is a well-established standard set of procedures for analysis of card sorts. Firstly, an analysis of the number of sorts is performed, followed by the number of groups into which cards were sorted. After this, the researcher analyzed the criteria by comparing them against those generated by the different participants. Consequently, respondents generated varying card sort numbers with obscure reasons for this finding.

Number of constructs and categories used

A total of eighteen constructs were identified across the respondents. Table 5-7 shows verbatim constructs generated by the lecturers. The table also shows the number of categories used for each construct which range from 1 – 10. The table also shows that some constructs appear to be similar yet they have been identified separately as shown in Table 5-7. The construct "Advantages/good points of the technology" is similar to "attributes associated with tool design". In fact, there is a similarity in the groupings 'clear terminology used', 'easy to perceive, understand, navigate and interact with system to record' and 'the system is intuitive'. The constructs 'Application/Usage' is also similar to 'Attributes associated with tool usage'. The constructs 'content delivery' and 'solutions to problems during distribution' also had a similar grouping by respondents.

In addition, there is similarity between the constructs 'attributes associated with tool design' and 'usability/use'. The categories involved include: 'clear terminology', 'Ease with which recordings are made', 'Easy to perceive, understand, navigate and interact with the system to make recordings', 'Off-line production of recordings' and 'recording entire lectures'.

Table 5-4: Verbatim constructs generated Vs Number of cards grouped in each criterion

Respondent #	Constructs	Number of cards
Respondent 1	C1: Problems encountered by students	5
	C2: Problems encountered by teacher	10
	C3: Recommendations to come up with quality recordings	5
	C4: Solutions to problems encountered during recording by teachers and access by students	5
	C5: Advantages/Good points about the technology	3
	C6: Problems that could be encountered during distribution of lectures	2
	C7: Solutions to problems during distribution of lectures	3
	C8: Lecturing the same course content to different groups	1
	C9: Avoiding Plagiarism	1

Table 5-4: Verbatim constructs generated Vs Number of cards grouped in each criterion

Respondent #	Constructs	Number of cards
Respondent 2	C1: Usability/Use	10
	C2: Application/Usage	4
	C3: Quality	6
	C4: Content Delivery	5
	C5: Problems/Errors	5
Respondent 3	C1: Attributes associated with tool design	9
	C2: Attributes of tool during listening by students	3
	C3: Attributes associated with tool usage	9
	C4: General qualities of the tool	7
Total Number of Constructs		**18**

In the same way, the constructs 'Listening to lectures by students' is similar to 'problems encountered by students' as evidenced by the categories: students access devices and student access to recordings. The similarity matrix below shows how many participants agree with each pair combination of cards. For each possible pairing of two cards in the survey, a count is provided at the corresponding point in the matrix. The count describes how many times the two cards were placed in the same category by all participants. The algorithm attempts to cluster similar cards along the right edge of the matrix.

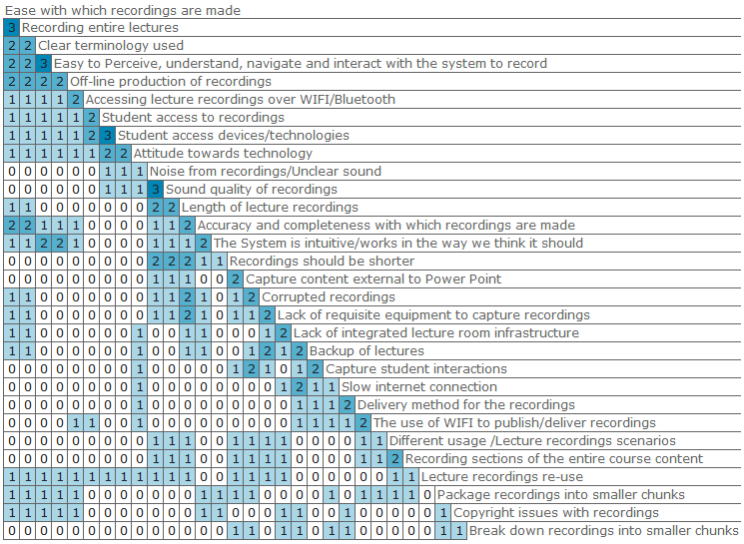


Figure 5-3: Similarity matrix

Commonality of Constructs

Five verbatim constructs were generated by more than one individual and are shown in Table 5-8 below.

Table 5-5: Verbatim constructs generated by more than one respondent

SN	Construct	Respondent1	Respondent2	Respondent3	Total
1	Problem(s)	1	1	0	2
2	General Tool Qualities	1	1	1	3
3	Content distribution	1	1	0	2
4	Usability	0	1	1	2
5	Usage	0	1	1	2

Clearly, all our respondents agreed with the following card pairings: 'Ease with which recordings are made' and 'recording entire lectures'; 'clear terminology' and 'Easy to perceive, understand, navigate and interact with the system to record '; 'student access to recordings' and 'student access devices'; 'Noise from recordings/unclear sound' and 'sound recording'. None of the respondents agreed with the card pairings: 'system is intuitive' and 'lack of requisite equipment to capture recording'; 'capture content external to Power Point' and 'lack of integrated lecture room infrastructure'; 'Ease with which recordings are made' and 'unclear sound' whereas only one respondent agreed to the card pairings 'clear terminology used' and 'attitude towards technology'; 'student access devices' and 'sound quality of respondents'; 'package recordings into smaller chunks and break down recordings.

Agreement Cluster Analysis

The Dendrogram (see figure 5.4) is used to illustrate data clusters using the actual agreement cluster analysis method built into optimal sort (http://www.optimalworkshop.com).

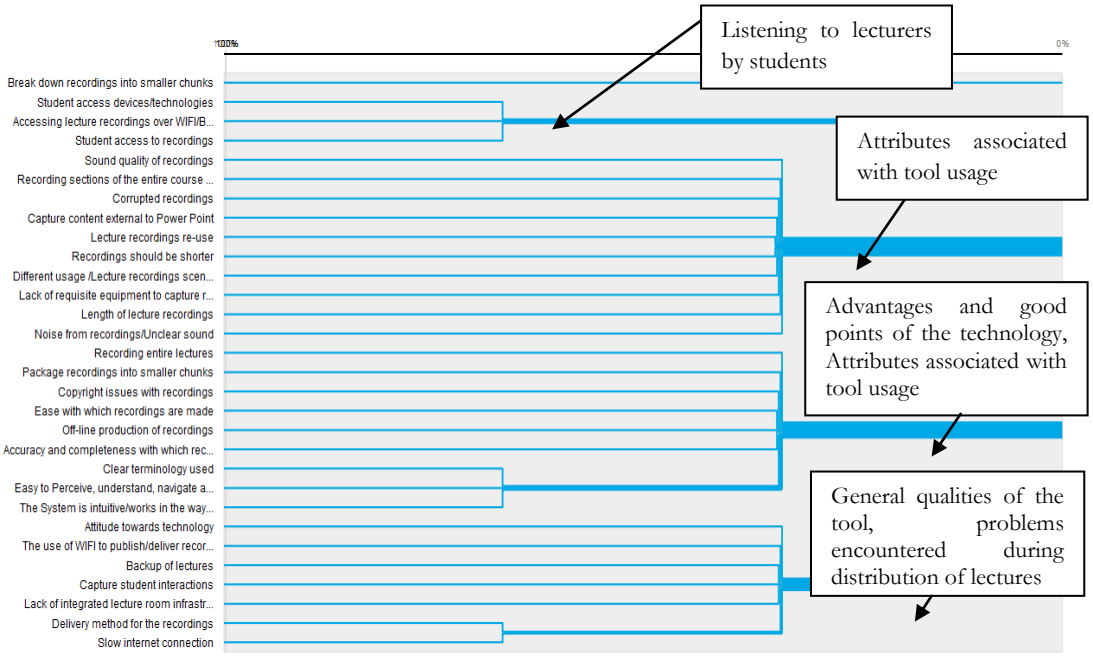


Figure 5-4: Dendogram

The scores illustrate that two out of three participants agree with the grouping "Listening to lectures by students", one out of three agrees with the groupings "advantages and good points of the technology" and "attributes associated with tool design" whereas two out of three agree with the grouping "problems encountered during distribution of lectures". However, these approaches did not reveal much of the more tacit ideas of podcasting, for example why limit the podcast to 5 – 10 minutes as opposed to recording an entire lecture? Why record sections of course content? And how these ideas could be incorporated into the design process? This suggested a different method was required that would get underneath the 'theory' of what one ought to do and look at how issues of podcasting are actually addressed – a method that would go some way to providing a descriptive view of podcasting use in the field. Such a method would need to be more subtle in teasing out assumptions about podcasting, and be more attuned to the everyday communication of designers.

5.4.3 Laddering Findings

The first step in the analysis is to record the entire set of ladders on a separate form and appropriately label each item that is an attribute (A), consequence (C), or value (V). Table 5-6 provides the summary content codes for our study that reflects all the elements (A-C-Vs) elicited.

Table 5-6: Attributes, consequences and values

Attributes									
1	Noisy recordings	7	Lecture backup	13	Short recordings	19	Slow Internet	25	Media format
2	Access devices	8	Capture entire lecture	14	Capture external content	20	Delivery methods		
3	Student access	9	Feedback	15	Student interactions	21	Ease to perceive, understand & navigate		
4	Sound quality	10	Easy to record	16	Small recordings	22	WIFI/Bluetooth access		
5	Easy to follow	11	Compatibility	17	Intuitive system	23	Offline production		
6	Attitude	12	Windows support	18	Clear terminology	24	Copyright issues		

Table 5-6: Attributes, consequences and values

Consequences							
26	End user problems	32	Wasted time	38	long videos	44	Easy to use for first time
27	Access challenges	33	Dodge lecture	39	Limited attention	45	Problem to download
28	Unclear sound	34	Requisite Applications	40	External applications	46	Problem to upload
29	Negative attitude	35	fewer slides	41	Better solutions	47	Use terms that are easy
30	No LMS	36	Incomplete work	42	Interesting arguments	48	Use Bluetooth
31	Stolen laptop	37	Failed first usage	43	Downloading large files	49	Acknowledgement

Table 5-6: Attributes, consequences and values

Consequences							
50	Copyright abuse	61	Capture questions	73	Usability	85	Attention/Interest issues
51	Limited Internet access	62	Sound tracks	74	Output quality	86	Integrate all applications
52	Lack of storage devices	63	Short recordings	75	Complex sections	87	Capture screenshots
53	Files not limited to devices	64	Quality	76	Videos Vs reading	88	Terminate recordings
54	Unclear sound	65	Flash disks	77	Devices	89	Design issues
55	Play back using DVD	66	Limited equipment	78	Slide animations	90	Bluetooth
56	Screen interaction	67	Short videos	79	Short explanations	91	Smooth access
57	Like system	68	Manipulate voice	80	Terms and conditions	92	Live recording
58	Positive reaction	69	Different interpretations	81	System notifications	93	Class Q&A
59	Copy of lectures	70	Fully online	82	Ignored recordings	94	Invade privacy
60	Stored for future use	71	User interface	83	Affects quality	95	Lecturer Evaluation
		72	Small chunks	84	Terminate recordings	96	Copy of lecture

Table 5-6: Attributes, consequences and values

Values					
97	Improve technology	103	Students get bored	109	keep listener interested
98	End user problems	104	Enjoyed the idea	110	Usability
99	recordings re-use	105	Make presentation lively	111	Critical parts of lecture
100	Lecturers get bored	106	Enrich recordings	112	Solve infrastructural problem
101	Replace lecture with video	107	Affect tool availability		
102		108	Captivate listener		

5.5 Summary

In this chapter, the researcher has introduced a prototype evaluation of MLCAT – a lecture podcasting tool. In order to determine the underlying values of our participants, this chapter proposed a research design that uses the following techniques in sequence: formative evaluation, semi-structured interviews, survey and focus groups in the first phase. Results indicate that MLCAT solves the inadequate infrastructure problem because it provides a stand-alone podcasting solution that relieves pressure off the HEIs; it is important to have short recordings so that students are less bored; the ability to re-use; lecturers and students alike enjoyed the podcast authoring experience very much hence the enthusiasm; important that the tool can be used for authoring offline because the Internet is very unreliable; WiFi/Bluetooth access for students and the need to capture student interactions as hearing one voice is boring.

Next, Chapter six moves on to provide conclusions and combines the findings from this chapter with those from the wider thesis.

Chapter 6 Conclusions and future directions

This chapter is organized into four main sections. The first revisits the research problem while the second draws attention to the study limitations. The third section highlights the research contributions whereas the fourth presents the methodological reflections. Finally, section five presents possible directions for future work.

6.1 Revisiting the research problem

This research aimed at improving the HCI4D knowledge base for the design of the podcasting tools. Today's academics encounter a wide range of problems in authoring appropriate content, and consequently there is a need to develop podcasting tools to better support this activity. As discussed in chapter three, previous published research relating to this area has been limited. Although many studies of podcasting have been carried out, few have considered the need and or development of podcasting tools relevant for developing HEIs. Therefore, there is a lack of empirical foundation for podcasting design work.

Accordingly, much of the design work in this area has been technologically motivated rather than grounded in contextual requirements. On the other hand, many of the innovative prototypes have not been evaluated. Since designers' claims have not been empirically validated, they offer little research value beyond indicating possible routes for design. This thesis set out to answer the following questions:

RQ1: What are the current podcasting practices, limitations and experiences in developing world HEIs?

RQ2: How can techniques from Human-Computer Interaction for Development (HCI4D) support the design of podcast production tools that are suited to lecturers and students needs in developing HEIs?

RQ3: How is podcast content/media used by students? What are lectures' and students' perceptions of podcasts/podcasting?

To answer these questions, this thesis starts out with an analysis of literature review (RQ1) and later on applies Participatory Action Research approach structured on a four-stage process of user-centred design: (1) Analysis, (2) action planning, (3) action implementation and (4) evaluation (RQ2). Analysis, fact finding and conceptualization – the exploratory study, reported in chapter four, investigated the use of podcasting tools by lead users at UCT and MAK. It enabled the identification of opportunities, challenges and podcasting models for developing HEIs (RQ1). During this stage of the PAR cycles, this thesis utilized ethnography and mixed methods studies (RQ3) to tease out the various features that are similar or different for the developed versus developing world podcasting usage scenarios. Table 6-1 offers a summary of these features.

