INSTRUCTIONAL DESIGN PROCESS IN A WEB-BASED LEARNING MANAGEMENT SYSTEM: DESIGN, IMPLEMENTATION AND EVALUATION ISSUES

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A thesis submitted in fulfilment of the requirements for the degree of Master of Information Management in the Department of Information Systems, University of the Western Cape.

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KEYWORDS

Instructional Design

Instructional Theory

Instructional Technology

Theory into Practice

Design Patterns

Instructional Patterns

Learning Materials

E-Learning

Developmental Research

Web Learning

ABSTRACT

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Web technologies have necessitated a transformation culture in higher education institutions. Many of these institutions are employing web technologies whose development, for varying reasons, is not supported by research in their field and domain of use. One such field is instructional design for the web learning. Although there is a lot of research on the most effective instructional design strategies, the use of research for web-based learning applications has been limited.

This thesis reports on a study aimed at transforming the research on instructional design into practice by designing an instructional design system and providing an argument for its implementation. The argument is intended to facilitate the design and development of an instructional design subsystem of the web, that would in turn offer effective and efficient ways for creating web-based learning materials to instructors.

The study started by examining the various paradigms, theories and practices of instructional design with the intent of using them to enrich and improve the practice of instructional design in web learning. It undertook a thorough and systematic review of the literature on instructional design in order to come up with an instructional design system. The design approach used successful design patterns that have been used elsewhere, e.g. in software design, to create common responses or solutions to recurrent problems and circumstances. Instructional design patterns were identified in this study as the recurrent problems or processes instructional designers go through while creating instructional materials, whose solutions can be reused over and over again.

This study used an iterative developmental research process of finding and modelling an instructional design process as the research methodology. This process follows and builds on existing research on instructional models, theories and strategies, and ensures that the same methodology can be used to test the theories in the design, thus improving both the research and the design.

December 2005

DECLARATION

I declare that Instructional Design Process in a Web-Based Learning Management System: Design, Implementation and Evaluation Issues is my own original work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged as complete references.

James Kariuki Njenga December 2005

Signed: . . . .

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I cannot fully express my gratitude to the exceptional team at Free Software Innovation Unit (FSIU) and by extension the bigger team of the Africa Virtual Online Initiatives and Resources (AVOIR) for their good work in supporting me in writing the code, and testing the instructional design subsystem. Special thanks too, go to the e-learning division of the University of the Western Cape (UWC) for their assistance.

My genuine indebtedness also go to my family for their support and prayers – to mum and dad thanks a lot for the confidence you have in me and for my brother and sisters, thanks a lot for your encouragement. And to all my friends – Muthoni, Ng'ang'a, Charles, Keter, Jane, Snehta, Lengaji, Kamau, Olusola, Edwin, Steve – am greatly indebted.

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Abbreviations and Acronyms

ADDIE – Analysis, Design, Development, Implementation, and Evaluation

AVOIR – Africa Virtual Online Initiatives and Resources

CDT – Component Display Theory

CMS – Content Management System

ES – Expert System

FSIU – Free Software Innovation Unit

HE – Higher Education

HEI – Higher Education Institution

HICTE – Information and Communication Technology in Higher Education

ICT – Information and Communication Technology

ID – Instructional Design

ISD – Instructional System Design

ITT – Instructional Transactions Theory

KEWL – Knowledge Environment for Web-base Learning

KEWL.Nextgen – KEWL, the next generation, See also KNG

KNG – see KEWL.Nextgen

LCMS – Learning Content Management System

LMS – Learning Management System

LO – Learning Object

MVC – Model View Controller

PPP – Pedagogical Patterns Project

R→P – Research into Practice

SDL – Software Development Life-cycle

SDL-pattern – Software Development Life – Pattern approach

T→P – Theory into Practice

UOL – Unit of Learning

UON – University of Nairobi

UWC – University of the Western Cape

WBIDS – Web-based Instructional Design Systems

WBL – Web-based Learning

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Chapter One

Introduction

1.0 Introduction

This thesis investigates and reports on the instructional design process in web-based learning management systems. It emphasises on the transformation of research theory in instructional design into practice, through the implementation of a web-based instructional design subsystem. Its investigations revolves around the theory of instructional design (ID) and how it can used it to inform the process, design, development, implementation and evaluation of a web-based instructional design subsystem.

This chapter gives a brief background about the researcher in section 1.1; section 1.2 addresses the research problem, section 1.3 the research objectives, section 1.4 the research methodology and research design, section 1.5 the limitations and delimitations of the study, section 1.6 defines the terms that are repeatedly used in the thesis and section 1.7 describes the overall structure of the thesis and the chapter layout.

1.1 Background of the research

At the beginning of 2002, the University of Nairobi (UoN) started offering online courses. The university needed the human capacity to assist and train the professors and other faculty staff to 'go electronic'. The main tasks included staff training in Information and Communication Technologies (ICTs) and how the technologies can be used and incorporated in teaching and learning within the university. The training was initially designed for the faculty members who had basic computer literacy skills. The training mainly focused on the simple conversion of existing learning materials into electronic format and basic presentation skills and web design and ended with the learning materials being posted in a server where the target audience, the students could access it from.

At the beginning there was a lot of enthusiasm and commitment from the academicians who wanted to convert their learning materials into electronic format. The initial conversion was a success since almost all the courses that were earmarked for conversion and hosting in the server was done. With this success, and with motivated academicians, the university embarked on phase two of the project.

In the second phase, the university adopted a web-base learning system (WBL) that would integrate more content, time, and student management features. This system had to host the converted material from the first phase. The university organized training on how to host the materials in the WBL. Most of the professors whose materials were converted expressed interest and enrolled for the training.

The training scheduled took four sessions:

1. Instructional design and educational constructs, where the professors were taken through the basics of what makes a good course or learning experience.
2. Content structuring, sequencing and chunking, where the educators took their already converted material into a form identified and backed up by the instructional design and educational constructs.
3. The online authoring stage, where the already structured content was put 'online' in the WBL.
4. The final stage, where they were trained on learner support techniques and strategies using the new form of teaching and learning.

The training sessions and training follow-ups were spread over a period of 18 months, during which the following observations were made:-

- Most professors and university instructors were not trained in instructional design.
- What was thought of as a small task of just converting material from one form to another became a very challenging task, leading to frustration for the academicians, so that a high percentage dropped out of the training.
- The academicians did not want to work ‘outside’ the systems. They wanted to do everything to do with their course on the computer. In this case, as in many other

WBLs, only the authoring stage of the instructional design process was 'online', leaving a lot more work for instructional designers to do 'outside' the systems.

- The work involved was seen as complex, time consuming and labour intensive.

As a remedy, instructional designers were employed to work with the academicians to design the online courses. However even this was another challenge as it soon became apparent that:

- The academicians wanted to do the design of their courses themselves.
- Due to differences in working styles, the few academicians who opted for this approach were not always available when the instructional designers needed them.

At this point, much of the investment in the learning management system and the conversion of materials was at risk. An alternative is to be sought for the instructors to use in designing their courses. One of the solutions that looked promising was to create an Expert System (ES) or a template based system that would incorporate all or most of the instructional design process in the system. This would allow incorporation of the best theories, models, and practices into the new tools.

The ES systems could be implemented within a larger Courseware or Content Management System (CMS), with the main aim of guiding and assisting instructional materials designers through the process of instructional design. CMSs are common in many institutions and they offer stable and reliable ways of presenting content (example KEWL in UWC, Sakai in University of Cape Town, WebCT in University of Stellenbosch among others). However, these systems provide very few alternatives to instructors in the form of how to create instructional materials – offering only authoring tools. These systems need to make the instructors' job easy by providing tools so that even Subject Matter Experts (SMEs) who are not trained or experienced in instructional design can create online materials. For these to happen, the ES designed can:

- Ease the instructional designers' work when creating course materials based on established instructional design strategies, using a guided approach throughout the process. One way of achieving this is through the provision of a simple user interface that allows for the creation and customization of instructional material with minimal effort, training and time.

- Integrate the whole process of Instructional Design into a Learning Management System. This would ensure that the systems provide all the necessary tools for the design and management of the instructional material as well as delivery, and the instructor could avoid low-level activities, and reliance on external tools and sources that might cost more time, effort and money during the instructional design process.
- Adopt measures and ways of ensuring reusability, adaptability, and generalisability of instructional materials. This might not only work as a motivation towards using the systems, but also could ensure that the materials prepared by the instructor can be easily accessed and modified for use in another course or context.

The design of the ES focus on instructional design could be from the design patterns perspective, where recurrent problem-solution pairs are documented and prepared in such a way that it can be reused over and over again. Every person creating instructional material goes through some common steps. The ES designed provides an answer to the following questions: Can the common tasks be identified from the research, abstracted and automated? Are there instructional design theories and models that can be identified and used to design and develop the ES?

1.2 The research statement

The research sought to address the concerns and limitations that were identified in the researcher's background (section 1.1 above).

