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The use of ICT for Teaching and Learning in South African Higher Education Institutions

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INTRODUCTION

A shift towards new technologies in teaching and learning is considered part of the solution to addressing the changing learning needs of societies. It is also taken to be the answer to the need to do more with less. An example of doing more with less would be the potential to attract more students (Gultig, 1999), and serve these increasing numbers of students through the use of an Learning Management System (LMS) without increasing the number of educators, and without compromising the quality of teaching and learning (Mlitwa, 2005). In this case, e-Learning management system can be used by one educator and accessed by a much greater number of learners than would have been the case in the traditional classroom, simultaneously. Reasons according to Bates (2000: 8) include "*the changing learning needs of society*", "*the need to do more with less*" and "*the impact of new technologies on teaching and learning*".

The flexible capabilities of learning management systems (LMSs) have led to an increasing acceptance of web-enabled e-Learning tools among institutions of higher education globally in the early parts of the 21st century (Czerniewicz, et al, 2007). The University of the Western Cape (UWC) in South Africa, has completely moved to the Knowledge Environment for Web-based Learning (KEWL) as their e-Learning platform (UWC e-Learning, online; Angel, online). KEWL is an Open Source product that is available free to anyone who wishes to use it for educational, commercial or any other purpose (Beebe, 2003). The University of Cape Town (UCT) uses an open-source learning, collaboration and research content management system known as VULA (UCT, online) for similar purposes. Similarly, the Cape Peninsula University of Technology (CPUT) and the University of Stellenbosch (in South Africa) are using a proprietary learning management system known as WebCT and blackboard (CPUT, online; Stellenbosch, online) as an e-Learning platform to support teaching and learning processes, to mention just a few examples.

The reason is that e-Learning covers a wide range of instructional material that can be delivered over a local area network (LAN) or on the Internet to provide the learner with information that can be accessed in a setting free from time and place constraints, at his or her own pace (Light & Light, 2009). The purpose is usually to enhance knowledge and performance, hopefully by offering learners control over content, learning sequence, pace of learning, time, and often media, allowing them to tailor their experiences to meet their personal learning objectives (Caeiro, 2002). So, networked technology, including the Internet, Intranet, extranet, TV, cell phones, and other personal organizers that could offer these learning advantages in varying scales for a student may constitute an

e-Learning environment. It is clear therefore, that it is the learning capabilities of an electronic medium, and not whether a student is a distant or face-to-face learner, that describes an e-Learning platform.

EDUCATOR PERSPECTIVES OF EDUCATIONAL TECHNOLOGY IN SOUTH AFRICAN UNIVERSITIES

Recent studies in South Africa reflect divergent and speculative perspectives held on the role and impact of ICT in teaching and learning (Czerniewicz, *et al.*, 2005). For the constructivists, technology should be learner-centred. Arguments are that when applied correctly, technology improves the quality of learning experiences (Tinio, 2002) or education (Muianga, 2004). Its decentralized nature frees the learner from the educational provider (Khan, 2000). E-Learning technologies should enable students to actively engage in the construction (rather than the passive receipt) of knowledge (Muianga, 2004). It could even help eliminate some debilitating factors in education, such as time, space, and pace (Sekgwelea, 2004). Authors such as Fox and Mills (1997) even expect web-technologies to totally change distance education. Arguments are that technology such as e-Learning will continue to "…*inevitably transform all forms of teaching and learning in the twenty-first century*" (Brown, 2002).

This paper thus, builds on the view of a www as a key component of the networked form of e-Learning. In line with preceding discussions, a LMS is accepted as a key tool and an enabler of this form of e-Learning. Approaching e-Learning from this angle highlights a few points in preceding discussions. The first point is that ICT such as a LMS is accepted as a positive innovation to teaching and learning processes. While claims of positive enhancements that e-Learning practices add to the quality of teaching and learning processes are abundant in the literature, there is no agreement on how it should be implemented to achieve results as claimed. It emerges in the above discussion that e-Learning adds value to both the knowledge-transfer (transmission) and the constructivist (information processing) models of learning. Constructivism for example, is characterized by (a) discovery learning (b) independent learning; (c) interactive learning; (d) collaborative learning; (e) facilitated learning; (f) socially mediated learning; (g) continual learning; (h) active participation; (i) constructed (not transmitted) knowledge.