Table 6-1: Developed Vs Developing world podcasting features

	Developed World features	**Developing World features**
Authoring	Use mostly commercial tools needing licenses	Use commercial tools only for the duration of the trial period as cost are normally prohibitive
	Automated authoring process to a high degree and require the requisite infrastructure in place	Lack requisite infrastructure
	Have the expertise and human resource to administer and configure podcast equipment.	The set up is normally complex even for advanced IT users.
	Normally capture presenter and their presentation	Capturing the presenter is viewed as being Intrusive.
	In most cases technicians handled all production activities. In some cases students can stream live lectures as they take place.	This is viewed as extra work and streaming might not be possible.
	Better institutional organization	Not much institutional organization.
Distribution	Automated distribution of large recordings to a server over good Internet links	This is normally done manually as content may be uploaded to the LMS
	Lectures normally distributed to server immediately after recording	This may take several weeks
	Always on Internet connections	Intermittent Internet connections
Access	The use of subscription models (i.e. RSS)	Preference for Bluetooth
	Access via PC mostly	Preference for cell phone access
	NA	Off-campus access issues by students
	NA	Incompatible media formats
	NA	Limited PC ownership
	Many powerful multimedia devices	Not very many powerful multimedia devices but this is improving

Table 6-1 suggests that the technology baselines are in some ways similar to those in the developed world. However, in the developing world, developed world tools are only used on trial basis because of the procurement costs involved. Moreover, these tools may in some cases require complex set up and administration. Consequently, enthusiastic academics normally replace them with piece-meal alternatives. For instance, at UCT, some lecturers were using a camera connected to a Mac Book to capture their audio and presentation screen. This approach greatly slowed down the podcasting processes as it required technicians to post-process the recordings whereas others trialed with audio only recording tools i.e. Audacity. Furthermore, some developed world tools capture the presenter in addition to their presentation. However, in the developing world, despite the fact that the infrastructure is not in place, it was seen as an infringement on lecturers' privacy or being intrusive.

In addition, developed world environments have the requisite infrastructure; better institutional organization; and automated distribution of large recordings to storage servers over good Internet links. In developing world environments, podcasts are normally uploaded manually onto an LMS and this may take several weeks. Finally, accessing podcasts by students in developed world environments is normally done via RSS using powerful multimedia devices and always on Internet connections whereas in the developing world, preference was given to the use of Bluetooth to access and share files.

1. Action planning – this phase of the PAR cycle described participatory design and paper prototyping activities with academics. The purpose was to develop detailed requirements specifications for the podcast production prototype (RQ2).

2. Action implementation – this phase detailed the implementation of the MLCAT prototype

3. Evaluation – chapters four and five reported the field-study based evaluation of the MLCAT prototype (RQ3). The evaluation facilitated the assessment of the design, as well as the development of guidelines for the wider podcasting design genre.

Consequently with our probe, we decided to examine different developing world environments hence TSiBA (South Africa) and MAK (Uganda). From both these sites, we teased out the various podcasting features that are similar and/or different (see table 6-2).

Table 6-2: TSiBA Vs IUEA features

	TSiBA features	**IUEA features**
Authoring	*No infrastructure	*No infrastructure
	*Author short podcast chunks/ sections of content	*Author short podcast chunks/ sections of content
	??	Capturing interactions during class
	*Lecturers have access to PCs/Laptops running Windows Operating System	*Lecturers have access to PCs/Laptops running Windows Operating System
	*Capture content from different sources	*Capture content from different sources
	??	*Podcasts viewed as alternatives to lectures in case academics were not present.
Distribution	*This was done via flash drives from the lecturers' laptop after the lecture then via data cable onto cell phone.	* This was done via flash drives from the lecturers' laptop after the lecture to their laptops
Access	Mobile access with PC access only on campus	Some mobile access but preference to use laptops for access.
	Preferred podcasts access model was via Bluetooth.	Preferred access models to podcasts are via WIFI and Bluetooth as they mentioned that they download movies comfortably.
	Privacy was an issue	This did not seem to be as issue
	A few students owned no technology at all	All had at least a laptop
	Other technology used off-campus included DVD and TV	Mostly laptops and Cell phone
	Slow Internet connections	??
	They were concerned that they would not access MS Office documents via cell phones	??
	Software on home devices is different from that of on campus ones	??

In the TSiBA environment, mobile access was critical as cell phones were the primary device that students owned and interacted with while off-campus whereas in the IUEA environment students were given laptops after paying fifty percent of their tuition fees. As a result, laptops were their preferred access device even off-campus. In both TSiBA and MAK, there was no basic infrastructure to support podcasting processes; there was a preference for shorter podcasts; all lecturers had access to PCs/Laptops running Windows Operating System and also expressed the need to be able to capture content from different sources.

In the Ugandan environment, lecturers valued the capturing of interactions during lectures such as question and answer sessions or class discussions. In Uganda, academics seek employment at other public and private HEIs in order to increase their earnings. As a result, podcasts were mostly viewed as alternatives to lectures in case they could not make it or 'dodged' lectures at one of the HEIs due to heavy workloads. Finally, privacy was not an issue in Uganda perhaps owing to the slow development of privacy laws.

Therefore, despite these characteristics, Africa is not all one country – different places do things differently. In some places there is a prevalence of computers whereas in others cell phones. Another concern was that software on home devices used off-campus is different from that on campus and therefore presents access challenges. Conversely, there are other effects such as authoring podcasts off line that are different and need to be supported by a tool owing to the lack of class room infrastructure. Therefore, it is worthwhile to have a different tool for those reasons.

6.2 Limitations

When conducting scientific work, one must keep in mind the various aspects which validate the outcomes of research work. In our case, we discuss the validity of our samples of participants, the data we collected, the repeatability of our studies, and the generalization of results. The validity of studies was limited by the number of participants involved and the duration. Moreover, there is need to acknowledge the difficulty in recruiting participants for such studies as well as the resources required to conduct such deployments. In the context of a Ph.D. thesis which involves three years of work, the researcher chose to use a triangulation approach to study the research problem from various perspectives.

The data collected is largely qualitative, which may be considered unusual in computer science as it mostly focuses on quantitative metrics such as time or error rate. In fact, the exploratory nature of this work did not allow the researcher to conduct hypothesis testing experiments. Instead, the researcher chose to let properties emerge from active interaction and to eventually describe these emerging properties for designers and researchers to reuse. However, great attention has been paid to the methodology used (i.e. PAR) to allow researchers conduct concurrent observations and seek the emergence of phenomena. In Chapter four, the researcher paid particular attention to describing the context in which observations took place, and the user population involved.

Finally, the researcher acknowledges that the methodology limits the generalizability of results. This is frequently the case in HCI where only a limited portion of the population is studied. However, it is believed that the data collected, analyses and discussions provided a different perspective on the use of podcasting tools in developing HEIs. While observations and analyses were limited to African HEIs, the researcher believes that some phenomena reported could be applicable to a larger population. This thesis could therefore trigger explorations within the larger community of m-learning researchers.

6.3 Contributions

The thesis contributions are structured into two main areas. Firstly, sub-section 6.3.1 presents contributions presented in different sections of the thesis. Secondly, sub-section 6.3.2 discusses contributions resulting from the design, implementation and evaluation of the MLCAT prototype.

6.3.1 Improved Knowledge of podcasting

This section details contributions that relate to the first aim of the thesis: to develop increased understanding of podcasting. Table 6-3 provides a summary of contributions providing increased understanding of podcasting.

Table 6-3: Contributions providing increased understanding of podcasting

Chapter	Contribution	Type of contribution
2	Definitions and podcasting conceptual framework	theoretical
3	Critical review of previous work	theoretical
4	Podcast production ecology model	Theoretical model
4	MLCAT design framework	Theoretical framework
4	Use of PAR to design podcasting tools	Methodological
5	New evaluation research design	Methodological, empirical findings
5	Insights into podcast production and use by faculty and students	Empirical findings

Chapter two made theoretical contributions that were two fold; providing definitions and a conceptual framework for podcasting through a review of literature. In chapter three, the critical analysis of previous work presented theoretical contributions. Chapter four reported on AR-PD studies to investigate podcasting in developing HEIs – the primary contributions from Chapter four are: a podcast production ecology model; the MLCAT design framework; the use of PAR to design a lecture podcasting prototype. Chapter five reported a follow-up eight week prototype evaluation of MLCAT use. As well as investigating podcasting behavior, the field study acted as a research vehicle to evaluate the MLCAT prototype.

6.3.2 Design, Implementation and Evaluation

The second main area of contribution resulted from the design, implementation, and evaluation of the MLCAT prototype. Table 6-4 provides an overview.

Table 6-4: contributions relating to the development of MLCAT

Chapter	Contribution	Type of contribution
4	Design and implementation of MLCAT	Design and implementation
4	Results from the initial evaluation(s) of MLCAT	Empirical findings
5	Results from the longitudinal evaluation of MLCAT	Empirical findings
5	Design implications from MLCAT evaluation	Design guidelines
6	Methodological recommendations to guide the design and evaluation of MLCAT	Methodological recommendations

The first contribution is the MLCAT prototype itself, as described in Chapter four. MLCAT is offered as a novel, empirically-grounded form of podcasting. It enables the user to author and distribute podcasts, for students to access via Bluetooth. In contrast to limited research in the area, MLCAT is an example of HCI4D design. As well as suiting the limited development resources available, this approach enabled straightforward use with minimum disruption. The initial evaluation(s) of MLCAT reported in chapter four, resulted in a number of design improvements before a more extensive evaluation was performed. The follow-up prototype evaluation reported in Chapter five, resulted in two further contributions: (1) an assessment of MLCAT, and (2) design implications for designers working in this area. The final contribution presented in section 6.4 is a set of methodological recommendations for the design and evaluation of podcasting tools. These were structured based on the extended theoretical framework developed in chapter four.

6.4 Methodological reflections

From a methodological standpoint, this thesis encourages a shift in design thinking. Existing HCI4D methods require an understanding of target users, their contexts, values, work practices and technologies available to them. The designers had to reflect on contextual data in order to apply their skills to build appropriate technological solutions in the spirit of pragmatic design. Therefore, contextual analysis led to the development of models about the user, their contexts, values, work practices and their technologies. The designers' experiences combined with evidence from literature points out that the pragmatic design approach is appropriate for users in their contexts. This is true because as Cockton (2004) suggests, the delivery of value is of paramount importance.

Additionally, there are very few studies that have reported the use of HCI methods in the design of m-learning applications. This research started out by postulating that if we adopted these approaches then designers would develop locally relevant tools that would be easily adopted in developing HEIs where there has been very low adoption of developing world technology imports. There is also limited guidance on how these approaches can be used therefore, the researchers provide a practical guide to building m-learning tools as summarized in the table 6-5. The designers also found problems (during the design iterations) related to evaluating prototypes. This was due to a lack of appropriate frameworks to evaluate mobile learning prototypes. Consequently, values were generally very difficult to tease out while using natural language approaches i.e. semi-structured interviews, surveys and focus groups.

This is clearly reflected during the second PAR cycle where MLCAT was deployed at TSiBA. Despite the fact that we obtained interesting results, it was not clear which values appealed to participants with respect to the tool usage.

Moreover, low-fidelity prototyping methods from HCI did not yield much as despite users knowing the kind of features they wanted the podcast production tool to have, they could not represent these on paper. There is limited guidance on the use of PAR in the design of interactive technologies as well as choice and sequencing of techniques during each of the cycles. Therefore, based on our experience in using PAR, we offer some guidelines on its use in designing podcasting and other information systems. Table 6-5 clearly shows the purpose at each stage, key activities and possible outcomes.

For instance, in the first PAR phase, the goal is for designers to understand context prior to any to any new technology being introduced. This phase is analogous to contextual inquiry in which designers identify problems using techniques such as ethnographies, semi-structured interviews and surveys to identify themes, specifications and user models. This is followed by planning how to solve the problems identified during analysis through brainstorming or PD sessions in order to generate fairly detailed requirements for the intended technology intervention. The Action Implementation stage then requires the technical skills of the designers/researchers to generate low fidelity prototypes. This is then followed by formative evaluations in order to validate design against the requirements.

In the second AR-PD phase, the goal is for designers to analyze users and their context from a technical standpoint based on the findings from the first phase; derive revised user models. This is followed by identifying system and user requirements leading to the generation of more concrete requirements. This next phase also involves the development of more system functionality leading into a high-fidelity prototype(s). These are then evaluated formatively un-earthing reflections on use and frameworks for more concrete design.

Finally, the goal of phase III is for designers to generate robust high-fidelity prototypes (to take into account any design compromises that may have arisen from the phase II) and evaluate them in a real world environment or context. At this point we utilize our evaluation framework illustrated in Figure 6-1 which involves the use of natural language techniques i.e. interviews, surveys, focus groups followed by card sorts and laddering.

Table 6-5: A practical guide to using PAR in the design of m-learning software

Phase I	**Purpose**	**Key Activities**	**Outcome**
Analysis	Identify problem	Surveys, interviews, focus groups, ethnographies, contextual inquiry	*Themes *Specification document *User model(s)
Action Planning	Plan on how to solve problem	Participatory design sessions	*Requirements document
Action Implementation	Build vertical prototype	Paper prototyping	*Low-high fidelity prototype
Evaluation	Evaluate design against requirements	Formative evaluations	*Usability issues
Phase II	**Purpose**	**Key Activities**	**Outcome**
Analysis	Analyze users and context from technical stand point.	Data analysis from phase I	*Revised user models
Action Planning	Identifying system and user requirements	Requirements analysis	*Revised specification document
Action Implementation	Develop more functionality into the prototype	Coding	*Hi-fi prototype
Evaluation	Evaluate prototype(s) against requirements	Formative evaluations, semi structured interviews, focus groups, surveys, etc.	*Reflections on use *Frameworks
Phase III	**Purpose**	**Key Activities**	**Outcome**
Analysis	Analysis of prototype use in context	Analysis of evaluation results from phase II	*Final design specification
Action Planning	Plan on how to make final prototype improvements	Final requirements analysis	*Identify design compromises
Action Implementation	Re-design prototype as appropriate	coding	*High fidelity prototype
Evaluation	To further evaluate a more robust prototype in the field	Using our evaluation framework (interviews and Surveys followed by card sorts and Laddering)	*Reflections on use *Values *Theory development

These techniques offer a triangulation and are sequenced in such a way that the end result is values generated from evaluating technology use. The card sorting methodology generated lots of rich data. It provided both quantitative (categorization of cards) and qualitative (explanations of categorizations) data. Chapter five presented the data in a fashion that is representative of this and provides the essential elements of the analysis. In order to understand participants' values, a technique called laddering was then introduced after the card sort exercises were completed. This technique has been adopted in marketing to represent the influences of products on consumers. It may be that these values are the ones that the users' feel the strongest sense that the designers' address during the design or evaluation process.