Content Management Systems (CMS) are commonplace in many institutions. The CMS are intended to help instructors by providing easy to use tools that do not need experience and that economise on the time and effort necessary to create course materials However, instructional design happens outside these systems – the user has to do a lot of course planning, design and development before starting to use the tools(Avgeriou, Papasalouros , Retalis & Skordalakis, 2003).. Only authoring capabilities are supported in most of the CMSs. This is limiting for users who have either limited knowledge in instructional design or who would like to develop all their content within the systems.

Automating the process of instructional design is not simply a transformation of one specification into another; it involves complex and referential tasks that must be undertaken by the Instructional Designer. With research into instructional design that is now available, but has not yet been incorporated into CMSs and LMSs, there is a clear opportunity to deploy it in a practical way in new tools that will assist instructional design.
The research question can therefore be stated as follows:

> How can instructional design for web-based learning be optimized through the use of existing research?

The question guides the research to build on the existing literature on instructional design in the context of web-based learning, and to come up with ideas that will address the concerns and limitations discussed above.

1.3 Research goals

The objectives in this study are threefold:

- To examine the field of instructional design and to find instructional design principles, constructs and theories that can be used to design a web-based instructional design system.
- To develop an understanding of the relationship between the theories and practices of instructional design, especially in the area of web-based instructional systems and web-based instructions.

- In so far as is possible within time and resource constraints, to design and implement components of the system so as to demonstrate the potential benefits.

1.4 Research methodology and research design

In order to achieve these objectives, and because of the novelty of the idea, an iterative approach to the research was needed. Further, the study is concerned with design at both the system and instructional level. It was therefore decided to use a Design Experiments methodology, a form of developmental research that has been described by many authors (Richey, Klein & Nelson, 2004; Naidu, 2003; Cobb, Confrey, deSessa, Lehrer & Schauble, 2003; Jones, Gregor & Lynch, 2003 Reeves, 2000; Brown, 1992). It has an evolutionary and iterative nature that suits the needs of the project.

Developmental research has the dual objectives of developing creative approaches to solving human teaching, learning, and performance problems while at the same time constructing a body of design principles that can guide future development efforts (Reeves 2000) by "systematically studying those approaches and the means of supporting them."(Cobb et al, 2003:1). This approach ensures checks and balances and at the same time enables improvements to the project as new insights and ideas are realized (Naidu, 2003). It provides practitioners with theory-based guidance on the design and implementation while at the same time providing researchers with a number of theory-based principles (Jones, Gregor & Lynch, 2003).

The procedures of the design-experiment methodology used here entailed creation of a developmental context for the web-based instructional design subsystem, creation of the initial model based on existing knowledge (instructional design models, theories and paradigms) and technologies (in this case web-based technologies[1]), testing and implementation of the model and finally an iterative inquiry into the effectiveness of the

[1] Web-based technologies or Web technologies are a host of advanced and sophisticated tools designed to allow easier information exchange within a network mainly using intuitive graphical interfaces and hypertext links.

model followed by revision, refinement and modification of the model. More detailed information about the research design is given in chapter 3.

1.5 Limitations and delimitations of the study

The learning and instructional theories are paradigms - philosophical and theoretical frameworks of the discipline of education within which laws, practices and generalizations are formulated and studies are then performed in support of them. As such, even though this study has tried to organise them into categories, in reality it is very difficult to put boundaries into place.

Although this study has gone into considerable depth, there may be some aspects of the literature not dealt with here, that some experts would consider essential. However, there is enough literature reviewed here to argue and support the case of the design, development and implementation of a Web-Based Instructional Design System (WBIDS). Later refinement of the ideas, and reconciliation with other theories not included here, must be left as a matter for others to investigate.

In as much as the researcher would have wanted to do literature review in the African context generally and South Africa in particular, this was not possible. The reasons for this are twofold: first, instructional design for web-based systems is a relatively new field and web based learning itself is still in its formative stages; second, only limited work was found within the African context. One notable contribution was a thesis by De Villiers (University of Pretoria, 2002): "The dynamics of theory and practice in instructional systems design". She also pointed out that her thesis has an "international flavour". The research background and the research methodology adopted counter this situation, and the results of this further work, undertaken in Africa by an African, will be applicable in the South African context and the wider African and international context. Higher education and instructional design in particular, are becoming more international by the day.

On the design, development and implementation of the WBIDS, it is important to state that not all of the principles of the theories and the literature in general can be realized in a single web-based or computer-based system. However, this work took into consideration most components of the theories that could be found, and implemented them the design of the intended system.

The developmental nature and context of the research process requires more time than was available for this study. The product of the whole process, nonetheless, is the best that could have achieved within the time. If all the iterative inquiries and subsequent revisions, refinements and modifications to the product are done, it will lead to a superior system and, more importantly, a contribution to the understanding or modification of the theories under considerations.

1.6 Definition of terms

Instruction is defined as the systematic provision of information, opportunities and resources to promote the development of a repertoire of knowledge and skills (WMU, 2004). The Merriam-Webster dictionary defines instructions as procedures or directions, actions, practice, or profession of teaching (Merriam-Webster Collegiate Dictionary, 2000). It is the opinion of the researcher that the former definition fails because the process of instruction is not always systematic. Systematic approaches always have the notion of modularity and procedures. It is not always linear and there is no one procedure that can be applied neither is it modular.

The instructors or instructional designers use methods that fit their situations (Israelite & Dunn, 2003) which are in most cases based on heuristics: some of the methods are based on documented best practices while others are based on instructors' experiences or what the instructor thinks is the most appropriate and effective means of conveying the instructions. Some theories of instruction argue that instructional process is independent components that form a complete whole as the knowledge is actively constructed as users interact with the environment or the learning materials (Locatis, 2001).

The second definition also fails because it puts all the emphasis to the process and provider of the instructions without putting enough considerations to the recipients of the instructions. The recipients of the instructions are the learners. Freeman (1994:7) defines learning "as a change in human disposition or capability that persists over a period of time and is not simply ascribable to processes of growth". Therefore, a learner is one who is actively engaging with the process of learning. For the arguments presented in this thesis, instructions are procedures, actions, behaviours, methods and practices that enhance learners' gaining or realization or understanding of knowledge or skill through the provision or exposure to the necessary information, opportunities, environments and resources. This can be through study, teaching, and interaction with the environment or experience.

Anything relating to instructions is instructional. The most visible relationship will be between the processes, the parties/stakeholders involved and the environments. An instructional instance or occurrence would therefore be composed of at least these three things – people, materials and environment. Learning materials are instructional components such as such as textbooks, lecture notes, computer-based training applications, that are used to pass knowledge to the learners. Learning materials together with communication channels and tools, and educators or instructional facilitators are examples of learning resources. A learning service is a set of learning resources provided by a learning service provider in order to support the accomplishment of a specific learning objective or to pass on knowledge to learners.

A theory is a "plausible or scientifically acceptable set of general principles offered to explain phenomena" that have been observed over time and the existing knowledge cannot discredit it (Merriam-Webster Collegiate Dictionary, 2000).. A theory forms a "comprehensive, coherent, and internally consistent system of ideas about a set of phenomena" (Knowles, 1978:5) and is a hypothesis assumed for the sake of argument or investigation, an unproved assumption (Mergel, 1998).

Learning theories are descriptive theories that propose how learning occurs and identify concepts that describe the knowledge to be learned. Learning theories are inferential in nature. Inference is the logical process of drawing conclusions from a collection of data and relationships between data and potential conclusions. When used in the learning environment, the learning theories describe the process of learning by the inference from a particular form of human cognition, development, behaviour among others and describe what and how learning resources would be provided.

Instructional theories, on the other hand, are prescriptive in that they set out rules regarding the effective ways of teaching knowledge and skills, setting procedure for the development of instructions (De Villiers, 2002). Instructional theories are normative in nature. Normative theories not only gather and prescribe facts, but they also point out areas under consideration that can be improved.

Learning theories and instructional theories are indistinguishable. The line dividing them is thin as De Villiers (2002), points out:

> "a strong relationship exists between them [learning and instructional theories], in that the descriptive theory facilitate understanding of why design theories work and, in the absence of design theory, the descriptive theory helps the practitioner to select instructional methods that meet the given needs (Reigeluth, 1983; 1999) ...There is no rigid line between the learning and instructional theory, and between the descriptive theories and prescriptive practices" (De Villiers, 2002:86).

A model is a mental picture or a mind map that helps us to understand something we cannot see or experience directly. An instructional model is a set of instances or set concepts employing instructional and learning theories and their relationships forming a mind map that helps us in understanding the instructional design process.

Instructional design is "the distinct systematic process through which evolves a superior instructional product…as delineated through an instructional design model" (Crawford, 2004:2). It is the "concept of analyzing human performance problems systematically, identifying the root causes of those problems, considering various solutions to address the root causes, and implementing the solutions in ways designed to minimize the unintended consequences of corrective action.” (Rothwell & Kazanas 2003:3)

1.7 Thesis structure and chapter layout

Chapter one introduces the study, background of the study; the research statement, goals, methodology and design; limitations and delimitations and definition of terms used in this thesis. It ends with a chapter overview that outlines the various learning and instructional theories and other related features and how they can be translated into practice.
Chapter two reviews the theory - studying the main paradigms of learning, teaching and instructions. It also covers the research to practice (R→P) forming an argument towards an integrated and holistic view of the theories and how they are applicable to the design of the WBIDS.