Arguments are stronger however, that a LMS should enable constructivist learning - which in turn supports flexible and independent but guided learning. Without disputing the positive correlations between networked e-Learning platforms and constructivist learning in this context, a cautious approach against claims that "e-Learning equals constructivist learning" is adopted in this paper. Instead, we build on positive perceptions of usefulness by all pedagogical fronts in the discussion above to argue that e-Learning tools are useful for both constructivist and instructionist forms of teaching and learning. However, to understand the practical ways in which it can be applied to achieve the claimed effects on the quality of education, exploring the 'how' aspect becomes necessary. In choosing a theoretical approach to learning on e-Learning platforms for this study, we compare the defining characteristics of constructivist and instructivist formats of learning in table 1. The characteristics of each model are viewed within the context of "perceived usefulness factors" of e-Learning , its tools such as LMSs and the claimed contributions of e-Learning to the quality of education.

Table 1: e-Learning and the constructivist vs. instructivist theoretical models

	Constructivist Model	**Implications**	**ICT & e-Learning as an enabler**	Knowledge transmission (transfer) **Instructivist Model** (Conway, 1997)
Defining Characteristics (Social + Cognitive)	Interactive learning (Paiget, 1977; Vygotsky, 1978)	Active participation	Challenging tasks online – requiring initiative. Most educators use LMSs for content (information banks, data-bases, encyclopedias) & tasks such as tests, quizzes, and related games	Direct instruction, Guided practice, independent practice, corrections and feedback, occasional reviews (Skinner, Thondike)
	Social collaborative learning (Piaget; Vygotsy)	Work with others: group work, class discussion	Online real-time discussion rooms, chart rooms, group e-mails are standard for most LMSs (constructivist).	Active participation by individual students
	Socially mediated learning (Vygotsky)	Social (society, family, culture, language, industry, etc) & environmental frames of references influence learning.	Existing social frames of references inform prior experience upon which constructivist learning builds. Learning can be modelled around social settings, i.e. group projects. LMS discussion forums can be used by in diverse locations for this purpose. Modelled under behaviourism, instructivism emphasizes the individual behaviour & less on group	Knowledge is situated with educators, and the environments of practice – hence the apprenticeship notion. Revisions, tests, corrections, & feedback are used.
	Facilitated learning (Rodgers)	Teacher/ Lecturer is present to guide, not dominate	Educator important in both models. e-Learning supports both mediums.	As a custodian of knowledge, teacher takes the centre stage
	Computers in learning (Papert)	interactive presence, unlimited access	LMSs come in formal languages of learning. The www is 24hrs accessible with audio & visual communication capabilities to support both models of learning.	Learning content should be understood, even better when always accessible
	Independent/ experiental learning (Rodgers)	Do tasks on your own, at your own time & pace. Self directed learning	Unlimited access to content, exercises, & frames of reference. For instructivist, tasks can be set for repetitive practice	Independent practice of a task teaches a student to internalize practice instructions
	Discovery learning (Bruner, 1986)	Try new things, test what you know to find new meaning	Access more information than needed for current tasks. Through web based LMSs you can search other fields, find additional examples, try own tasks, etc to expand learning. For instructivists, LMSs usefully transmit structured factual information.	Structured content – usually educators transmit predefined sets of information to learners. Some may learners whilst other may simply memorize facts
	Continual (lifelong) Cearning;	Discover & build new frames of reference, new skills to process further info	As you process own information, you develop skills to process further information independently. Educators can flexibly arrange online content for this objective.	There is very little said of life long learning under this model.
	Project type Learning(Dewey , 1897, 1938)	Take initiative, be inquisitive, do it yourself	Educators can use e-Learning to for high cognitive tasks that require initiative, i.e. physics or simply just in the instructivist mode as a transfer of learning content	Active reception of information from instructor. Giving feedback to demonstrate understanding