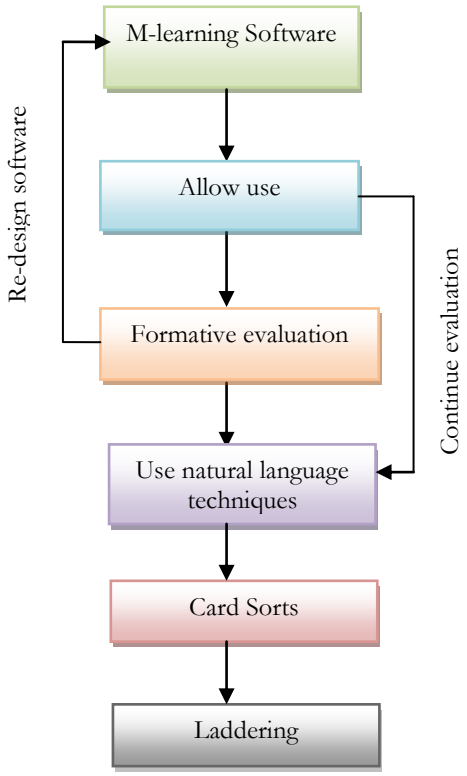


Figure 6-1: A practical framework for evaluating mobile learning software

6.5 Future research directions

Building upon our work, we suggest three main directions for future work: longitudinal evaluation of MLCAT; further development and validation of the podcast information ecology and extended use of the practical guidelines to design and evaluate m-learning applications. This study has opened up avenues for empirical investigation of podcasting in developing HEIs. Since podcasting is a highly individual phenomenon, there is a clear need for follow-up studies.

The longitudinal evaluation of MLCAT studies would be carried out over a one year period or longer using a triangulation of data collection methods as in Chapters four and five. As one of the main efforts of the thesis have been focused on development a podcast information ecology model, it has not been possible yet to use it by researchers and practitioners in the field of mobile learning. A next step in the coming research would be to offer the framework and its application to a number of initiatives in order to study how they use it and what feedback they can offer. This should be followed by a more extensive study where the effects of using the framework are investigated.

In addition to these studies, there is need for extended use of the practical guidelines for the design and evaluation of m-learning applications by researchers and practitioners in order to validate and further improve them.

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APPENDICES

Appendix A – Ethics Clearance

	RESEARCH ACCESS TO STUDENTS	DSA 100

NOTES

1. This form must be completed by applicants that want to access students for the purpose of research. Attach your research proposal.
2. Return Completed application forms to: Moonira.Khan@uct.ac.za; or deliver to: Attention: Executive Director, Department of Student Affairs, North Lane, Steve Biko Students' Union, Room 7.22, Upper Campus, UCT.
3. The turnaround time for a reply is approximately 10 working days.
4. NB: It the responsibility of the researcher/s to apply for ethical clearance to the relevant (a) Faculty's 'Research in Ethics Committee' (RiEC), and (b) to the Executive Director, HR to access staff for research purposes.
5. For noting, a requirement of UCT is that items (1) and (4) apply even if prior clearance has been obtained by the researcher/s from any other institution.

SECTION A: PERSONAL DETAILS

Position	Staff / Student Reference No	Title and Name	Contact Details
Student Number	MGWRAY002	MR. Raymond Mugwanya	0791927506
Academic / PASS Staff Number			
Visiting Researcher – ID No.			
Contact details of faculty officer for inquiries		Prof. Gary Marsden	021 650 2666
University / Institution at which employed / or a registered student	University of Cape Town	Address if not UCT:	
Faculty and Department	Department of Computer Science, Faculty of Science		
Division / School / Unit			
APPLICANTS DETAILS	Title and Name	Tel.	Email
	MR. R Mugwanya		Ray.mugwanya@gmail.com

SECTION B: SUPERVISOR DETAILS

Position	Title and Name	Tel.	Email
Supervisor	Prof. Gary Marsden	650 2666	gaz@cs.uct.ac.za
Co-Supervisor			
Co-Supervisor			

SECTION C: APPLICANTS STUDY FIELD AND TITLE OF RESEARCH PROJECT / STUDY

Degree	Ph.D Computer Science
Research Project / Title	Software Support for Creating Mobile Content for Education
Research Proposal attached	Yes [X] No [ ]
Target population	Students
Lead Researcher details	Raymond Mugwanya; Dept. Of Computer Science, UCT; ray.mugwanya@gmail.com
Research Methodology and Informed consent:	Qualitative and Quantitative research
Ethical clearance status	

SECTION D: APPROVAL STATUS - FOR ACCESS TO STUDENTS FOR RESEARCH PURPOSE
(To be completed by the ED, DSA or Nominee)

APPROVAL GRANTED	Ref. No.: *MGWRAY002*	Yes [■] No [ ]	Comments	
APPROVED BY	Title and Name	Designation	Signature	Date
	Ms Moonira Khan	*Executive Director Department of Student Affairs*		*29/09/ 2010*

Appendix B – QUIS Questionnaire

Please circle the numbers that most appropriately reflect your impressions about using this computer system.

	Distantly closely
1. Terminology relates to task domain	0 1 2 3 4 5 6 7 8 9 10 NA
	Confusing clear
2. Instructions describing tasks	0 1 2 3 4 5 6 7 8 9 10 NA
	Never always
3. Instructions are consistent	0 1 2 3 4 5 6 7 8 9 10 NA
	Distantly closely
4. Operations relate to tasks	0 1 2 3 4 5 6 7 8 9 10 NA
	Never always
5. Informative feedback	0 1 2 3 4 5 6 7 8 9 10 NA
	Never always
6. Display layouts simplify tasks	0 1 2 3 4 5 6 7 8 9 10 NA
	Confusing clear
7. Sequence of displays	0 1 2 3 4 5 6 7 8 9 10 NA
	Never always
8. Error messages are helpful	0 1 2 3 4 5 6 7 8 9 10 NA
	Confusing clear
9. Error correction	0 1 2 3 4 5 6 7 8 9 10 NA
	Difficult easy
10. Learning the operation	0 1 2 3 4 5 6 7 8 9 10 NA
	Overwhelmed are respected
11. Human memory limitations	0 1 2 3 4 5 6 7 8 9 10 NA
	Discouraged encouraged
12. Exploration of features	0 1 2 3 4 5 6 7 8 9 10 NA

13. Overall reactions

Terrible wonderful
0 1 2 3 4 5 6 7 8 9 10 NA

Frustrating satisfying
0 1 2 3 4 5 6 7 8 9 10 NA

Uninteresting interesting
0 1 2 3 4 5 6 7 8 9 10 NA

Dull stimulating
0 1 2 3 4 5 6 7 8 9 10 NA

Difficult easy
0 1 2 3 4 5 6 7 8 9 10 NA

Appendix C – Student Survey on the use of ICTs for education

You can help us learn more about the use of technology for instructional purposes by completing this survey. Your participation is voluntary and your course grade will not be affected if you do not participate in the survey. The information you provide will remain **STRICTLY CONFIDENTIAL**. The survey responses will be aggregated and only a summary will be reported. The results will be used only for research purposes to determine the status of podcasting. Please provide as accurate and honest an answer as possible to each question. Please return the completed survey form as instructed.

1. Which of the following technologies do you own? (T**ick all that apply**)

- Personal computer (desk top or laptop)
- Handheld computer or PDA
- iPod/MP3
- Cell Phone (Please indicate **make, model and storage capacity** i.e. Nokia N95, 8GB)

  _____
- Other handheld device (Specify_____)

2. What technologies do you use at home? (I.e. Personal Computer, Laptop, Mobile phone, iPad, etc.)_____
_____
_____
_____

3. Can you always find a PC at to work at the International University of East Africa?

☐ Always or often ☐ usually ☐ rarely ☐ never

4. How often do you use the following technologies for school assignments or other academic work? **(Tick all that apply)**

	Never	Rarely	Sometimes	Often
a. Personal computer for assignments, projects	1	2	3	4
b. Handheld computer or PDA for assignments, Projects, or presentations	1	2	3	4
c. iPod/MP3 for listening to course materials	1	2	3	4
d. Internet for finding information or research	1	2	3	4
e. Cell Phone for accessing course materials	1	2	3	4
f. Use a computer or other electronic resources for Research (i.e., to access lectures recordings)	1	2	3	4

5. Please rate your confidence in the following areas. **(Circle one number for each)**

	Very Little				A great Deal
a. Using the internet or library search engine for research	1	2	3	4	5
b. Using a hand-held, PC or laptop to take class notes	1	2	3	4	5
c. Using PC software to complete class assignments	1	2	3	4	5
d. Downloading course material to Personal Computer/iPod/MP3 player	1	2	3	4	5
e. Completing interactive lessons using wireless access (i.e. cell phone)	1	2	3	4	5

6. What is your understanding of Podcasts? (**Describe in your own words**)
_____
_____

7. Do you normally access your lecture podcasts in digital form (i.e. text, audio, video, etc)? **(Please tick one)**

☐ Yes ☐ No ☐ Don't Know

8. If you answered **yes** in 7. Above, how do you access the podcasts? (I.e. Cell phone, laptop, PC, etc.)(**Briefly describe**)
_____
_____
_____

9. What challenges do you face when accessing this content?
_____
_____
_____

10. How much time do you devote to each of the following activities for this course? **(Fill in a Number for each activity)**

a. Completing written assignments: _____ hours per week outside of class

b. Reading: _____ hours per week outside of class

c. Memorizing material: _____ hours per week outside of class

d. Group work Discussions with others: _____ hours per week

11. Since the beginning of the semester, how often have you downloaded lecture podcasts or other course material to a computer, iPod/MP3 or Cell Phone to study? **(Check one)**

- ☐ Never
- ☐ Once or twice this semester
- ☐ Once or twice a month
- ☐ Once or twice a week
- ☐ Several times a week or more

12. If you used the podcasts for this course less than once a week, what were the reasons that you didn't use them more often? **(Tick all that apply)**

- ☐ I didn't have a PC, iPod, or MP3 player to listen to them.
- ☐ I don't know how to download them.
- ☐ I didn't think they would help me.
- ☐ I don't have time to download and use them.
- ☐ Other (specify: _____)

13. Would you be more likely to enroll in a course if lecture podcasts and other course materials were available for the class? **(Tick one)**

- ☐ YES
- ☐ NO
- ☐ Not sure/Don't know

16. To what extent does the availability of podcasts and other course materials affect the following things? **(Circle one number for each item)**

	Very little				A great deal
a. Increase the amount of time you studied	1	2	3	4	5
b. Decrease the amount of time you studied	1	2	3	4	5
c. Make learning the material easier	1	2	3	4	5
d. Make it easier to complete assignments	1	2	3	4	5
e. Make it easier to get feedback from teachers	1	2	3	4	5

17. If podcast lectures were made available, would you access them using your mobile phone?

- ☐ YES
- ☐ NO
- ☐ Other (Please Explain)_____

18. If you were to access lecture podcasts on your cell phone, how would you want to do this?

- ☐ Via Bluetooth
- ☐ Via WIFI
- ☐ Other (Please Explain)_____

19. What is your programme of study (i.e. B. Com Accounting)?

_____

20. What is your academic year? **(Tick one)**

- ☐ Year 1
- ☐ Year 2

- ☐ Other (specify: _____)

21. What is your age group? **(Tick one)**
    - ☐ 18 years or under
    - ☐ 19 - 20 years
    - ☐ 21 to 25 years
    - ☐ 26 to 29 years
    - ☐ 30 years or older

22. What is your gender? **(Tick one)**
    - ☐ Male
    - ☐ Female

Thank you for taking the time to fill out this questionnaire. **"It is not mandatory to indicate your name in the space below"**. Any comments you make will be treated by me in the strictest of confidence, regardless of whether you leave your name or not.

Full Name……
Contact……

If you'd like to volunteer to be interviewed, and get the chance to express your feelings and ideas on using cell phones to access and interact with podcasts in greater depth, please contact **ray.mugwanya@gmail.com**

Appendix D – Semi-structured Qualitative Interview on the use of podcasting systems

We are conducting a study on the use of podcasting systems by academics and students respectively. The purpose is to identify opportunities, understand the challenges and evaluate MLCAT - a lecture podcasting tool. The responses will be treated with ***"Strict Confidentiality"*** and only used for academic purposes.

A. Demographics

1. Age: ☐ 17 - 24 ☐ 25 - 32 ☐ 33 – 40 ☐ 41 – 48 ☐ 49+

2. Gender: Male ☐ Female ☐

3. Position: Prof ☐ A/Prof ☐ Senior Lecturer ☐ Lecturer ☐

4. Years of Teaching: 1-3 ☐ 3-5 ☐ 5+ ☐

5. Experience using Computers: Basic ☐ Intermediate ☐ Advanced ☐

6. Highest Academic Qualification: PhD ☐ MSc ☐ BSc ☐

7. Courses taught and year of study?

.....

.....

Podcasting use (Experience)

1. How do you normally present lecture podcasts to students?

2. Are there any tools involved? Which ones are they and what are the challenges? Why? Can you please tell me what you are thinking about? Why???

3. In what media form (i.e. text, audio, video, etc.) are lecture podcasts made available to students? Why is this? What are the challenges?

4. What do you understand by Podcasting?

5. Are there any opportunities from podcasting available to students? What are these? What about the challenges?

6. If you were to make podcasts available to students, in what form would they be?? Why??

7. What aspects of your course would you be interested in recording?

8. On which access devices would this content be appropriate/well accepted? Do you think if the content was made available on their mobile phones, they would access it?

Appendix E – Faculty post-system semi-structured Interview on authoring of podcasts by faculty and their use by students

We are conducting a study on the authoring and use of podcasts lecturers by academics. The purpose is to identify opportunities, understand the challenges and evaluate MLCAT - a content authoring system. The responses will be treated with ***"Strict Confidentiality"*** and only used for academic purposes.

Podcasting use (Experience)

1. Could you imagine yourself using the podcasting application in your day to day work as a lecturer? Yes/No

   Why do you feel this way?