Chapter three describes the developmental nature of the development of the research methodology, mapping the research into the practice. It uses the findings of the literature review, validating them and using them to inform the design, development and implementation of the WBIDS.

Chapter four describes the technical aspects of the design of the WBIDS in the Learning Management System that is known as "KEWL.NextGen" (KNG). It shows how the various aspects of instructional design can be achieved in a web-based system using a module pattern approach. It also gives the discussions of the whole research approach and methodology, the achievements of the system designed. It also reflects on the merits and demerits of the designed system, giving example of situations where it is applicable.

Chapter five discusses the design issues, challenges and achievements, the achievements of the research, how the research question is answered. It also summarizes the Instructional System Design (ISD) approach that is used and its relevance to the WBIDS. Finally it gives some recommendations and suggestions for further research in the WBIDS.

Chapter Two

Literature Review

2.1 Introduction

This chapter reviews literature on the background and research of learning instructional theories that would form a basis for the implementation of the web-based instructional design system. It forms a backbone of the whole study on the current trends in learning and instructional theories, with specific emphasis on the practice of designing instructions for web-based learning and web based learning systems. The reviews in this chapter are intended to provide a foundation to a framework for the design of an instructional design subsystem. The main aim of the subsystem is to support designers and practitioners in facilitating effective web-based learning. The events of the study will involve the use of web based learning management systems, but mainly as used by the instructors or instructional facilitators. The subsystem would inform the practice with the theories of instructional design and their relationship to the design, development and delivery of web-based learning materials.

Conducting the literature was a lengthy and complex navigation of a very bumpy and uncertain terrain that involved iterations. A systematic approach of working through the sources and keeping a comprehensive record made the process manageable. The search started by the identification of the key terminology instructional design and its variants like design of learning, course creation among others. Because the specific emphasis was the design of an instructional design subsystem for the web, web instructional systems also formed part of the keywords. Initially, the search was done using the major search engines on the internet, and later, in the electronic journals. The references that were given priority were those published in the last 5 years to make sure that the literature is current. After an article or journal was found, a scan of the references was done to check for catchy titles of resources that would have been instrumental. This led to more findings on a topic or keyword until the author was satisfied about the quantity of the resources. Author search was also taken into consideration especially where the author is renowned and widely refereed. While at the author, the context of the author was taken into consideration to ascertain if the working context of the literature provided is congruent to the operational context where the study results would be applied. Other keywords that were used in the search were learning theory, instructional theory, information systems design, Expert Systems and Artificial intelligence, Software design, design patterns, instructional methods, Human Computer interface, ICT in Education, Computer based learning and Learning Systems, web based learning, and hypermedia design among others.

Figure 1 below shows the structure of the literature review section, the various components and their interrelations. It also gives the weight and details in which the various components are delved at.

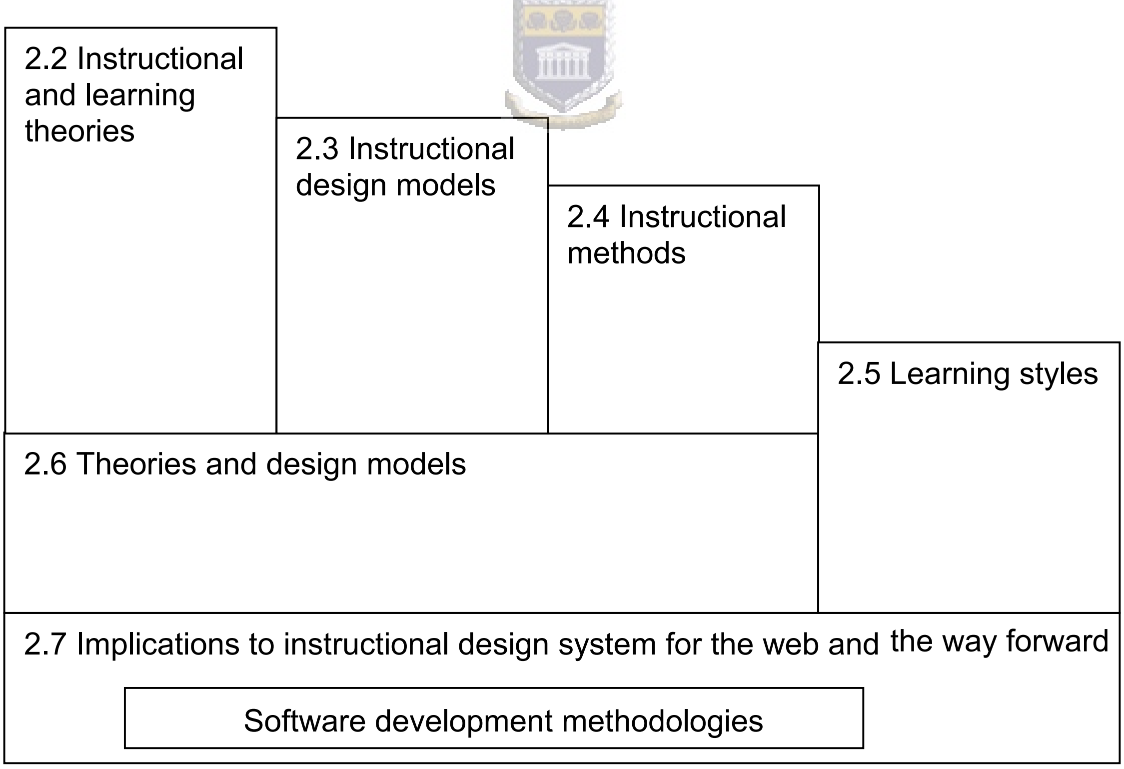


Figure 1: Structure of the literature review

Section 2.2 describes the instructional and learning theories. This forms the foundation of the study and it is reviewed in details. Section 2.3 deals with the instructional models, the various ways researchers and practitioners have tried to give structures, or systems or an approach to the process of instructional design. Section 2.4 outlines some of the widely used instructional methods – the components of the instructional strategy defining a particular means for accomplishing a stated objective. Section 2.5 explains the various learning styles - the way individuals concentrate on, absorb, and retain new or difficult information or skills. Section 2.6 brings the theories and the models of instructional design together taking into consideration the instructional methods and the various issues of the learning styles. Finally section 2.7 wraps up the literature by looking at the implication the whole literature that has been identify has for the design of web-based instructional design system.

2.2 Instructional and learning theories

As discussed in the terminology section (section 1.6) a theory is a plausible or scientifically acceptable general principles offered to explain phenomena that has been observed over time and existing knowledge cannot discredit. A theory forms a "comprehensive, coherent, and internally consistent system of ideas about a set of phenomena" (Knowles, 1978:5) and is a hypothesis assumed for the sake of argument or investigation, an unproved assumption. The learning and instructional theories are paradigms - philosophical and theoretical frameworks of the discipline of education within which topics, tools, methodologies, premises, laws, practices and generalizations and the studies performed in support of them are formulated (Koschmann, 1997).

Instructional theory is a description of a variety of methods of instructions indicating when to use or not to use each of the methods. Instructional research aims at the improvement of teaching and learning, which means that it includes evaluation of the present state and also of the direction of future development. The methods usually evolve in process of taking instructions. Certain theories, as we will see later, concentrate on explaining the process that take place during the design, development and delivery of instructional materials. The majority of them however, have an aspect of the delivery of the materials to the target learners, the processes and changes that take place when the learners are subjected to the materials. These instructional and learning theories explain how learning occurs and how it can be facilitated in some disciplines. This includes the demographics of the learners, purpose of the instructions, the cognitive abilities of the learners among others.

Even though this chapter on the review of the theories has classified the instructional and learning theories into behaviourist, cognitive and constructivist, it should be noted that each of the classification is made up of a group of theories and is not a theory by itself. It is not always easy to put a theory into these classifications, since theory in its philosophy and framework, can be put in more than one classification. As such, even though the researcher has tried to delineate them into categories, in reality it is very difficult to put the demarcations. The classifications identified here are just a pointer to the main arguments that the theories in each class have in common.

The contexts in which the theories are applicable are divergent. However, it is imperative to select theories that are generic and that can be incorporated in appropriate ways into instructional environments to foster effective learning. This could be achieved by using certain theories where there are optimum results or use a hybrid of all the relevant theories. A hybrid can be reached at by the simplification of phenomena and isolating domain specific aspects. This leads to methods "of communicating information so as to help learners apply knowledge, and integrate and transfer it to the complex domains" (De Villiers, 2002:22).

Instructional theories are used to optimize the role and design of effective leaning materials and explain the applicable learning and instructional design as a basis of explaining "why we do what we do" (Lee & Owens, 2004). They attempt to describe, explain and predict how learning takes or should take place (Freeman, 1994). Freeman further states that these theories relate to specified events comprising instruction to learning processes and outcomes whose results are based on several assumptions/principles which are stated slightly different by various experts.