	Knowledge constructed (not transmitted, not reproduced) – Piaget, Vygotsky	Draw on **prior experience**, reflect on social influences, reflect on the environment, to translate current experiences & construct own new meaning	LMS content as source of reference; engage classmate online; The transmission model: access lecture notes online, do repetitive tasks, quizzes, tutorials, send messages to the instructor	Knowledge situated on instructor & practice environment

Table 1 shows a clear line of convergence between technology as an enabler of participative, active, and independent learning and the defining characteristics of constructivist learning. This convergence is often translated by most constructivists – into claims that technology such as learning management systems is useful for teaching and learning only if used within the constructivist paradigm. Despite the predominance of this line of thinking in the constructivist literature, table 1 shows that technology is equally significant for learning in non-constructivist pedagogical models as well. From this analysis, ICT for education will not be reduced into a mere constructivist medium of learning in this study. Instead, it is taken as a useful tool to enhance teaching and learning in many pedagogical paradigms.

Such an approach to looking at ICT is supported by the work of leading scholars in the paradigms of ICT for teaching and learning, including the work of Kschmann (1996). Koschmann for example, outlines four paradigms that highlight different roles played by ICT in teaching and learning: (i) Computer Assisted Instruction paradigm (CAI); (ii) the Intelligent Tutoring System (ITS) paradigm; (iii) the Logo-as-Lati paradigm; and, (iv) the Computer Support for Collaborative Learning paradigm (CSCL). In a detailed discussion of these paradigms, no attempt is made to chose between them, but to indicate the relevance of e-Learning technology tools in advancing teaching and learning processes across all the paradigms. Instead of looking at technology as a platform for, and an enabler of either a constructivist or instructivist model of teaching and learning, we build on Koschmann's (1996) paradigms in figure 1 - to argue that technology supports both instructivist and constructivist forms teaching and learning, in various degrees.