_____
_____

2. How can you change the application to make it more useful?

_____
_____

3. What factors would influence/affect your decision in using such a podcasting tool?

_____
_____

4 (a) List the aspects of the lectures that you recorded. Why do you think these were the most interesting?

_____
_____

(b) What would a typical lecture podcast look like?

_____
_____

5. How long were these podcasts? What formats were they? Over how many PowerPoint slides did you record audio over? _____

6. What did you do with the podcasts you made? How were they delivered to students? Do you think this is an ideal delivery method?_____

7. Are there any challenges you have encountered? How did you overcome these challenges?_____

8. Do you feel that the total time taken to complete a recording is too long for what it is worth? Yes/NO?

Please give reasons

_____

_____

9. Would you consider this type of system for your day to day activities as a lecture? YES/NO

If Yes, what would be the selling point of this podcasting tool?

_____

_____

If No, what changes would you make to the Lecture recording tool?

_____

_____

10. What were your initial expectations?_____

Have these expectations been met? How?

Demographics

Age: 17 - 24 ☐ 5 - 32 ☐ 33 – 40 ☐ 41 – 48 ☐ 49+ ☐

Gender: Male ☐ Female ☐

Position: Prof ☐ A/Prof ☐ Senior Lecturer ☐ Lecturer ☐

Years of Teaching: 1-3 ☐ 3-5 ☐ 5+ ☐

Experience using Computers: Basic ☐ Intermediate ☐ Advanced ☐

Highest Academic Qualification: PhD ☐ MSc ☐ BSc ☐

Courses taught and year of study?_____

END!!!

Appendix F – Focus group I (Student use of podcasts)

- What does mobile learning or podcasting mean to you?
- Tell me about the last time you interacted with mobile learning content or Podcasts?
- How did you access this lecture content? How often did this happen?
- Tell about when you made use of this content (i.e. at Home, on the train, at TSiBA, etc.). Why was this?
- Do you access this content off-campus? How does this happen? Why?
- What systems did you use? Tell me more about these systems?
- How well do the current systems work? Have you encountered any challenges? How did you overcome these? Any suggestions for possible improvements?
- Are there any other forms of lecture content delivery at TSiBA? Tell me more about these?
- How would you feel about accessing lecture content on your mobile devices? Why?
- How much content do you think you would handle at any given time?
- What do you think should be done to improve access to lecture content?

Appendix G – Focus group II (Student access to lecture podcasts)

- Were you able to access the podcasts? How did you do this? What challenges did u face? How did you overcome these?
- Are there any preferences to the technologies used?
- How did you download these podcasts onto your mobile device?
- How often did this happen? Why was this?
- Did the availability of these podcasts affect your attendance? If so why?
- When did you consume this content (i.e. at home, school, etc.)?
- Was it of any value? Why?
- What can you say about the quality of the podcasts? Why is that?
- Where would you want to see changes proposed? Why? Tell me more about this?

Appendix H – Participatory Design

Phase 1 (10 Minutes)

Session A: Introduction to sessions

- Participatory design
- Paper prototyping (Show Examples)

Session B: Users present a set of **goals, risks and concerns** that they agree upon

- ✓ Think about the things you do most frequently as you prepare for lectures and during the actual presentation.

- ✓ Which ones are important? Group according to **"Most Important", "Moderately Important"** and **"Less Important".**

- ✓ List a set of questions regarding functionality, navigation and terminology to be used in our prototype

Phase 2 (30 Minutes)

Session C: Purpose is to translate user goals and questions into tasks using the sheets provided. The tasks will be used during usability testing

Phase 3 (30 Minutes)

Session D: Purpose is to explore creative side and design paper prototypes

- List interface elements needed to support the tasks
- Walk-through before ending session (Rehearsal of Usability test) to identify issues i.e. missing links, incomplete interfaces, usability problems, etc

Phase 4 (20 Minutes)

Session E: Conduct Usability test to identify issues and further refine prototype

Session F: conduct another walkthrough to document the prototype navigation through video recording

Appendix I – Card sort exercise on podcasting tool use

Please read this before completing the sorting exercise and the attached form.

There is a general lack of podcasting tools developed for use in developing world Higher Education Institutions, and this is one of the areas that are currently being researched. As part of this exercise, we are investigating perceptions of podcasting tool use and therefore would like to find out more about them.

We would be grateful if you could spare approximately ***30 – 45*** minutes of your time to complete the Sorting Exercise. We would like to point out that there is no right or wrong answer to sorting the cards or to the questionnaire, what we are interested in is your personal views.

Thank you for your time and co-operation!!

Instructions for Respondents on carrying out Card Sorts

The researcher will give you some cards to sort. Each card will have descriptive text on it. We would like you to choose a topic or "criterion" for sorting: use one criterion at a time and place the cards in groups or categories and name them. Each time you sort the cards, please tell us what the criterion was and what the categories were so that we can record this. Repeat the sorting until you cannot think of any more criteria. If you think you want to continue but have no more ideas, ask the researcher for help.

For example: if the task was sorting different pictures of **food** –

The **first criterion** might be "*taste*" and the groups might be "salty", "sweet", "bitter" etc.

The **second criterion** might be "*cost*", with the groups being "cheap", "medium", "expensive" and "very expensive".

The **third criterion** might be "*food which I eat*" and the groups "never" "sometimes", "often", etc.

You can choose any criteria you want and any groups you like (including "don't know", "not sure" and "not applicable"). The main thing is to use only one criterion in each sort – please don't put two or more together, for example, "cost and availability". If you're not sure about something, just ask.

Please Note: the cards are numbered only to help us record the results. The numbering is random, so please don't use that as a criterion for sorting!

Practice: The researcher will first give you a selection of cards to use so you can practice the procedure and answer any doubts you have. If you have any comments or questions, then please say, and we will do our best to help you. After that, when you are sure of the procedure, the researcher will start the experiment with the main set of cards.

Thank you for your help!!

Researcher's Script for demonstration of Card Sorts technique

For the practice card sort we will use these six text descriptions of houses: I will give you some examples of topics or criteria for houses and then I will sort them into groups or categories. After that you can do the same.

Let's say that the first topic or criterion is *"What is the house made of?"*, We can say for these cards, two or maybe three groups, " Wood", "Brick" and "Stone", what do you think?

The next topic could be, for example, *"Houses I would like to live in."* We probably have different opinions about this: I am interested in *your* opinion, so how would *you* sort them?

Now, can you suggest another topic for sorting?

Do you need help? (Dyadic elicitation)

Do you feel comfortable with this now or would you like to practice a bit more?

Then we'll continue with the main experiment.

Researcher's Script for introduction of main sort

I am now going to show you thirty three cards. Three are blank whereas thirty have text on your impression of using the lecture recording tool. All the text cards are about usability, desirability and perceptions of use.

You should think of a topic (or criterion) as you did in the practice and sort the cards into groups. When you are satisfied with each of your sorts, tell me *first* the names of the groups (or categories) and *then* the name of the topic or criterion, and then tell me the numbers of the cards in each group.

After that you can repeat the sorting process until you feel you have covered all of the topics you can think of. Do you have any questions at this point? Please take a little time to look at each of the cards and then when you are ready to start sorting, let me know and you can begin.

Other situations:

If you cannot think of a simple way to say something you can use a sentence to say it and I will use that as the name of the topic or group.

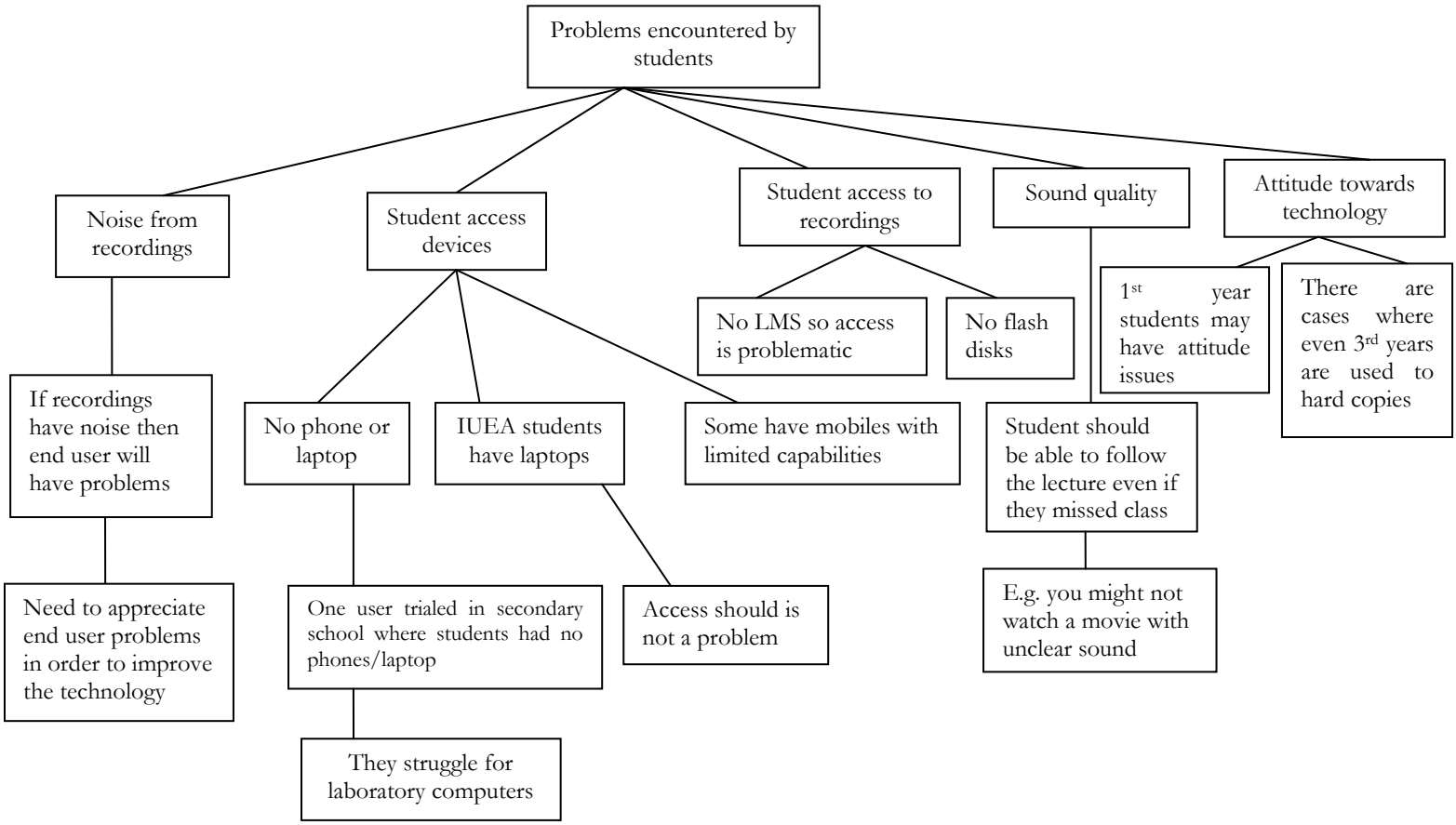
Please remember to use only one topic at a time – you can do another sort for the other topic later.

Do you want to continue, or have you done all that you can?