Instructional theories can be traced to the history of mankind. However, documented evidence of research in instructional theories was in the early 1920s. The view on the instructional process at this time was behaviourist which mainly sought to describe and prescribe the instructional process. In the 1970s, it was implemented as the "systems theory" due to its prescriptive sequence and interrelated organization. In the late 1980s there was the cognitive idea of the "information processing" where focus shifted to the organization of content in relation to how the mind processes information. Later in the 1990s, constructivist literature was implored where the focus was now to how learners construct knowledge and make meaning through mental activities in relation to their environment(Duffy & Cunningham, 1996). The discussion of each of the theories is organized as follows:

a) A general definition and description of the theory.

b) A graphical image depicting the main theme of the theory.

c) The implications of the theory that arise from the discussion.

d) An appropriate example. Some of the examples given cut across the theories, depending on the perspective and context they are viewed from.

However, the description given in the examples points out its merits to be categorized in the theory it has been listed under. Some theories have more than one example.

2.2.1 Behaviourist

Their main focus is the observable behaviour that can be changed (reaction/response) and reinforced (Ally, 2004;). The observable behaviour is measured when a learner is subjected to some learning materials (stimulus). The behaviourists believe for learning to take place, the learner should be conditioned to simple reflexes i.e. learning is a function of stimulus and response. The learners are continuously subjected to some stimuli and they are conditioned to react or behave in a prescribed way whenever they are subjected to similar stimulus in the future. This means that the expected change in behaviour is positively or negatively reinforced. In the day to day school activities, a high grade in an exam would translate to a belief that the learner is learning and doing well and a lower grade shows that the learner is not learning. The teacher's role in this case is to provide reinforcements in terms of learning resources that drill the students to attain the high mark. Figure 2 clearly depicts what the behaviourist teacher would be doing in order to facilitate learning. Attaining a high mark in class would equate to learning. As said earlier the teacher would start with providing some information (Stimuli) to the learners, and give them a test. Based on the results of the test (Response), the teacher would determine if there is need for more drilling (Reinforcement).

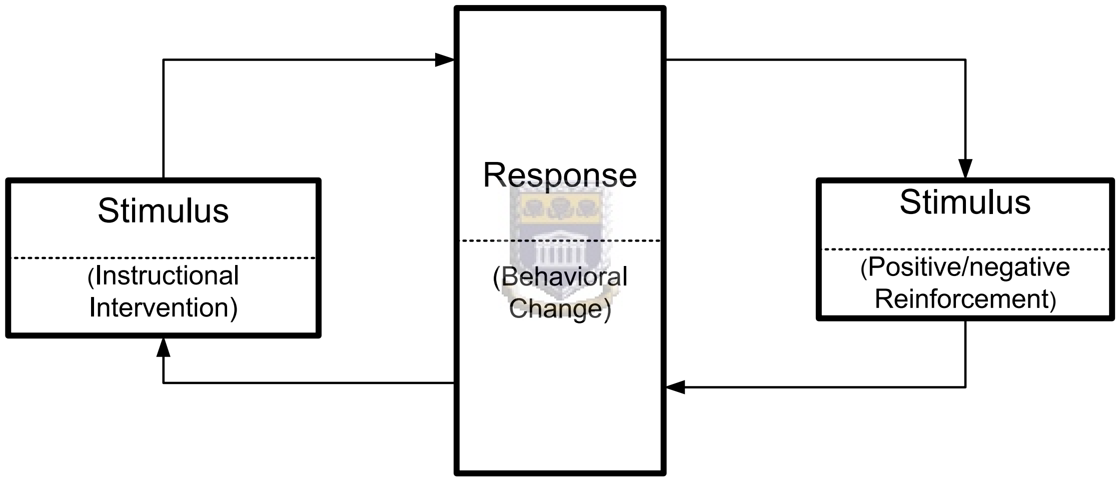


Figure 2: Stimulus-response-reinforcement

(Source: De Villiers, 2001)

The theory of behaviorism was developed after experiments done with animals, by researchers such as as Jerome Bruner, Abraham Maslow and B.F. Skinner, that found out that the behaviour of an organism can be changed by an external stimulus (Petrina, 2004). This was later applied to human beings.

There are two widely cited behaviourists: IP Pavlov and BF Skinner. Pavlov is considered the main researcher in behavioural theory. Pavlov used a classical conditioning approach while Skinner is used of the operant conditioning school of thought. While philosophically and theoretically there is no major difference between classical and operant conditioning, researchers always distinguish the two (Staddon & Cerutti, 2003; Kirsch, Lynn, Vigorito & Miller, 2004,). Kirsch et al (2004) have outlined the difference between the two as follows:

> "Classical conditioning used to be viewed as a type of learning that involves the acquisition of elicited responses (i.e., responses, like the defensive eye blink, that are preceded reliably by an identifiable eliciting stimulus and that are experienced phenomenological as automatic or reflexive). Similarly, instrumental (operant) conditioning was regarded as a type of learning that involves the acquisition of emitted responses (i.e., responses, like a wink of the eye, that can occur in the absence of reliable or well-defined antecedent stimuli and are experienced as voluntary). An implicit assumption of these old definitions was that what is acquired is a stimulus–response (S–R) association rather than a belief about the antecedents of an outcome (O, i.e., an expectancy)." (Kirsch et al 2004:370)

In his experiments with a dog, food and a bell, Pavlov observed that,

- Before conditioning, ringing the bell caused no response from the dog. Placing food in front of the dog initiated salivation.
- During conditioning, the bell was rang a few seconds before the dog was presented with food.
- After conditioning, the ringing of the bell alone produced salivation (Dembo, 1994 quoted in Mergel, 1998).

Other observations made by Pavlov are:

- Stimulus Generalization: similar stimulus will elicit similar response.
- If the reinforcement is stopped, the conditioned response becomes extinct.
- Extinguished responses can be "recovered" after an elapsed time, but will soon extinguish again if not reinforced.
- Discrimination: learning to discriminate between similar stimuli and discern which could result in a certain response (food and salivation) and which would not.
- Higher-Order Conditioning: Once the dog has been conditioned to associate the bell with food, another unconditioned stimulus, such as a light may be flashed at the same time that the bell is rung. Eventually the dog will salivate at the flash of the light without the sound of the bell. (Mergel, 1998)

Learning is the construction of a set of stimulus-response associations that are repetitive and reinforced (De Villiers, 2002) with increasing levels of difficulty. Most of the learning materials are developed by the lecturers and the learner has little or no input. The behaviourists believe that environment determines what learners learn and it is the lecturers' role to create the environment. The environment created by the lecturer should provide all the stimuli that are required for a student to elicit a behaviour that is measurable and directly linked to the environment or the stimuli provided. The learners in turn become tacit users or actors in the learning environment. In instructional terms, the lecturers' role is to create an environment that presents all the information and facts, and prescribe what the student should be able to do after going through the learning materials. The learners' role on the other hand is to assimilate the information and facts presented to them by the lecturers.

The learning materials and environments developed with a behaviourist mindset are instructor-centred, and therefore, always stipulate what the students should be able to the instructor a 'visible change in behaviour'.

Behaviourist theory assumes that knowledge exists external to the learners (Jonassen 1994 quoted by Young, 2003). This means that there are universal facts and truths, that the learner does not know, and only the instructor knows. The work of the instructor therefore is to impose the truths and facts to the learners. The learners do not have the capacity to question the truths or the facts, neither can they verify or validate the facts against anything else they have not learnt. Related to this, radical behaviourism hold that students cannot build on knowledge they already have to create some new knowledge or meanings. Whatever the student knows, if it is not higher order reinforcement, is not important for subsequent learning.

Behaviourists are also not concerned with individual differences in motivation or prior knowledge since all the facts and information will be provided to the learner in the learning environment.

Behavioural theories hold that certain theories are prerequisite to others (Locatis, 2001) that should be adhered to or met before the learners embark on the learning process.

Behaviourist theories have been criticized for emphasizing learning as an observable change in behavior while ignoring the learner's role in the process, at the same time, in a totalitarian way, prescribing what the learners should learn (Ally, 2004).

Ally (2004) identified implications to these theories as:

> Learners should be informed explicitly what is expected of them and can judge by themselves.
> Learners must be tested to determine whether or not they have achieved the learning outcome
> Learning materials must be sequenced appropriately to promote learning
> Learners must be provided with feedback so that they can monitor how they are doing and take corrective action if required (Ally, 2004:8)

2.2.1.1 Operant Conditioning Theory

Operant Conditioning is a term coined by B. F Skinner in the context of reflex physiology of the behaviour controlled by its consequences (Staddon & Cerutti, 2003). Learning is measured in terms of observable behaviours which can be changed with different kinds of reinforcement (positive or negative). It takes the form of drill-and-practice that has a reward system that can be reinforced. (De Villiers, 2002: 23) summarizes Operant Conditioning as:

> The principle of operant conditioning states that if the occurrence of an operant is followed by the presentation of a reinforcing stimulus, the strength us increased (Skinner, 1938). The initial stimulus is typically a question and the response is the learner's answer. Reinforcement, after the desired behaviour, may be an extrinsic reward or a positive comment.