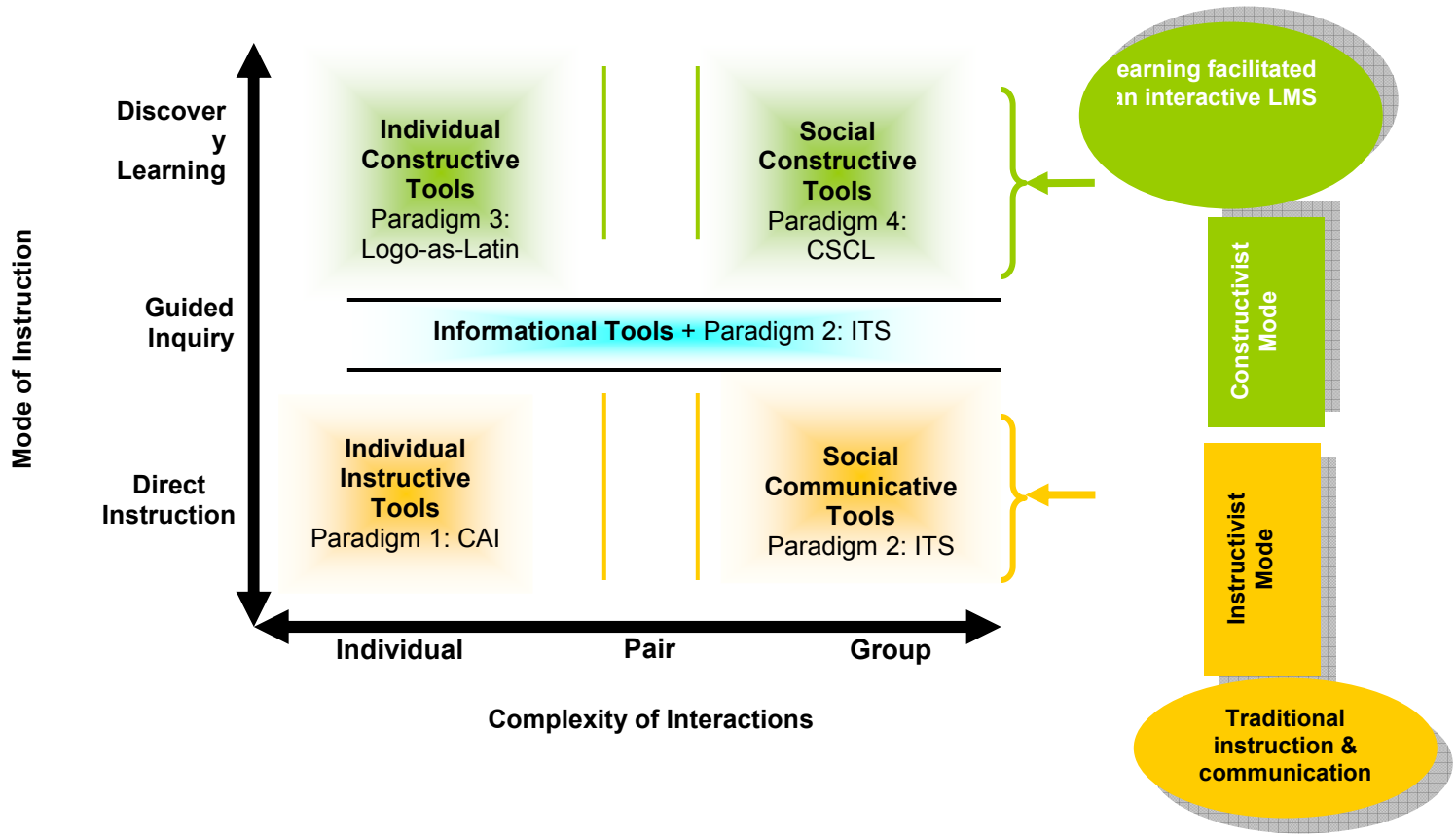

Figure 1: Mode of Instruction, Learning, and Related Tools

Figure 1 illustrates in a simplified manner, the three modes of teaching and learning. They range between "discovery forms of learning" in the constructivist paradigm and direct instruction in the instructivist modes of instruction/ learning. Between the two modes stands the guided inquiry model that carries both the constructivist and instructivist characteristics. The point of significance is that all instruction modes (reflected in figure 1) make use of some enhancement tools. Whilst discovery learning requires individual knowledge engagement (constructive) tools, it also emphasises the group (social) aspect of knowledge construction, with emphasis on interactive tools. The instructivist mode emphasises the tools to facilitate direct instruction for an individual, or for direct communication with a group.

Paradigm 1: CAI - Individual Instructive Tools

As a medium for 'computer assisted instruction', ICT in the form of a LMS is seen as an instruction support tool in paradigm 1 (CAI), without necessarily having to subscribe to the notions of constructivism. The LMS tool would enable the individual to locate and recognise "*information to be learned*", for the "*application of strategies to process that information*", and the individual "*engagement with the learning task*" (Rose & Strangman, 2007: 282). Examples of instructivist-based individual learning tools under this paradigm would include content storage (for notes and learning material), mail, notice-boards and announcement facilities (for educator instructions) as well as assessment and task submission tools in a LMS. Figure 2 illustrates the typical instructivist-based individual learning tools in an advanced LMS.