Appendix J – Laddering

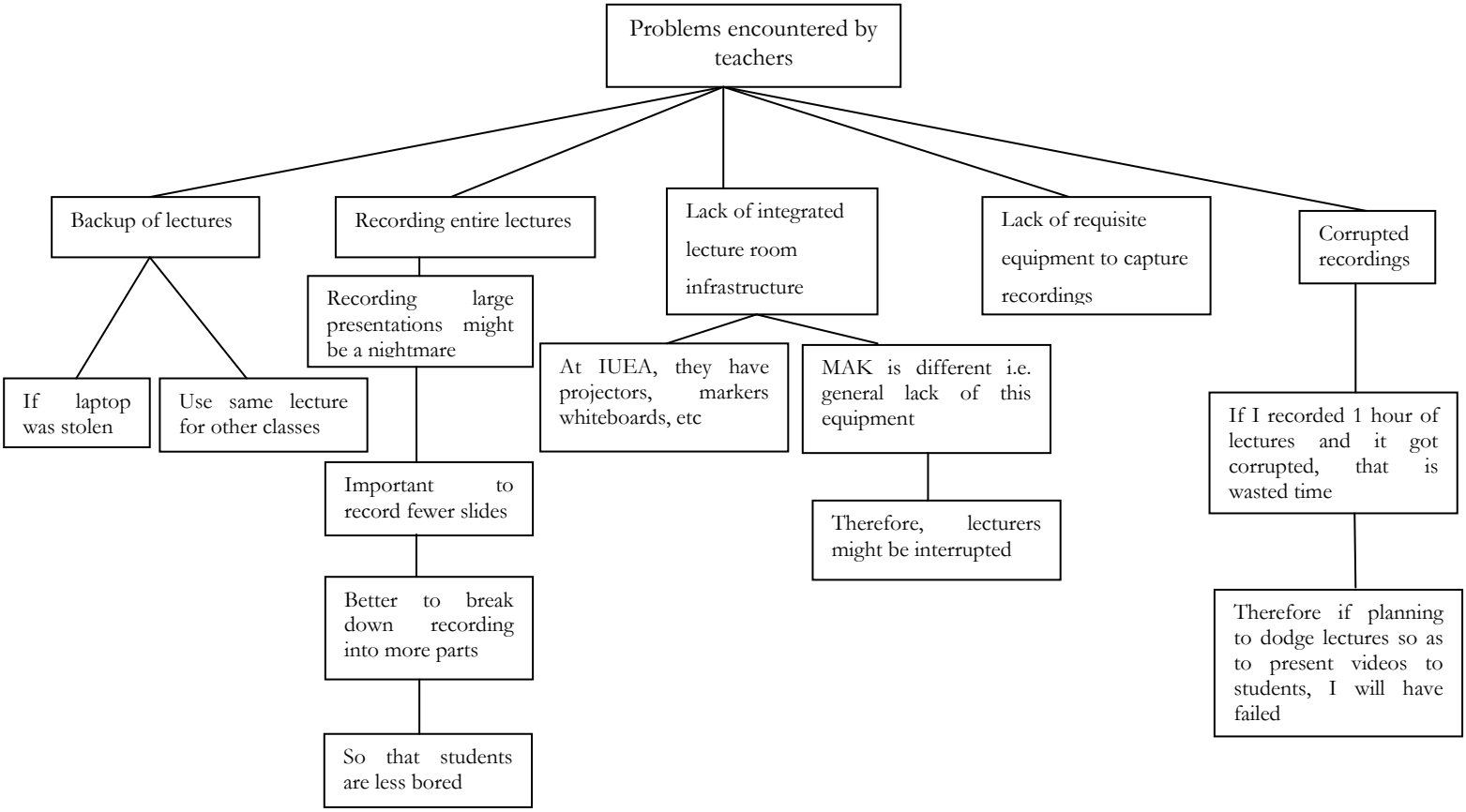
Respondent 1

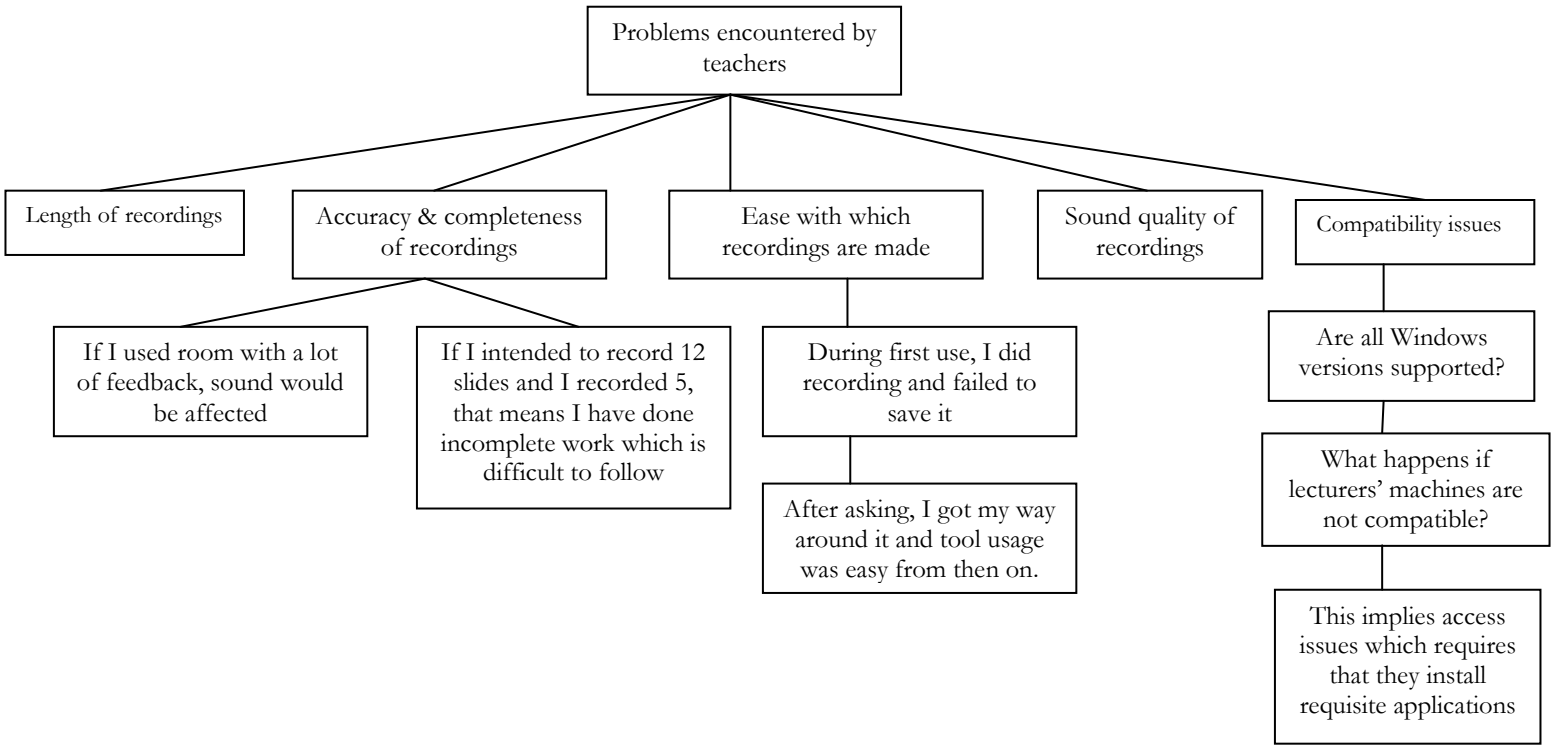
Construct 1 – Which problems were encountered by students?



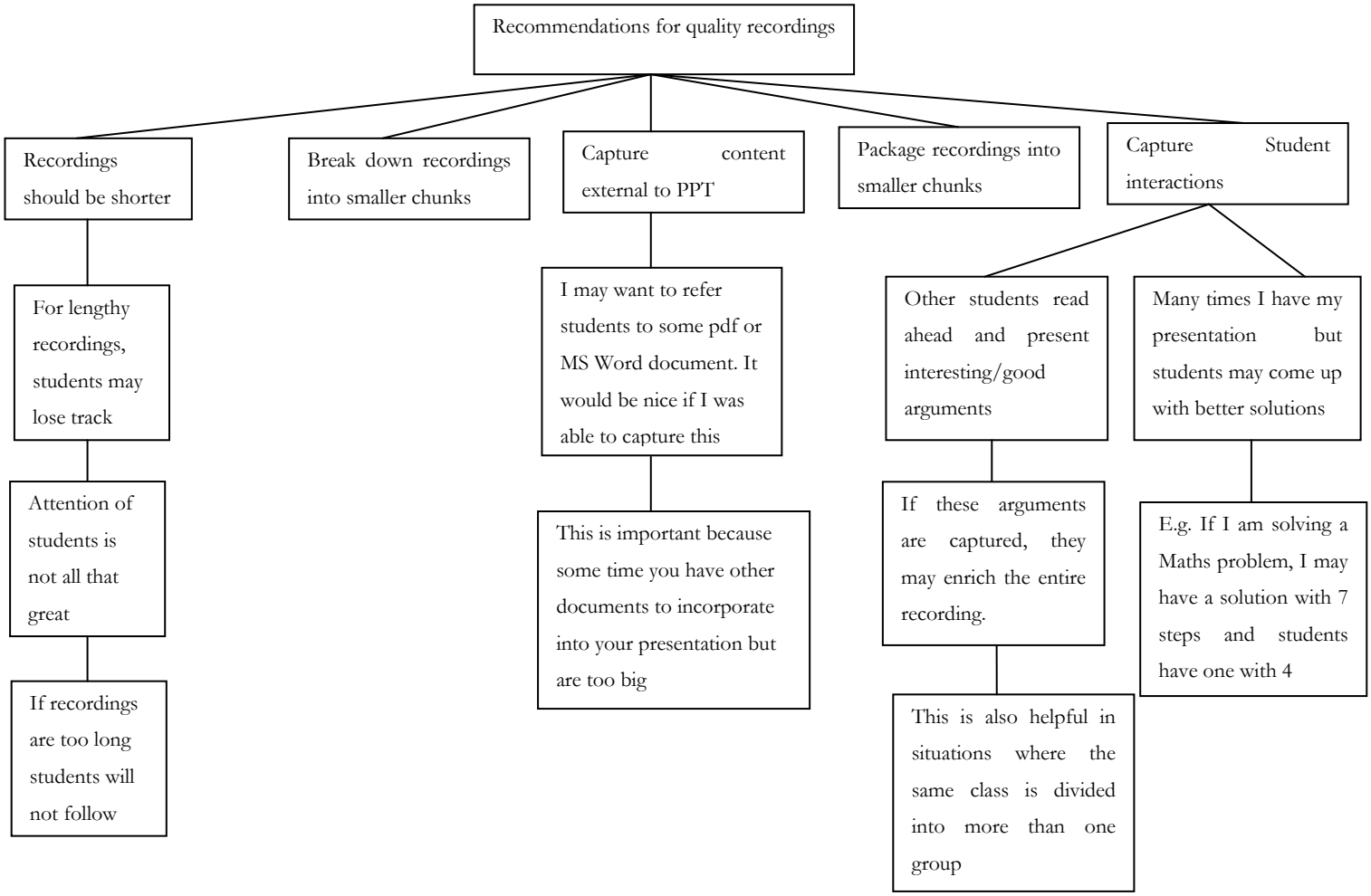
Respondent didn't group card 13 but instead added an extra card called "compatibility issues"

Construct 2 – Which problems were encountered by teacher?

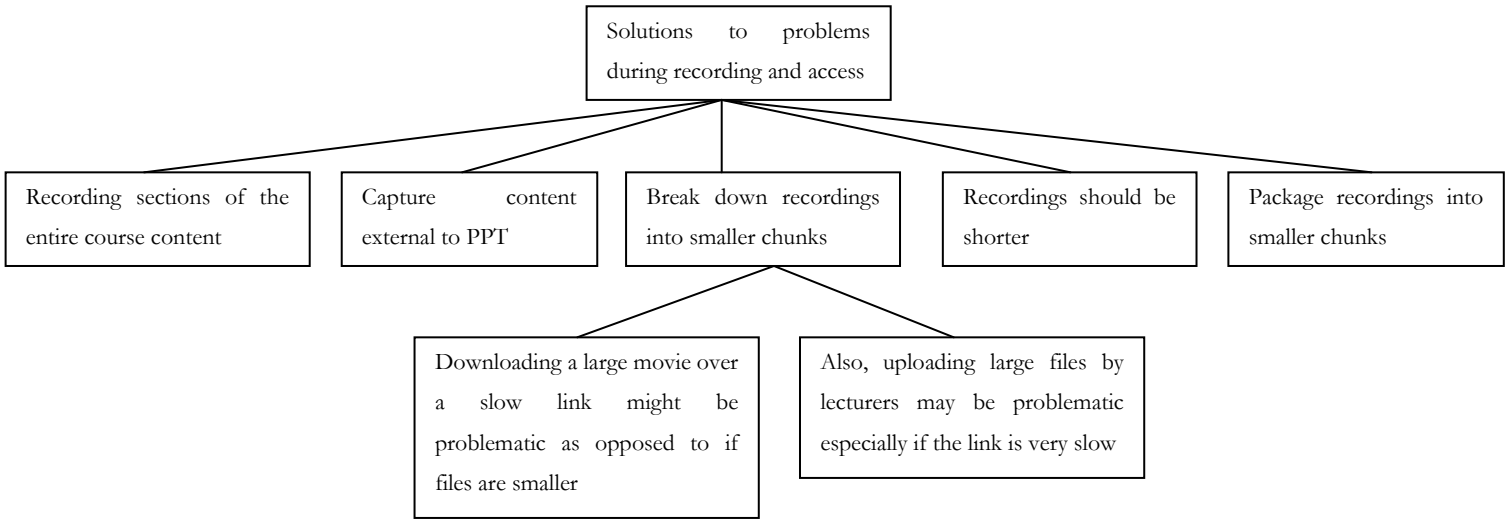




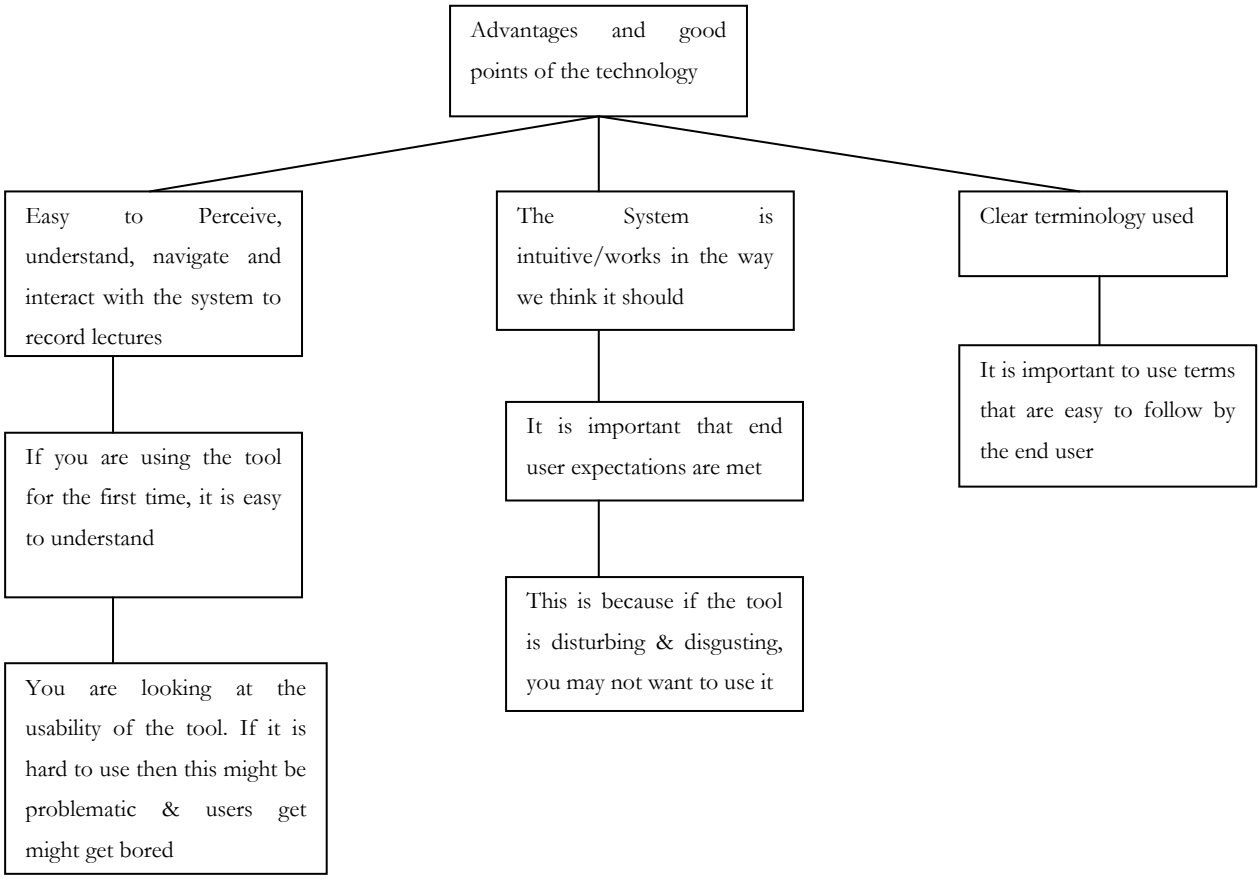
Construct 3: What are the recommendations to come up with quality recordings