2.2.1.2 Gagne's Conditions of Learning

Gagne's conditions of learning are optimal principles that are chosen to specific instructions for each objective and for the different types or levels of learning (Moallem, 2001). In this model, learning is said to have occurred if all the instructional materials are conveyed to the learner and they will exhibit a desired behaviour in a given context. The reinforcements of appropriate learner responses to stimulus situations are set up by the teacher.

2.2.2 Cognitive Theory

Cognitive theories stress on the cognitive response in the form of mental operations and internal states. These internal states include simple propositions, schema, general rules, skills, general skills, automatic skills and mental models. They view learning as an internal process that cannot be observed directly (Parhar, 2003) from an information processing point where the learner uses different types of memory during the learning process. Figure 3 shows the cognitive process as proposed to by the cognitive theorist. Information is presented as inputs to the sensory memory from where it is temporarily stored in the 'volatile' working memory. Information is later encoded and stored in the long term memory.

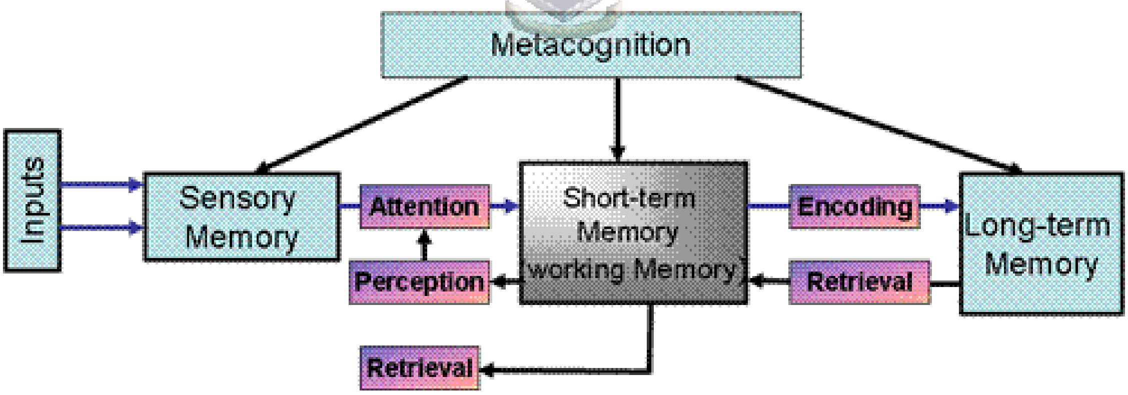


Figure 3: The cognitive processing

Cognitive theory acknowledges and considers the perceived and real issues that arise during the learning process due to individual learner's differences.

Learning involves the use of memory, motivation, thinking and reflection. It is the "execution of internal cognitive processes, such as thinking, remembering, conceptualization, application and problem solving" (De Villiers, 2002). Learning also involves the acquisition or reorganization of the cognitive structures through which human beings process and store information. Learning is an internal process and the amount learnt depends on the "learner's processing capacity, the depth of processing, and the learners existing knowledge structures" (Ally, 2004:7).

Learning materials are presented to foster understanding through the development of metacognitive skills and optimization or the internal human cognitive processes. For learning to occur, De Villiers (2002) suggests paying special attention to human knowledge representation, the relationship between prior knowledge and the new knowledge, cognitive strategies to improve the quality of learning materials, learner active participation and development of skills. Various learning strategies are employed in order for to construct knowledge. These strategies include memorization, direct instruction, deduction, drill and practice and induction (Jun & Gruenwald, 2001).

Mergel (1998) lists the key concepts of cognitive theory as:

- Schema - An internal knowledge structure. New information is compared to existing cognitive structures called "schema".
- Three-Stage Information Processing Model - input first enters a sensory register, then is processed in short-term memory, and then is transferred to long-term memory for storage and retrieval.
- Meaningful Effects - Meaningful information is easier to learn and remember.
- Serial Position Effects - It is easier to remember items from the beginning or end of a list rather than those in the middle of the list, unless that item is distinctly different.
- Practice Effects - Practicing or rehearsing improves retention especially when it is distributed practice.
- Transfer Effects- The effects of prior learning on learning new tasks or material.
- Interference Effects - Occurs when prior learning interferes with the learning of new material.

- Organization Effects - When a learner categorizes input such as items in a list, it is easier to remember.
- Levels of Processing Effects - Words may be processed at a low-level sensory analysis of their physical characteristics to high-level semantic analysis of their meaning. The more deeply a word is processed the easier it will be to remember.
- State Dependent Effects - If learning takes place within a certain context it will be easier to remember within that context rather than in a new context.
- Mnemonic Effects - Mnemonics are strategies used by learners to organize relatively meaningless input into more meaningful images or semantic contexts.
- Schema Effects - If information does not fit a person's schema it may be more difficult for them to remember and what they remember or how they conceive of it may also be affected by their prior schema.
- Advance Organizers - Advance organizers prepare the learner for the material they are about to learn. They are not simply outlines of the material, but are material that will enable the student to make sense out of the lesson.

These concepts call for specific strategies to employed in the design of learning materials and learning environments (Ally, 2004; Miller & Miller, 1999). These strategies are used to:

- Allow learners to perceive and attend to the information so that it can be transferred to working memory.
- Allow learners to retrieve existing information from the long-term memory to help make sense of the new information
- Chunk information to prevent overload during processing in the working memory
- Presenting the chunked content in a manner that hierarchically structures the sequence of information.
- Promote deep processing – means should be put in place to help transfer information to long-term storage.
- Create learning materials and experiences for different learning styles so that learners can select appropriate activities based on their preferred learning style.

- Provide adequate support to learners with different learning styles, obtaining student feedback to insure accuracy of understanding and also allow students question the educators.
- Present information in different modes to accommodate individual differences in processing and facilitate transfer to long-term memory
- Motivate the learners
- Encourage the learners to use their metacognitive skills to help in the learning process
- To facilitate the transfer of learning to encourage application in different and real-life situations.

2.2.2.1 Bloom's Taxonomy

Bloom et al in 1956 published Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook I: Cognitive Domain (Bloom, Engelhart, Furst, Hill, & Krathwohl, 1956) which is widely referred to as the Bloom's Taxonomy. They believed it could serve as a

- common language about learning goals to facilitate communication across persons, subject matter, and grade levels;
- basis for determining for a particular course or curriculum the specific meaning of broad educational goals, such as those found in the currently prevalent national, state, and local standards;
- means for determining the congruence of educational objectives, activities, and assessments in a unit, course, or curriculum; and
- Panorama of the range of educational possibilities against which the limited breadth and depth of any particular educational course or curriculum could be contrasted. (Krathwohl, 2002: 212)

Bloom's taxonomy is widely used to classify curriculum and instructional objectives. The objectives describe the intended outcome of a learning process and are stated in terms of "(a) some subject matter content and (b) a description of what is to be done with or to that content. Thus, statements of objectives typically consist of a noun or noun phrase—the subject matter content—and a verb or verb phrase—the cognitive process (es)."(Krathwohl, 2002: 213).

2.1.2.2 Component Display Theory and Instructional Transactions Theory

David Merrill developed the Component Display Theory (CDT) based on cognitive theory specifying ingredients necessary for efficient learning for a given objective and learner. This include rules, examples, recall, and exercise with feedback (Merril, 2000). However, Merril (2000) "found that CDT was not precise enough to allow computer implementation of expert system technology that would prescribe instruction" (Merril, 2000:1) and favoured Instructions Transactional Theory (ITT). The CDT was based on the assumptions that different classes of learning outcomes require different procedures for teaching and assessment, teaches individual concepts, classifies objectives on two dimensions, and formats instruction to provide student directed teaching (Parhar, 2003).
The rationale of the ITT is to derive theory and a methodology to facilitate automation of much of the labour intensive instructional development process by setting up content-independent shell.

2.2.3 Constructivist Theory

Constructivist theory holds that learners actively construct meaning by interacting with their environments and by incorporating new information into their existing knowledge (Moallem, 2001) and hence building on prior knowledge and skills. It allows students to develop and construct their own understanding of the learning materials and environments based upon their own knowledge and beliefs and experiences in connections to the new knowledge presented.

Learning materials for constructivist theories should therefore be presented in contexts that reflect how the knowledge acquired will be used in real life situations (Fry, Ketteridge & Marshall, 2004). This form of learning has been referred to by some researchers as situated learning where like apprentice; learners go through the learning process in the real-world settings and therefore for a learner to learn, he must enter the community and its culture (Naidu, 2003; Hedegaard, 1998).

In constructivist theory, learners only learn when they can create meaning and relevance of both the learning material and the learning environment with the learning environment matching the environment in which the learners would be applying what they have learnt. This in effect calls for the creation of learning environments that are rich and diverse with instructions being replaced with tasks to be accomplished or problems to be solved that have a direct relevance to the learner (Jun & Gruenwald, 2001).