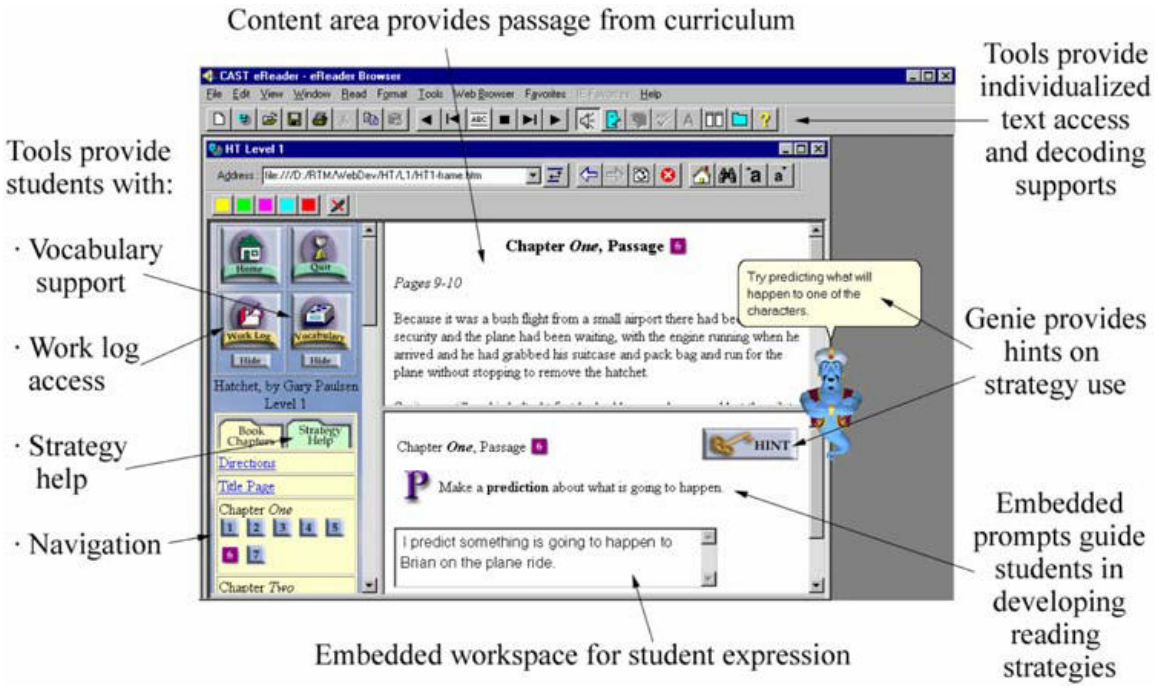

Figure 2: Individual Learning Tools in an Advanced LMS

(Source: Rose & Strangman, 2007: 388)

The focus in this learning paradigm is on the learning content, and on getting it to the learner – who must memorise and reproduce it afterwards. The tool which is personalised according to the cognitive abilities and disabilities of a learner offers added capabilities to better access the learning, and ultimately reflect the capacity to recall the content (Koshmann, 1996) in an embedded workspace.

Paradigm 2: ITS – Social Communicative Tools

With technology used as an intelligent tutoring system(s) in paradigm 2 on the other hand, the ITS phenomenon tends to accommodate constructivist convictions of group interactive communication, flexibility, and ability to handle complex problems, though like the CAI paradigm it is transmission oriented (Lund, 2003). The difference is that it enables more than just a communication between the teacher and the individual learner, but between the teacher and groups as well as intra and inter-groups. Synchronous (for time and space flexibility) and asynchronous online discussion forums and group broadcast messages in a networked PC of cell-phone would be ideal features of communication tools under the ITS paradigm.

Paradigm 3: Logo as Latin – Individual Constructive Tools

The third of Koschmann's paradigms, Logo-as-Latin advocates the paper of knowledge construction rather than instruction and knowledge transfer. It is therefore highly constructivist (*ibid.*) in that whilst a learner would be limited to reproducing the content in content-focused paradigms 1 & 2, in Logo – as – Latin (individual constructivism, paradigm 3) where the focus is on the learner, an individual would further reflect on experience, interpret, accommodate, reject and add their own meaning to the knowledge encounter.