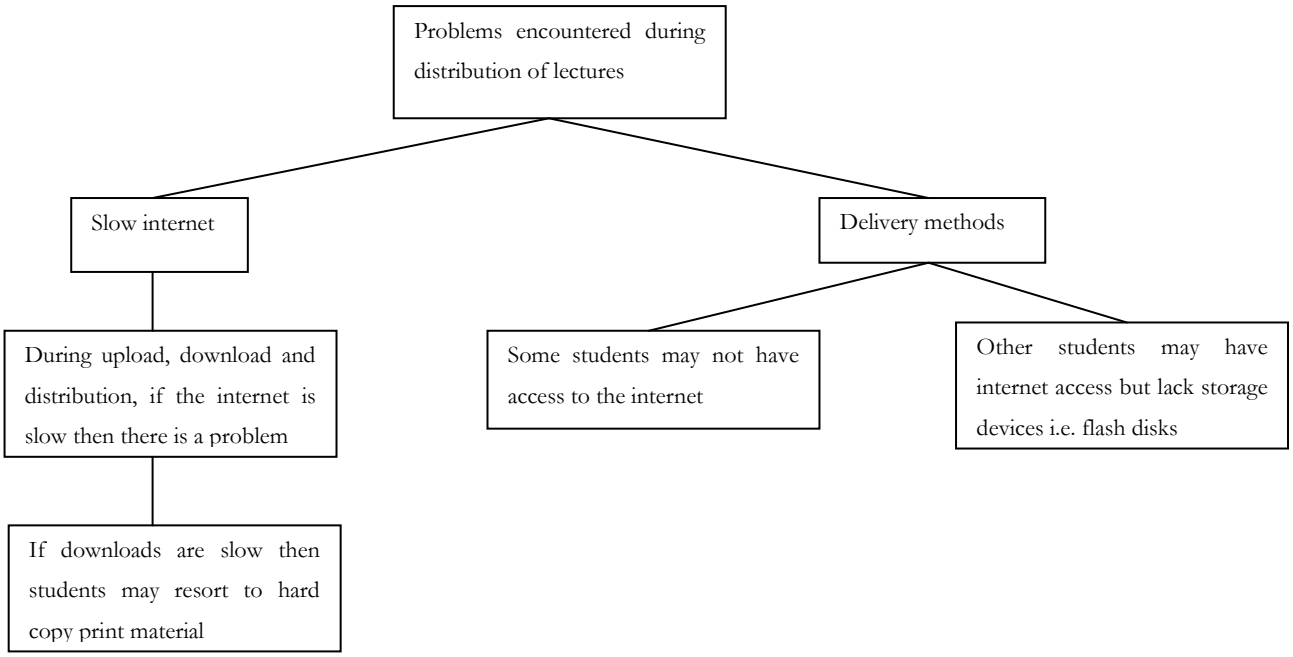
Construct 4: What are the solutions to problems encountered during recording by teachers and access by students



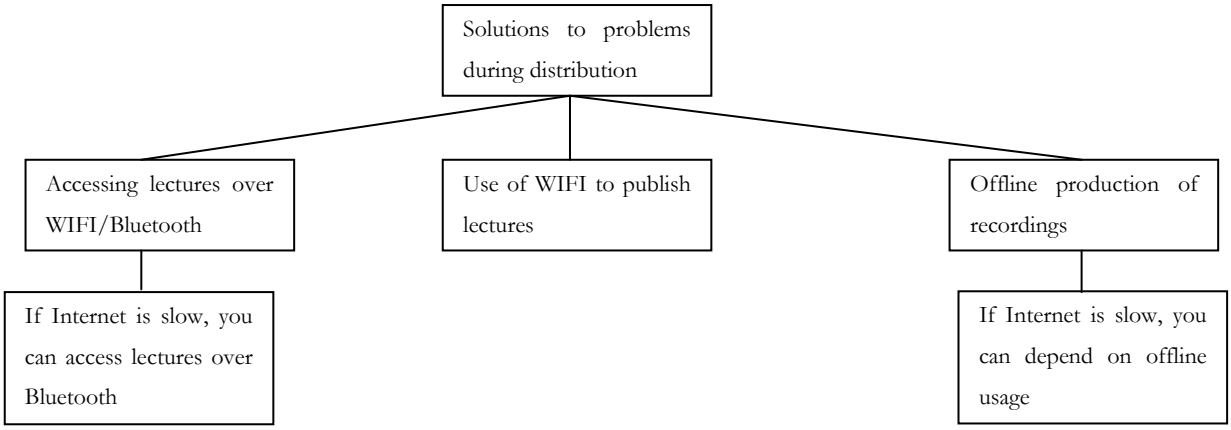
Construct 5: What are the advantages/good points about the technology



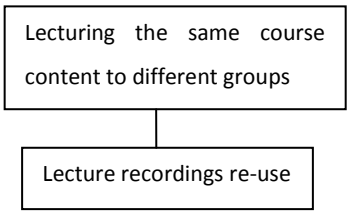
C6: What are the problems encountered during distribution of lectures



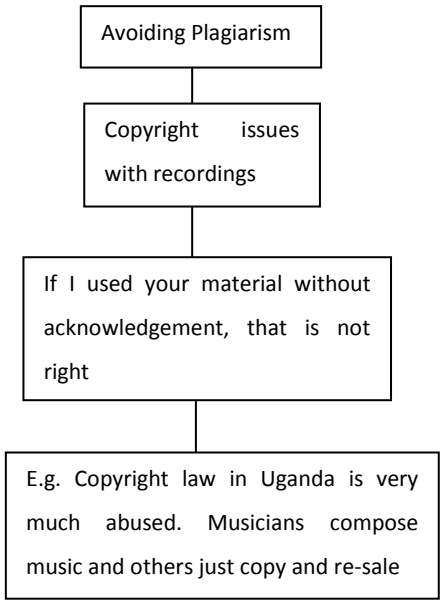
C7: What are the solutions to problems during distribution of lectures?