The constructivist theorists advocate for active, self-directed, learner centred and collaborative learning activities. Through communication with others, learners construct meaning of their experience (Miller & Miller, 1999). This in retrospect calls for greater collaboration, learner autonomy, generativity, reflectivity and active engagement (Moallem, 2001).

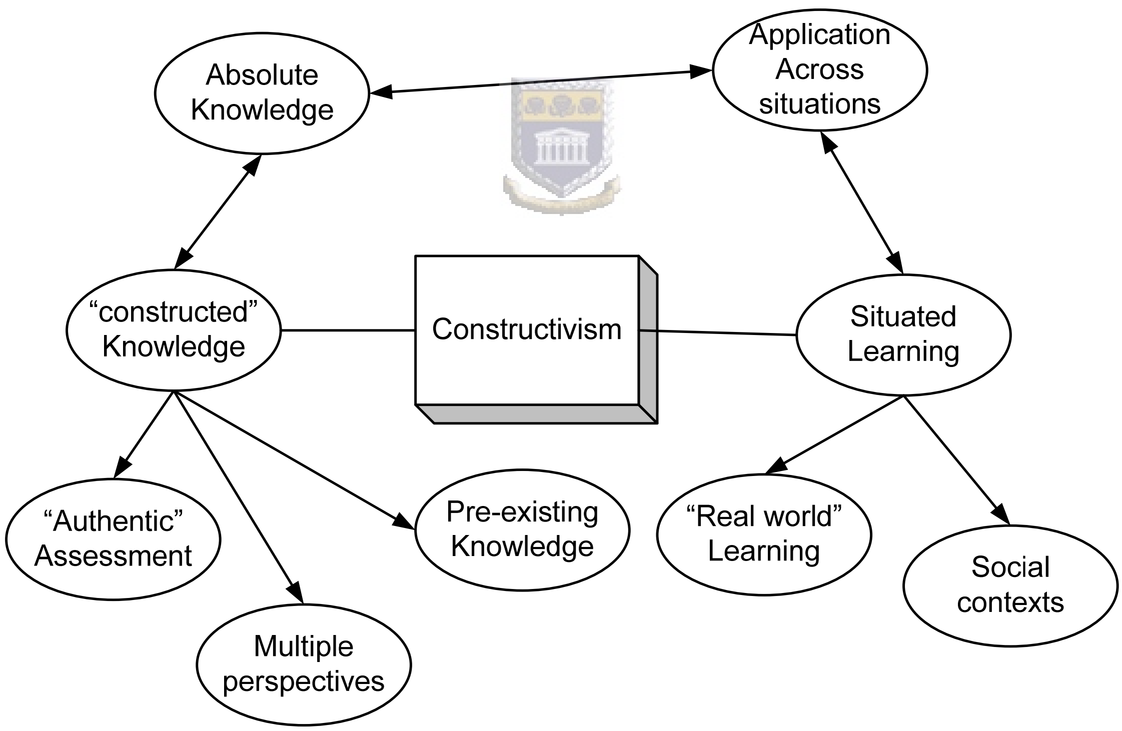


Figure 4: Constructivist view of learning

(Adapted from: Duffy & Cunningham, 1996)

As seen in figure 4, learners interpret information and the world according to their personal reality, and that they learn by observation, processing, and interpretation, and then personalize the information into personal knowledge (Ally, 2004). They continuously build and amend previous structures of schemata as new experience, actions and knowledge are assimilated and accommodated - extending and supplanting old understanding and knowledge (Fry, Ketteridge & Marshall, 2004). Learning is best achieved when learners can contextualize what they learn for immediate application and acquire personal meaning.

The learner is the centre of the learning, with the instructor playing an advising and facilitating role.

Constructivist theory have three common practices in the development process: recursive, reflective, and participative (Willis, 2000). Recursive practices acknowledge the dynamic relationship between various elements and components within the development process (Willis, 2000) and view these components as reciprocal and interrelated rather than separate and mutually exclusive. Reflective practices assume that important professional problems are difficult to define without involving the reflections of stakeholders and end users within the process. Reflective practices entail ongoing problem framing, implementation and improvisation, and an understanding of the context in which the professional work is done. Finally, participative practices where the instructional designer is actively involved in the collective efforts rather than seeing any of the parties as an object of study. The participative collaborative actions lead to multiple perspectives on the subject being studied. Learners have the opportunity to compare their view of the problem and possible solutions with the view of other students and the view of experts.

Savery and Duffy (1995) believe that constructivism is a philosophical view on how humans come to understand and know. They further characterize the philosophical view in terms of three primary propositions thus:

- Understanding is in the learners interactions with the environment,
- Cognitive conflict or puzzlement is the stimulus for learning and determines the organization and nature of what is learned and
- Knowledge evolves through social negotiation and through the evaluation of the viability of individual understandings.

The constructive philosophy implies that (Ally, 2004; Savery & Duffy, 1995; Miller & Miller, 1999):

- Leaning should be an active role
- Learners should construct their own knowledge rather than accepting that given by the instructor. This can be through encouraging testing of ideas against alternative views and alternative contexts
- Collaboration should be encouraged as its central to constructivist learning. Collaboration leads to construction of knowledge based on multiple perspectives, discussion and reflection.
- Learners should be given control and ownership of the learning process
- Learners should be given time and opportunity to reflect. The reflection is on both the content learned and the learning process to ensure the accuracy of the knowledge construction.
- Learning environment should be made meaningful for learners and at the same time support and challenge the learner's thinking.
- Learning environment should be realistic and presented in a problem-solving situation.
- Learning environment should be designed to reflect the complexity of the environment they should be able to function in at the end of learning.
- Learning should be interactive to promote higher-level learning and social presence, and help develop personal meaning
- The instructor should mentor, coach and facilitate the students' knowledge construction.

2.2.3.1 Problem based learning

Problem-Based Learning (PBL) is cited as one model that implements constructivist theory approach to learning. PBL as a general model was developed in medical education in the early 1970's and since that time it has been refined and implemented in many medical schools (Savery & Duffy, 1995). Its based on the assumptions that learning is improved when there is an activation of prior knowledge and that the elaboration of knowledge during the learning process enhances retrieval. It builds more on the knowledge of participants, their understanding, thinking, communication, teamwork and satisfaction. However, just like in other constructivist approaches where there are difficulties in assessment of learners' grasp of material, there is no convincing evidence that PBL improves knowledge base performance (Colliver, 2000). It is also very difficult to develop problems that will motivate all learners to encourage them to participate in the learning process.

2.2.4 Comparing and contrasting features of the theories

In this research a distinction between true-cognitive and objective cognitive theories is made. True cognitive theory is the higher order mental process of reasoning, memory, judgment and comprehension. The objective-cognitive is the philosophy that views learning as absorbing, storing information and retrieving it when needed.

In figure 5, the different paradigms are shown in respect to a) the level of learnership advocated for each paradigm, b) the teaching and learning methodology or knowledge dissemination type advocated and c) instructional design models that use the paradigm. The strategies promoted by different learning theories overlap. Learning theory strategies are concentrated along different points of a continuum depending on the focus of the learning theory and the level of cognitive processing required (Jonassen, McAleese & Duffy, 1993). The constructive theories are more viable for the advanced stages of learning while the behaviourist theories are best suited for introductory knowledge acquisition.