Paradigm 4: CSCL – Social Constructivist Tools

Lastly, the CSCL paradigm builds on the notion of learning as a situated and social process. Hence, the CSCL emphasizes ICT usage within social and collaborative settings to advance this model of learning. In accepting ICT as an equally useful teaching and learning tool that enables a productive interaction and distributed learning across pedagogical paradigms, one escapes a simplistic debate of whether ICT and multimedia is a constructivist or instructivist tool (Littleton & Light, 1999). Thereby engaging into a more constructive question of what is done with technology and how to benefit from the use of ICT and multimedia technology in learning.

For Andreas Lund (2003), technological developments have seen a shift away from learning with ICTs to learning via ICTs, a realization of uses that transcend across pedagogical paradigms. To this effect, governments, multinational development corporations see ICT as a facilitator of "*communication, learning, and the sharing of knowledge among individuals and organizations or institutions across geographical distances*" (GDLN Toolkit, 2005: 9) and are collaborating to use ICT to enhance teaching and learning.

In the case of an LMS, acceptance and use cannot be pigeon-holed into a single pedagogical paradigm. Instead, it is determined by the capacity (or perceived capacity) of the tool (system) to efficiently yield the realisation of goals (such as achieving discovery learning, guided learning, or the direct instruction mode). Determining the usefulness of a technology towards achieving a goal is further informed by user perceptions on its potential. The key terms and attributed meanings are outlined to highlight what researchers and technology users mean by "technology-usability" and see as characteristic of technology usability.

We draw on case studies of various but related types of multi-content handling technologies (web design interfaces, cell-phone menus, and LMS features) to understand meanings that users attach to the notion of usability, and the inferences the phenomenon has on perceived ease of use (PEOU - considered as the most significant indicators of technology acceptance) and the perceived usefulness (PU - is a very strong predictor of technology acceptance and use) of a networked technology such as an LMS in table 2.

Table 2: Technology Usability, Perceived Usefulness (PU) & Ease of Use (PEU)

Author	Case Study + Technology Type	Purpose of Case Study	Criteria per Case Study	Meanings/Implications for an LMS
Bojko, 2006	Using eye-tracking to compare web page designs	Comparing user-friendliness of two web designs	- enable goal achievement - enable efficiency - ease of use - meet user needs/ expectations	- Determinant of success or failure - Improves processes to the final goal - Does not add unnecessary physical strain - Does not force unnecessary user-adjustments
Sheng-Cheng Huang, 2006	Empirical evaluation of a popular cellular phone's menu system: theory meets practice	Determine effectiveness, efficiency, & user satisfaction of a cell-phone's menu system	- effectiveness - efficiency - user satisfaction - accuracy - clear labelling & descriptions - meet user expectations - compatible with intended task	- Enable successful goal achievement - Saves time, works fast, reliable - Users say it satisfy needs (user choices show) - Do only what it is intended to do, reliably - Should not be confusing - Relevant. No unnecessary user-adjustments
Kreitzberg, 2006	Can collaboration help redefine usability?	Opening debate for platforms that collaborate related information easy access, reference & use	- collaborated knowledge bases - single entry-points to knowledge	- Info. fragmentation complicates usability - Info. Collaboration improves cross-discipline interaction
Martin, et al, 2008	Compare usability compliance between LMSs: Moodle, Sakai and dotLRN – from a student tasks user perspective.	Test asynchronous learning support functionalities of e-Learning platforms	Using Nielsen's (1994) 10 Heuristics*, determine: - Visibility of System Status - Match Between System & the Real World - User Control & Freedom - Consistency & Standards - Help Users Recognize,	- System need to enable goal realization, flexibly & efficiently - System errors hinder usability & discourage usage. - Complexity instead of ease to use limits user control & freedom, & ultimately discourages use - System should be relevant to

			Diagnose, & Recover from Errors - Error Prevention - Recognition Rather than Recall - Flexibility & Efficiency of Use - Aesthetic & Minimalist Design - Help & Documentation	real world situations if the user is to easily adapt to its use. - Minimalist design, consistency & standards is needed for user to easily find features. - Users should not feel lost or stranded when facing a problem. Availability of 24hr help may support & encourage usage.
Reconstructed to reflect the findings of the case studies: Bjoko (2006); Sheng-Cheng Huang (2006); Kreitzberg (2006); Martin et al, 2008. * Heuristic evaluation (Nielsen, 1994) is a usability engineering method to find usability problems in user interface designs - for rectification during an iterative design process.				