C8: Lecturing the same course content to different groups

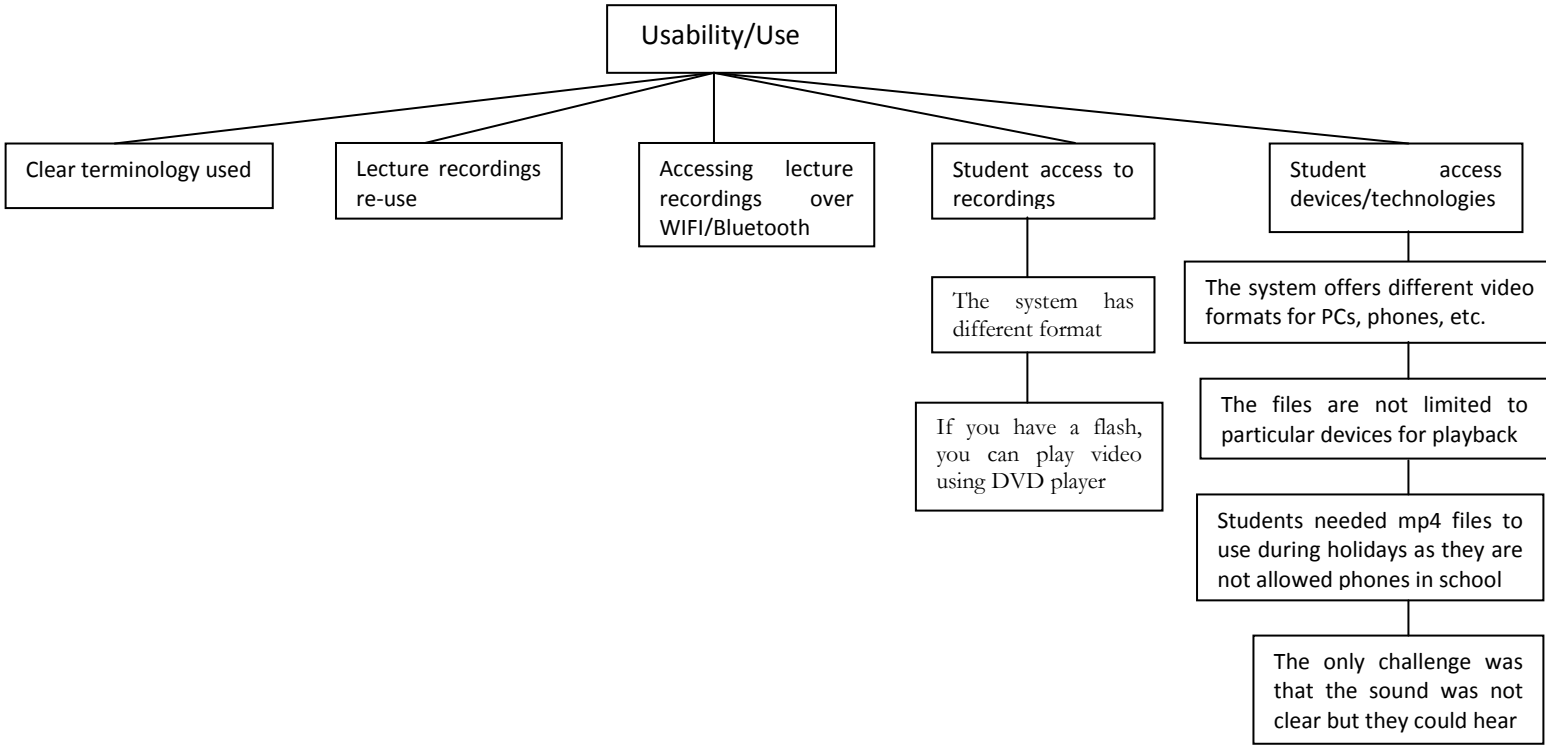


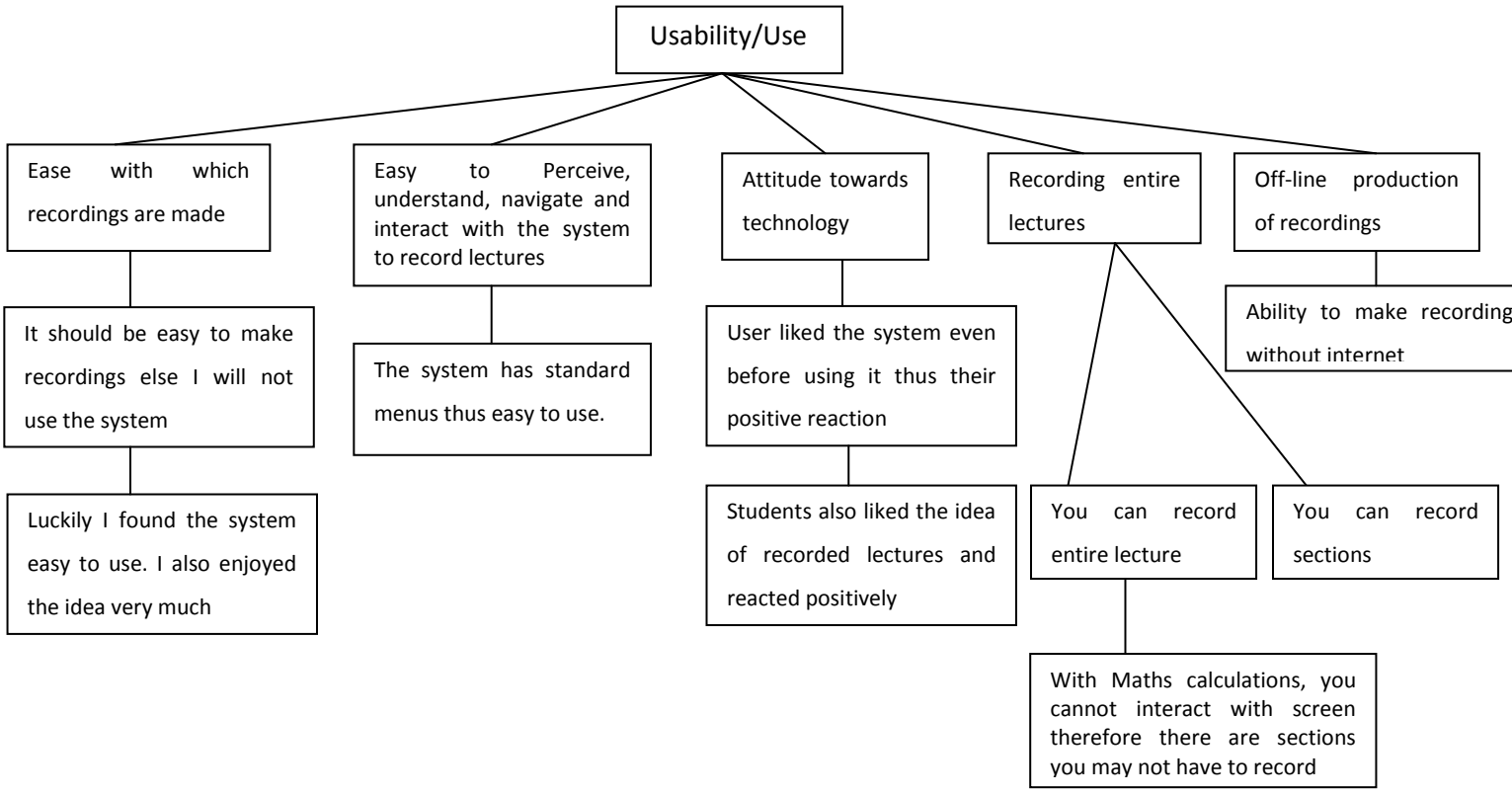
C9: Avoiding Plagiarism



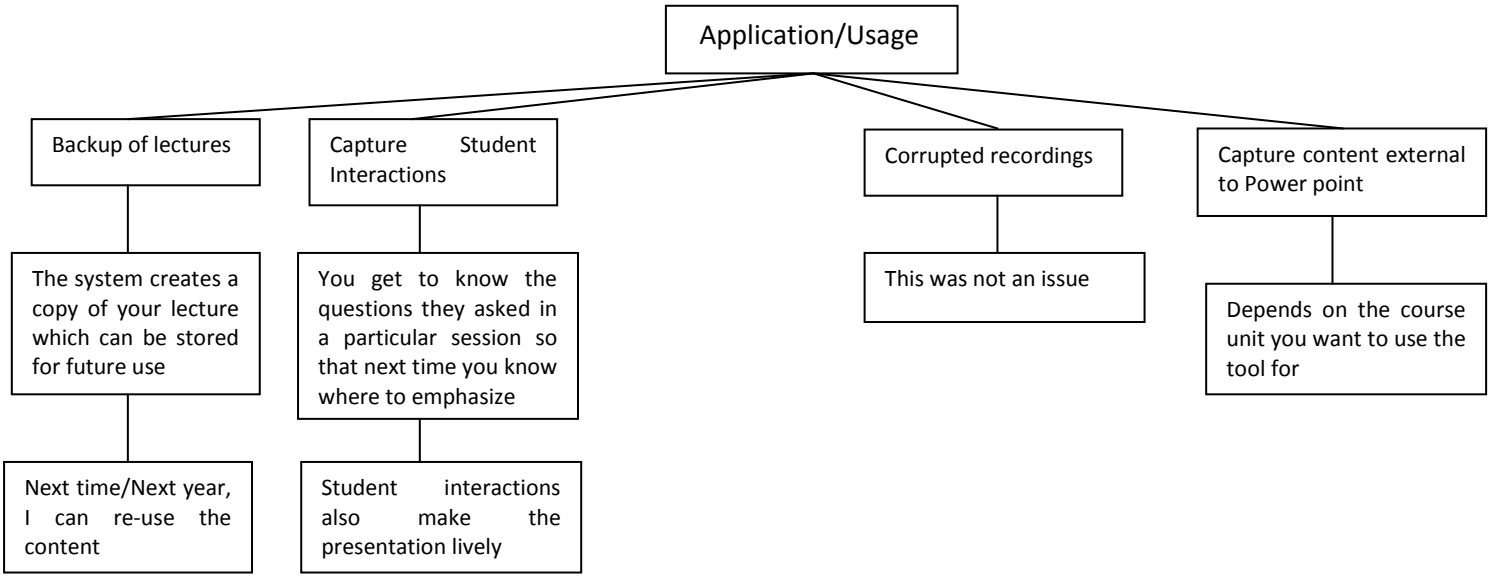
Respondent 2

C1: Usability/Use

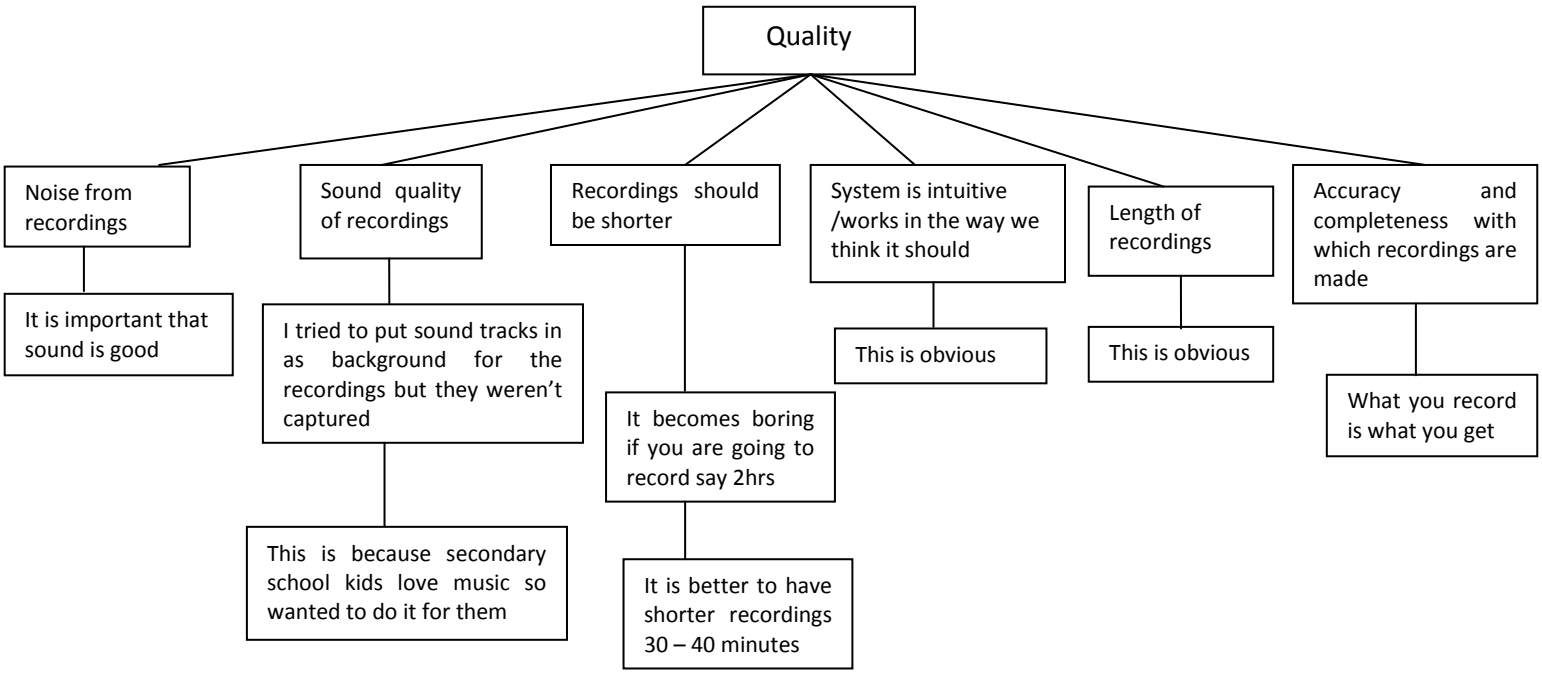




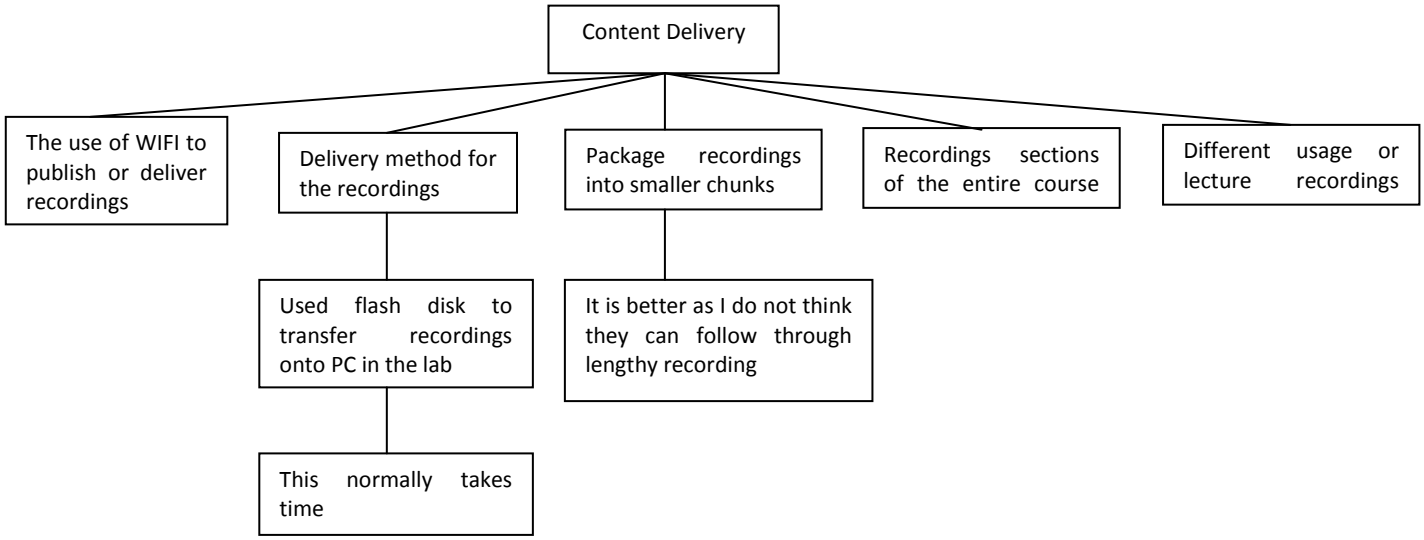
C2: Application/Usage



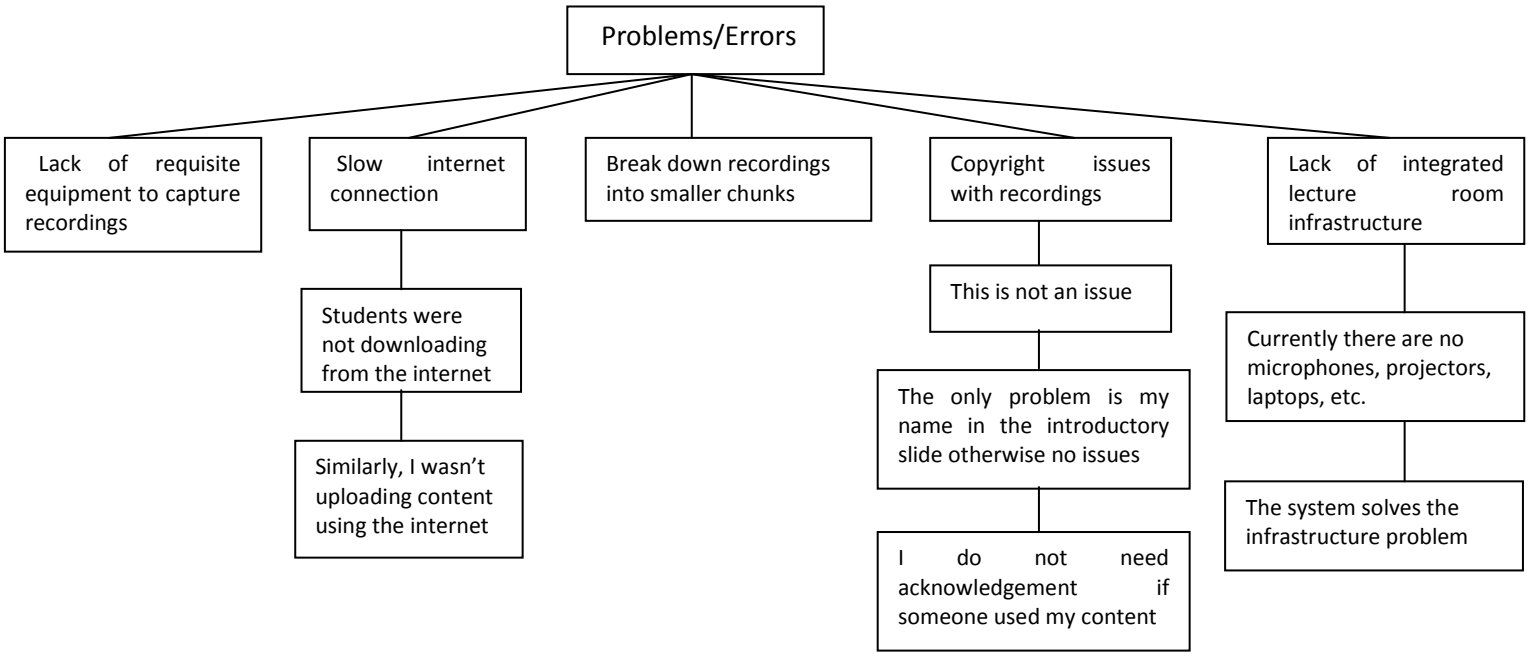
C3: Quality



C4: Content Delivery