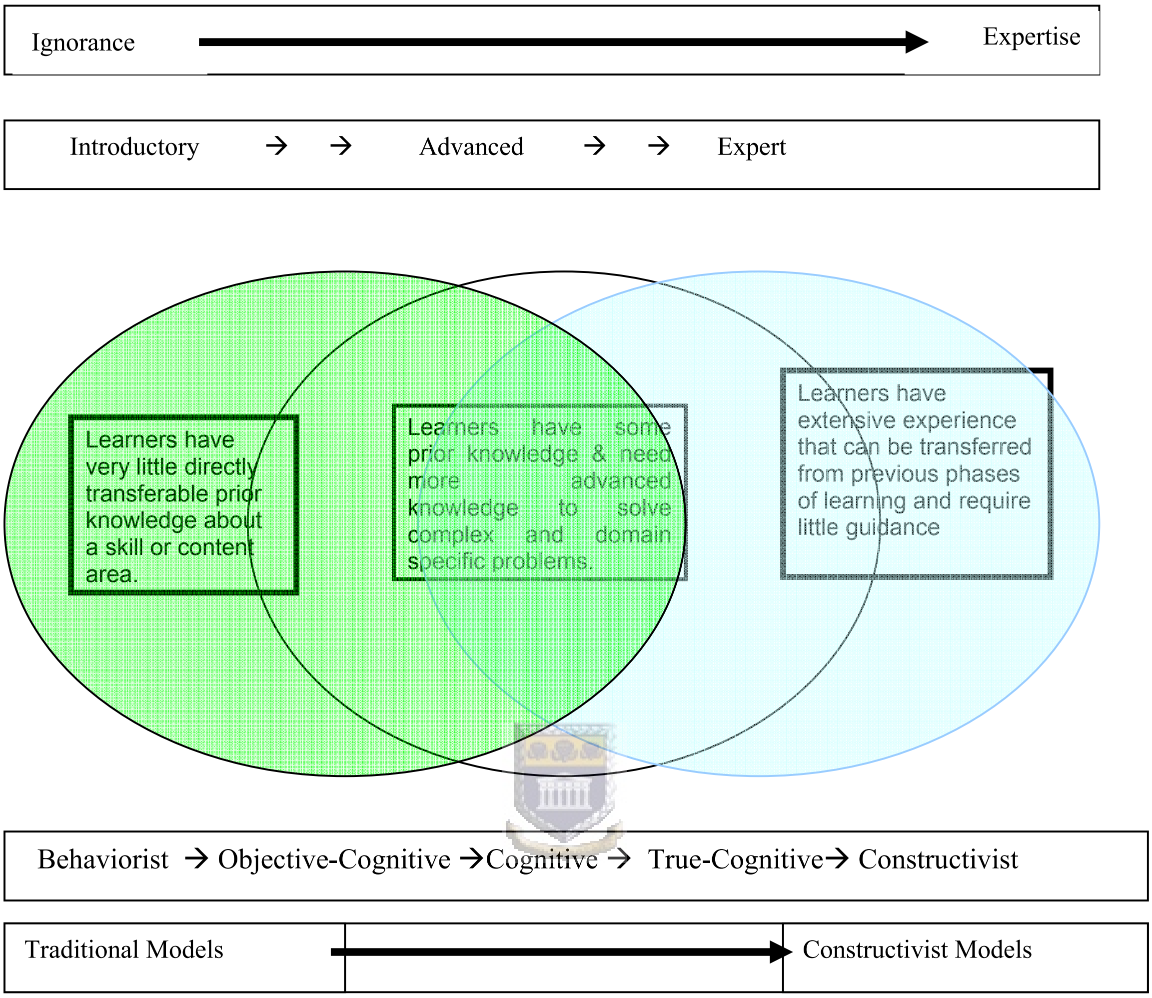


Figure 5: The Continuum of Knowledge Acquisition Model

(Source Jonassen, McAleese, & Duffy, 1993) (Modified)

The behaviourist theory and objective-cognitive theory requires that the identification and setting of "learners' prior knowledge, goals or general expected learning outcomes, specific learning outcomes or performance objectives, instructional strategies, assessment strategies and techniques, and evaluation procedures" (Moallem, 2001:114) be done before the commencing the learning activities. The constructivist theories require that the learning material be designed "with a set of very general guidelines and principles that can facilitate designing a constructivist-learning environment" (Moallem, 2001:116).

Behaviourism provides prescriptions about the correlation between learning conditions and learning outcomes. Cognitive theory has also contributed to traditional models by emphasizing the learner's schema as an organized knowledge structure. The constructivist theory is associated with cognitive science and constructivism and the performance of authentic tasks.

The predominant goal in the behaviourist theory is a visible and measurable change in behaviour (stimulus-response). In cognitive theory, the goal is to trigger a reorganization of internal knowledge structures '"schemas" (internal mental operations), while in the constructivist theory, aim it to encourage interpretation of meaning from experience and depending on the context (construct meaning in an environment by incorporating new knowledge with the existing).

The behaviourist view the world as objective with universal reality that can be imparted to learners, while the cognitive theorists view it as being made up of a common understanding to be attained by the learners. Constructivists view the world from a personal, subjective interpretation of reality that is achieved through social negotiation of meaning (De Villiers, 2002).

Behaviourists are unable to explain social behaviours that also influence the learning process. For example, children do not imitate all behaviour that has been reinforced. Furthermore, they may model new behaviour days or weeks after their first initial observation without having been reinforced for the behaviour (Mergel 1998). Cognitive theorists on the other hand view learning as involving the acquisition or reorganization of the cognitive structures through which human beings process and store information. Humans, according to cognitive theorists, must not receive and perform reinforcements before learning. The key differences between behavioural and cognitive learning theory is based on whether knowledge is external to the learner or an internal active process of constructing meaning by relating new information within existing cognitive structures.

Learning materials in behaviourism are created with very high control of the educator, in constructivist environment the control is only on what is taught without control on what students learn, as the ideological view of constructivism is that learners cannot develop and understand meaningful knowledge unless they discover it for themselves (Young, 2003). The divergent thinking and action can be a problem in situation where conformity is essential.

Locatis (2001) observe that behavioural theories hold that certain theories are prerequisite to others while cognitive theories are more tolerant and allow learners to progress without mastering the prerequisites. Table 1 below summarizes some of the major aspects of the instructional and learning theories considered that are important during the design of the learning materials.

Table 1: Comparison of the instructional theories

Instructional and learning theories			
Characteristics	Behaviourist	Cognitive	Constructivist
Prerequisites	Predefined objectives by instructor; Same for all learners	Performance objectives integrating multiple objectives	Evolve through negotiation; not same for all learners
Goal	Behavioural change	Reorganization of internal knowledge structures	Interpretation of meaning from the environment
Knowledge Location	External to learners	Internal	Internal to learners; created through interaction with the context
Control	Instructor	Instructor facilitates, materials presented activates	Negotiation and collaboration

2.3 Instructional Design Models

An instructional model is a set of instances of set concepts employing instructional and learning theories and their relationships forming a mind map that helps us in understanding the instructional design process. Its main focus is to choose or decide what is important for learners to be presented to them so that they can be transformed into 'being able to perform' a certain task at the same time effectively arranging the learning environments to maximize individual student's ability to learn or 'perform'.

2.3.1 The universal systems model

Based on the universal systems in model Figure 6, we can identify the main components of the instructional systems design (Beck & Schornack, 2003). According to this model, every system has

a) Inputs,

b) A means or process of transforming the inputs into outputs or product,

c) The outputs of the products and

d) Feedback mechanisms and the environments they operate.

The sources of the inputs can either be within or without the system. The design using this model therefore analyses the sources of the inputs (people, knowledge, materials, energy, capital, finance etc) the processes (identifying the needs, resources, delivery mechanisms, interactions, navigations, structuring etc) that produces the desired outputs (Learning materials, resources, experiences, environments etc).

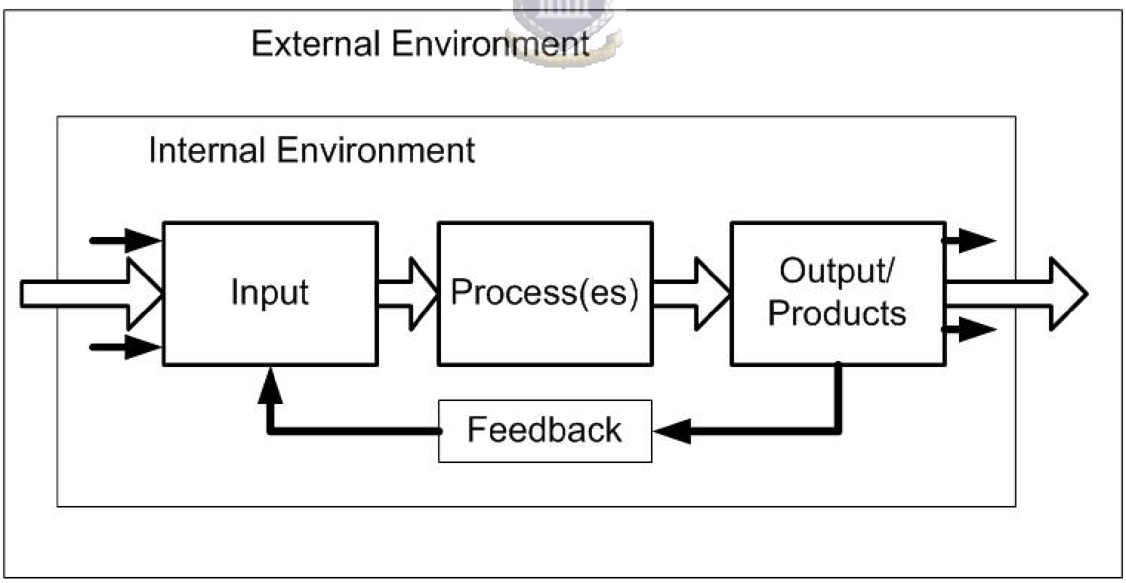


Figure 6: The universal systems model
(Source: Beck & Schornack, 2003)

This model, as shown in Table 2 below, assumes a universal, rational agent, which in the process of design instructions maximizes the utility of other values.

Table 2: Instructional components of a universal systems model

Inputs	Processes	Outputs
Objective element of resources and the subjective element of educationally philosophy Resources include the technology, library access and instructor resources.	Educational Integration – preparing and delivering the content. This is the focus on pedagogy and educational constructs – the process of designing instructional materials	Experiences: - the stimulating learning/educational materials arising from or as a consequence of the instructional design process Outcomes: - what the students acquire or are able to demonstrate mastery of after going through the educational/learning materials. Usually measured through assessment and more currently using the number (and type) of messages the learners post in the discussion forums.