Case studies in table 2 are drawn not to reflect on their findings, but with the intention to illustrate the operational meaning that users and researchers hold on usability of each networked technology. In the first case study Bjoko (2006) used the eye-tracking methods to compare the user-friendliness of the American Society of Oncology's two web designs in 2005. The Clinical Oncology Society had initiated a new improved website. Bjoko's was tasked to test and compare the usability of the original against the new website. Usability in terms of the criteria used, imply that a Website should enable goal achievement, enable efficiency, meet user expectations or needs, and mostly, be easy to use.

On the second case study, Sheng-Cheng Huang (2006) evaluated a Nokia Cell-phone menu system to compare the convergence between the theoretical and practical aspects of cell-phone menu usability in 2005. The findings offer an insight into what is perceived as the most usable cell-phone menu functionalities. On a slightly different angle, Kreitzberg (2006) introduces content provision as a significant aspect of website usability in the third case study. Collaborated knowledge with emphasis on a single point of entry is seen as a necessity for intuitive and convenient usage. In the fourth and final case study, Martin, *et al* (2008) reflects directly on the usability of a LMS – from the student user perspective. The status of an LMS (in terms of what can be achieved through it and whether it is functional) according to the final case study, should be visible to a student. In addition, a student needs to feel in control, free and independent (with as minimal assistance as possible) when using a system, otherwise they not find it easily usable. For this to happen, the system should be aesthetic (with minimalist and intuitive design) and consistent, with adequate help options in rare cases of need. In terms of usefulness, flexibility in terms of access to different forms of content, anytime and anywhere; and efficiency (speedily and in correct formats) are may encourage usage of an LMS (*ibid.*).

Whilst the handling of information, interaction and communication capabilities are a common denominator of technologies in selected cases, equally common are the meanings attached to the notion of usability and the levels of significance attached to the term in all cases. Evident in all four case studies is that good (highly usable) information handling or management platforms should enable the "satisfaction of the subject

(individual user or group) interests, goals, and meet their expectations efficiently, speedily and with ease". Terms used in all case studies tend to present an instrumentalist perspective of technology as a somewhat neutral tool (Feenberg, 2003) whose purpose is to adequately satisfy user-ends. Technology usability in the case of web pages for example, is high if technology functionalities enable goal achievement, enable efficiency, ease of use, and meet user needs/expectations (Bjoko, 2006). Sheng-Cheng Huang (2006) uses the terms of effectiveness, efficiency, user satisfaction, accuracy, clear labelling & descriptions, meet user expectations, and compatibility with intended tasks to make a similar point about the usability of cell-phone screen menus.

Just as Bjoko (2006) is concerned with user friendliness of the webpage, Sheng-Cheng Huang (2006) is concerned with user-satisfaction of cell-phone menu systems. Kreitzberg (2006) is also concerned with the improvement of information provision methods in websites, thus suggesting a collaboration of different information platforms and sources to improve user access. In the same light, learners need unlimited access to a fulfilling learning process, easily, flexibly, and efficiently, a need which remains utopian until appreciated, accepted and engaged by educators (Mlitwa, 2005). Computer technology usage in teaching and learning environments however, can be a daunting task when the system/s is difficult to learn (Kluge, 2002). When the purpose for usage is securely established therefore, it is still imperative that the interfaces to which users are exposed, are as easy to understand and as simple to use as possible (Melton, 2006).