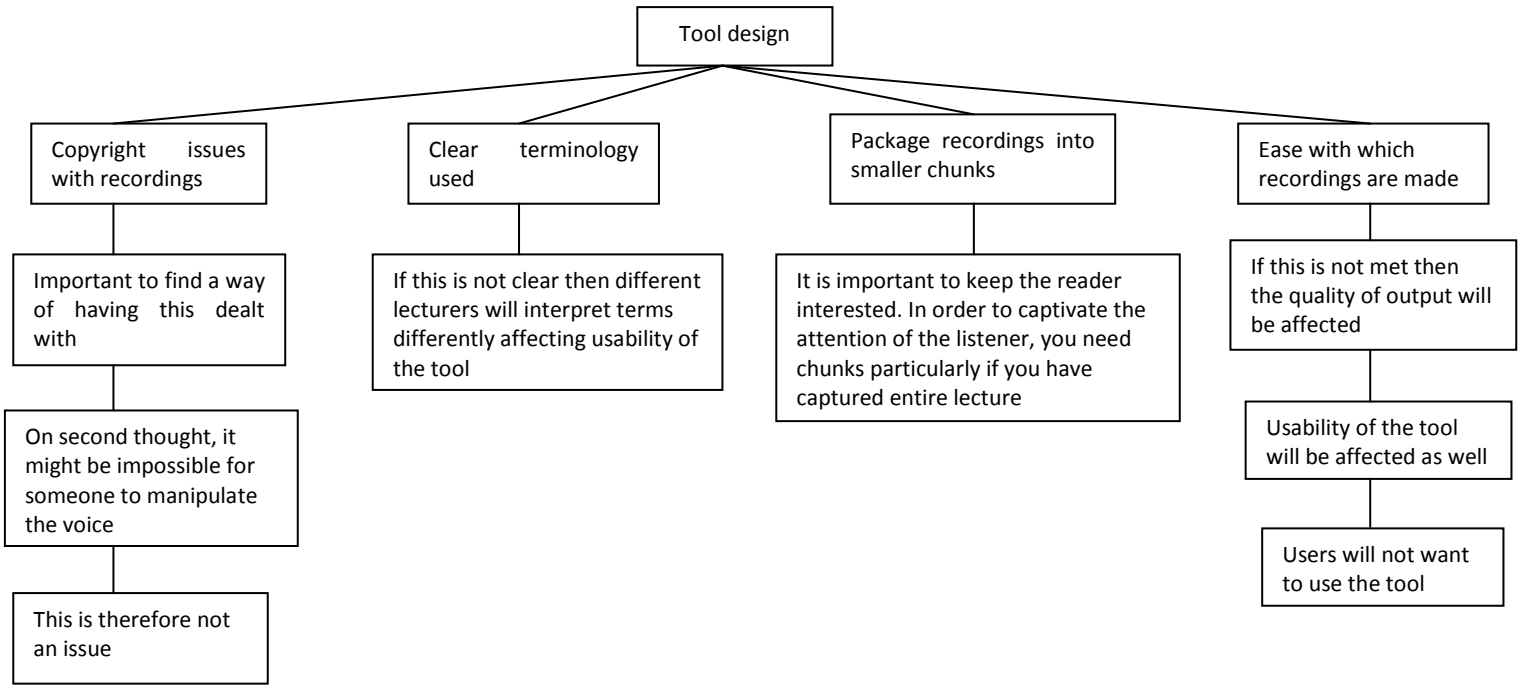


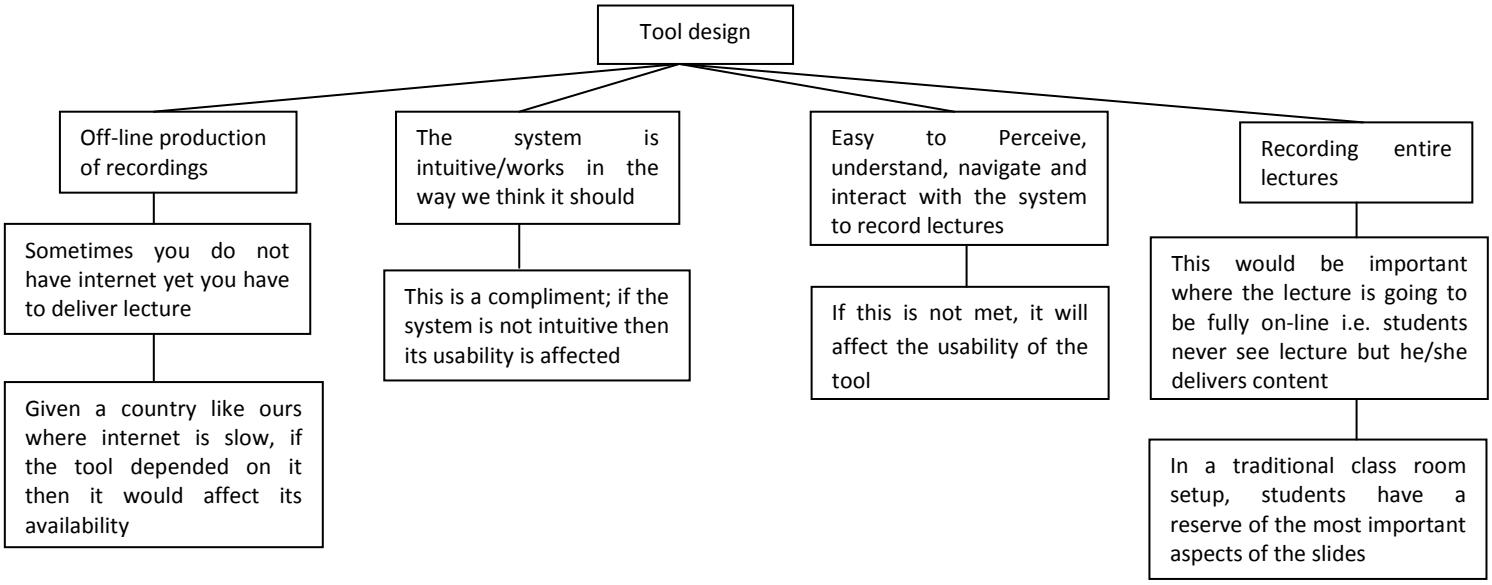
C5: Problems/Errors

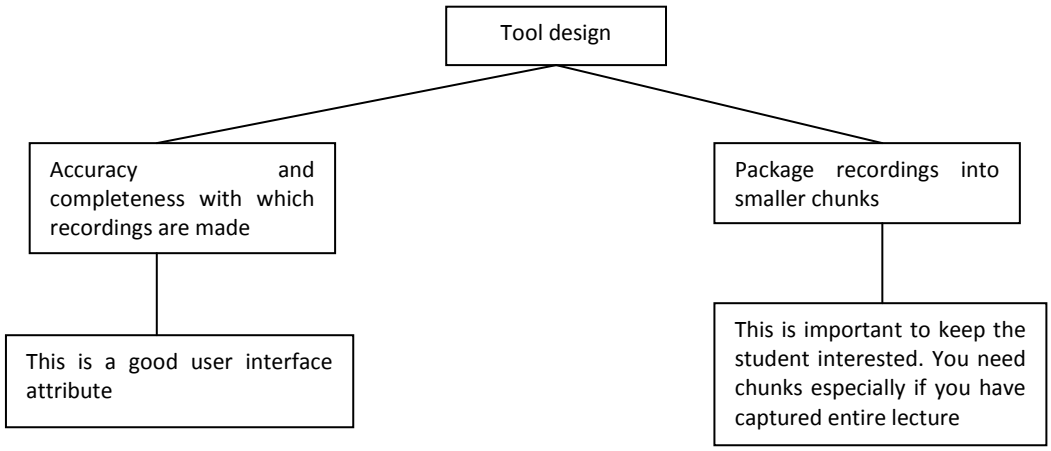


Respondent 3

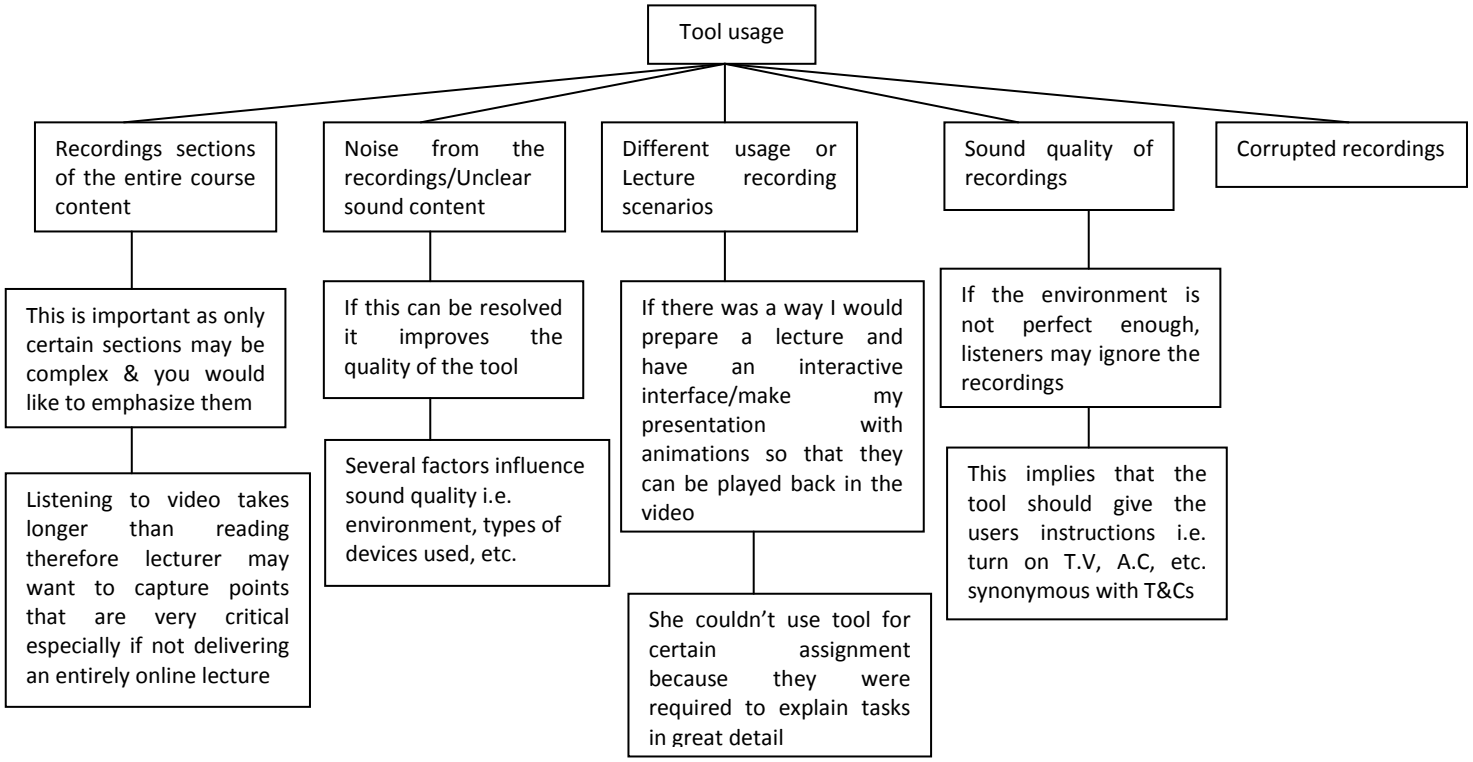
C1: Attributes associated with tool design

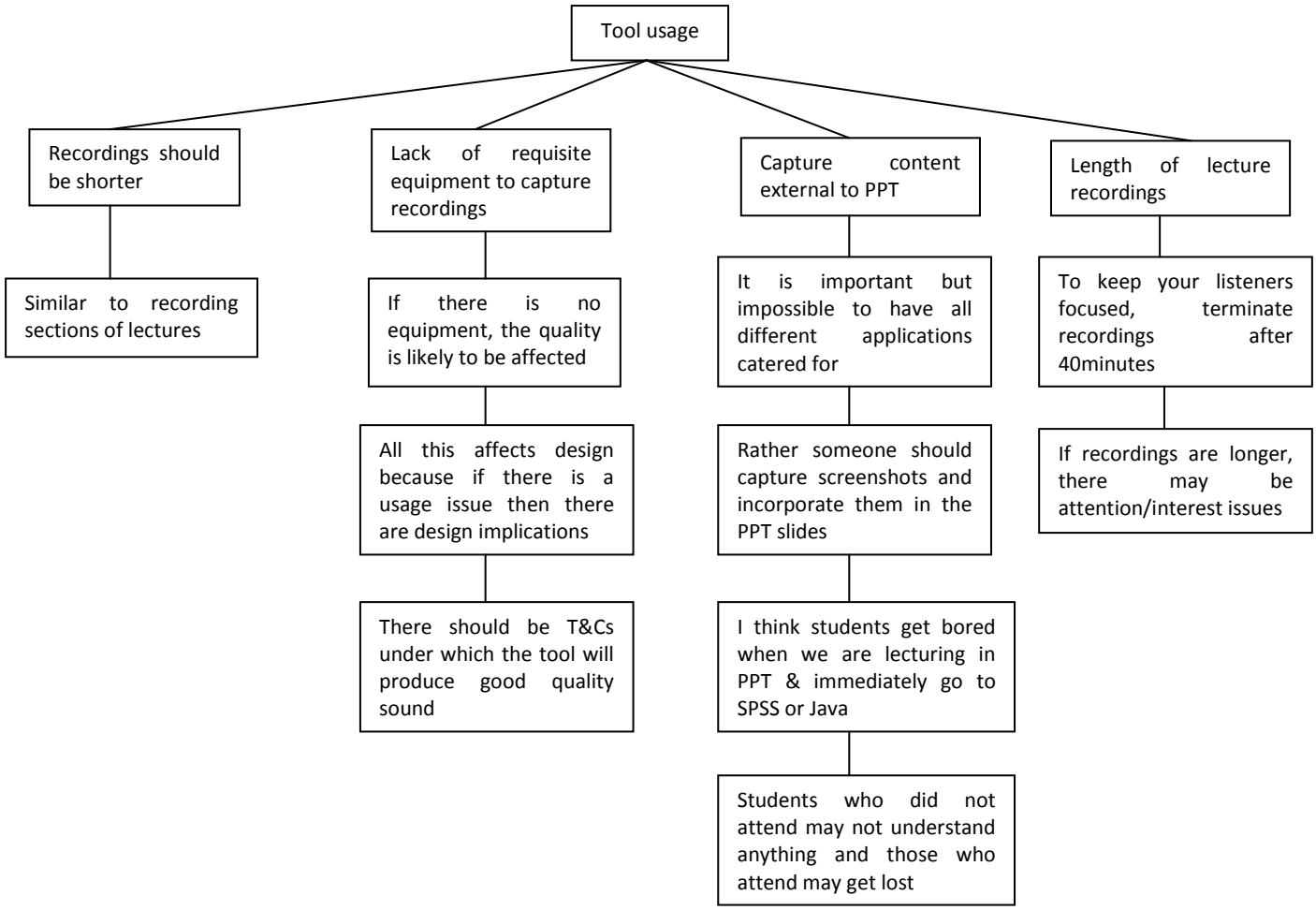




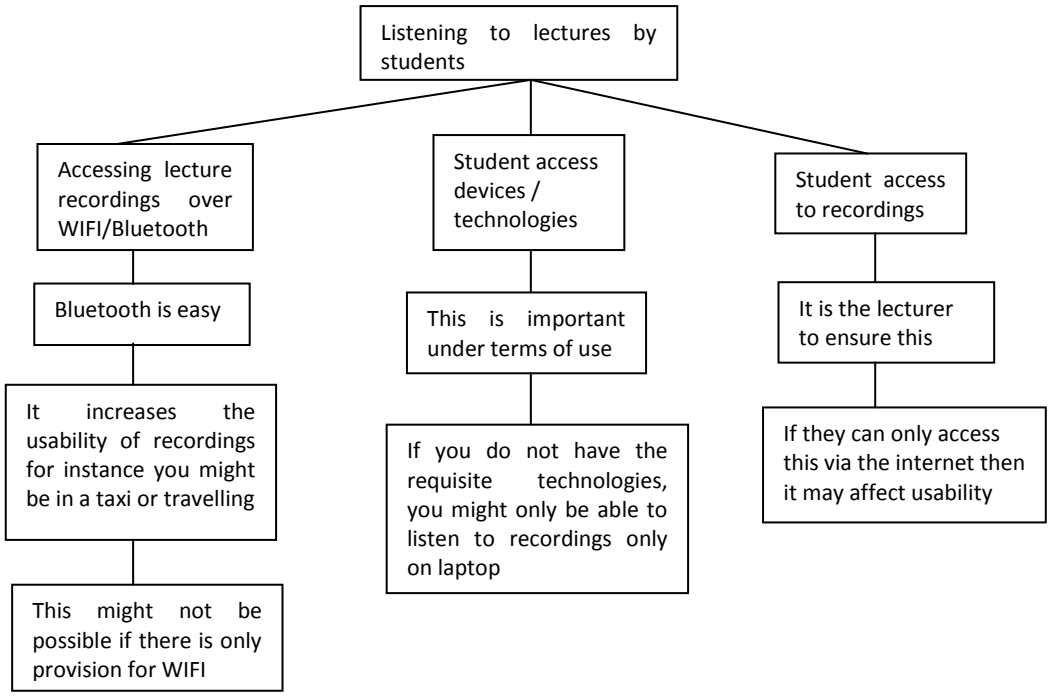


C3: Attributes associated with tool usage





C2: Attributes of tool during listening by students



C4: General qualities of the tool