This line of argument is consistent with the position of this paper that it is the goal of usage and convergence between the potential of a tool and realisation of the intended objective - rather than whether a LMS is a specific pedagogical tool, that is mostly likely to determine its acceptance and usage patterns in academia.

Keitzberg (2006) discusses the content delivery aspect of information technologies. The argument is strictly that of enhancing usability by improving the process towards access to information (motive for using a web-page including web-based applications such as an LMS). Collaboration rather than disintegration of information sources according to Keitzberg (2006) enhances information access processes and is likely to encourage usage of an LMS by educators.

The focus is clearly not so much on loyalty to a particular educational paradigm and pedagogy, but on subject activities towards the outcome. The first motivating factor is the belief on the extent to which a technology would help the teaching process, and simplify the management of educational processes (perceived usefulness). It has been clearly shown in preceding discussions that technology is perceived as a useful enhancement to educational processes in academia, though usage patterns remain limited. It is clear therefore that perceptions alone do not guarantee usage of a technology. To this end, usability case studies in table 2 confirm the perceived ease of use proposition in the technology adoption model – that users would prefer simple, easy and user friendly technology systems and processes. In an attempt to understand factors that affect technology usage patterns among educators in South African universities, investigation of usability factors in learning management systems would yield significant insight in this investigation.

CONCLUSION

ICT therefore, in higher education institutions is an indispensable tool in the modern teaching-learning process, hence its adoption (in terms of technology acquisitions rather than use) of learning management systems (LMSs) is growing significantly in the dawn of the 21st century, with recent studies reflecting almost all universities as either at an early stage of some e-Learning adoption or have fully implemented one or more aspects of it using the LMS – in supporting teaching and learning (Selinger, 1999; Beebe, 2003; Czerniewicz, *et al*, 2007). Forms of usage have emerged at an increasing rate after the creation of the web, with the trends ranging from full usage models in completely virtual institutions[1], to some online presence by distance education providers[2] and some blending of different models of e-Learning through LMSs with traditional models of teaching and learning by contact universities in South Africa, few notable examples include the Vula system: http://vula.uct.ac.za/ at the university of Cape Town (UCT); e-Learning via WebCT at the Cape Peninsula University of Technology (CPUT): www.cput.ac.za/elearning/ and the University of Stellenbosch: http://webct.sun.ac.za/; or e-Learning through the KEWL.Next Gen system at the University of the Western Cape: http://elearn.uwc.ac.za/.

To conclude, the educational pedagogy as embedded in a mode of teaching, therefore, would not be a limitation for usage. Instead, whether a technology would be useful to achieve the goal, whether conditions are conducive, and whether a technology is user friendly and easy to use would determine usage. The verdict therefore, is that e-Learning technologies cannot be reduced into a single pedagogy enabling tool. They are useful enhancers of teaching and learning processes across various modes of teaching (and learning). We have used Koschmann's (1996) paradigms of teaching and learning through technology tools to illustrate this point in figure 1. The four paradigms suggests that technology can be applied across constructivist and instructivist teaching modes, for individual or group (social) learning. Within the constructivist mode, LMSs for example may be used in varying degrees to enhance discovery learning either for individuals or for groups. It can also be used in various ways as a tool to support a direct mode of instruction, for individuals or for the group. The use of technology in each mode would require a specific adaptation to educational needs and objectives under pursuit. Whilst more emphasis will be placed on group communication tools under a group direct instruction mode for example, tools to enable flexible trails and errors as well as to take initiative will be prioritised under constructivism. In between constructivist and instructivist mode is the guided learning mode, which accommodates parts of discovery and direct instruction modes. An LMS in this case would need to be designed in a manner that promotes all teaching and learning modes.

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[1] Examples include the African Virtual University (AVU), the Arab Open University (AOU), or the Mediterranean Virtual University (MVU), among others.

2 MyUnisa online - of the University of South Africa, is a practical example.

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