(Source: Beck & Schornack, 2003)

Instructional design is iterative in nature (Jones, Gregor & Lynch, 2003). All systems are by their very nature interdependent with the other elements within the system. As systems change and as the environment within and about an institution changes, all elements of a system need to be systematically reviewed to be congruent and consistent with one another. This means that the timing of the design at each level must be planned for as well. The design processes is never complete and it is a rotational job. The systematic process of instructional design is of two forms: Systematic - methodical, step-by-step and system being an independent group of items that form the unified whole (Dick, Carey & Carey, 2001; Jones et al, 2003).

If the focus of the instructional system design is to aid or guide instructors in the process of developing sound learning materials (Armani, Botturi, Cantoni, Benedetto & Garzotto, 2004), they must be informed by research and proven constructs or theories. While there are many theories of learning and instructions (Jun & Gruenwald, 2001), generic, neutral theoretical orientations and designs for organizing instructions are hard to come by. However, a model that accommodates several theories can be achieved.

The instructor endeavours to reach out to meet the needs of the learners (Young, 2003), with an idea of what learners are (not being able to perform) and what they should be (able to perform) and how to make them be (able to perform) through the process of instructions. The role of the instructional design process is to address the discrepancies in what the learners are and what they ought to be. The process of instructions must therefore be based on sound instructional and learning theories and solid instructional foundations (De Villiers, 2002; Petrina, 2004; Locatis, 2001).

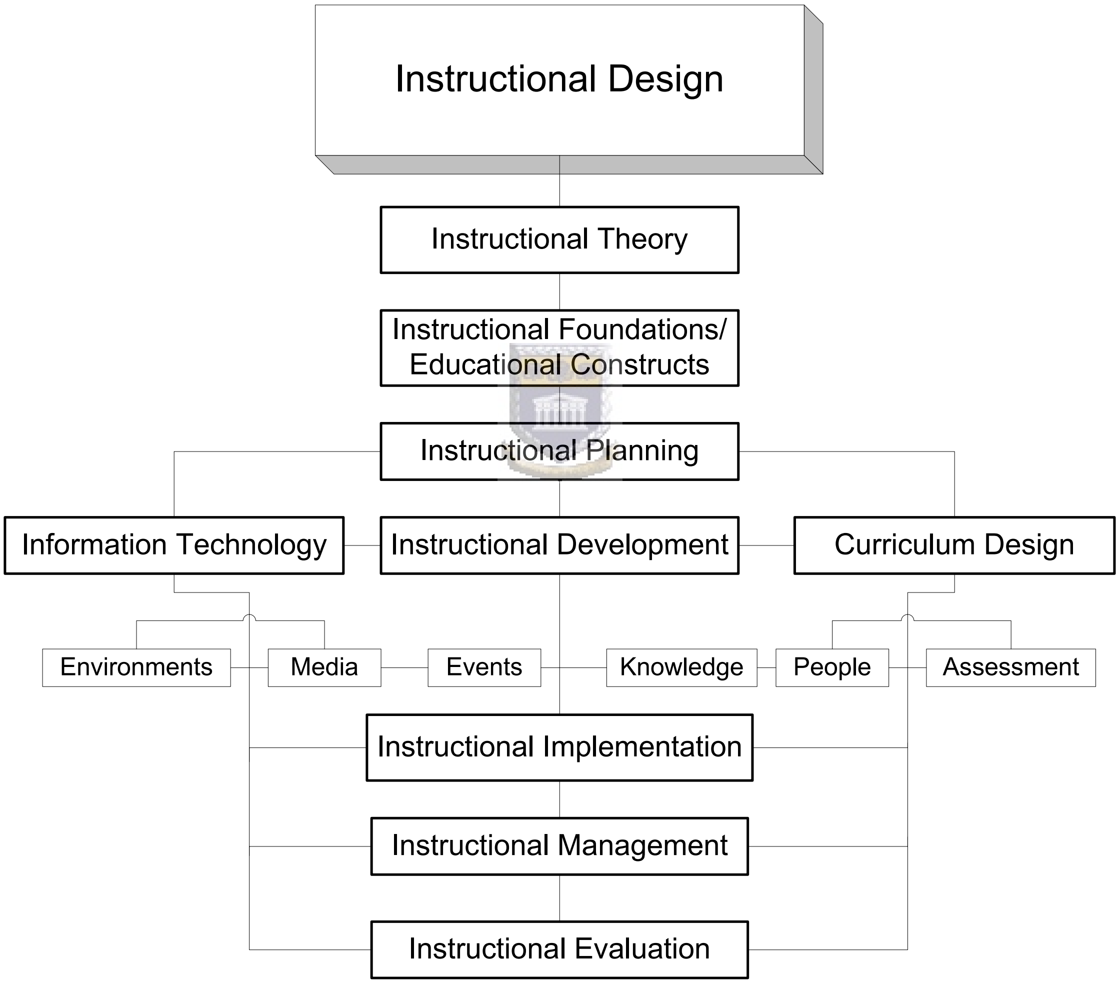


Figure 7: Conceptual map of instructional design

(Source: Petrina, 2004)

Figure 7 shows a hierarchy of the constituents of instructional design process presented as a conceptual map. The process starts with the identification of instructional theories. Instructional theory get its foundation from a wide range of disciplines – artificial intelligence, cognitive science, communication studies, cyber-cultural studies, cybernetics, human resource development, information processing theory, innovation studies, media studies, probability theory, computer science, economics, engineering, linguistics, philosophy, physiology, psychology, sociology among others (Petrina, 2004).

In the process of instructional design, after identifying the theory (or set of theories) to use, there is need for planning of the instructional process. Instructional planning is the analysis and determination of the relevant information from the present and the past and the assessment of probable future developments so that a course of action may be determined that allows the instructional designer to design quality or authentic learning materials and environments. The instructional planning phase may involve – cost-benefit analysis, futures analysis, needs analysis, methodology, occupational analysis, policy analysis, procedural analysis, program analysis, special needs analysis, systems analysis, task analysis and technology assessment.

As shown in figure 7, the next step in the process is instructional development. Instructional development is the systematic use of the knowledge (gathered from the theory and planning phase) toward the production of useful instructional materials, experiences, systems to meet identified instructional needs. This involves the analysis of the technology at hand and the curriculum that the learning materials should be developed upon. The considerations in this area are the learning environments and contexts, production storage and delivery media, Events, knowledge and people. An aspect of assessment is also considered for the curriculum design. The analysis in this phase covers also the subsequent phases of the instructional design process. Under media and technology the considerations include animations, assistive technology, audiovisual, diagnostics, distance delivery, game design, graphic design, intelligent tutoring, instructional systems, and interactive media, learning objects design, module design, networking, programming, prosthetics, simulation, systems modelling, textual design and virtual reality.

Instructional implementation involves the delivery of the learning materials to the intended audience and the use of the materials by the intended audience. During the implementation process, instructional management is done. Instructional management is the act of administering and controlling the processes of instructional implementation and ensuring that they operate efficiently and effectively to meet the intended goal.

In the instructional design process, evaluation is the final phase. Instructional evaluation is a judgment/examination as to whether the instructional goal was achieved. Evaluation considers formative evaluation, information management, performance analysis, instructional supervision, time management, Audio/visual analysis, cost analysis, qualitative evaluation, testing and measurement and summative evaluation. In the next section we consider some of the widely refereed models, forming a representation of all the other existing models.

2.3.2 Dick & Carey Model

The Dick and Carey model (Dick, Carey & Carey, 2001) prescribes a methodology for designing instruction based on a modular model of breaking instruction down into smaller components. Instruction is specifically targeted on the skills and knowledge to be taught and supplies the appropriate conditions for the learning of these outcomes. Figure 8 illustrates the steps of the Dick and Carey model.

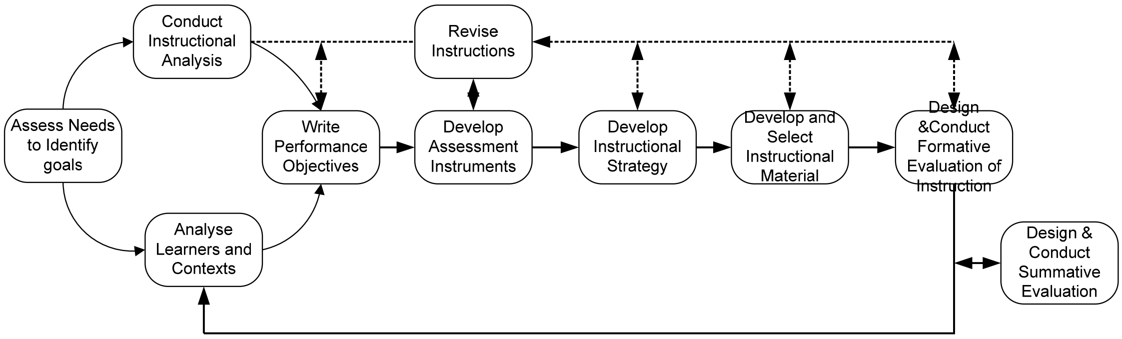


Figure 8: The Dick & Carey Model

(Source: Dick, Carey & Carey, 2001)

Elements the Dick & Carey model are:

1. Determine instructional goal - what do you want learners to be able to do when they have completed the instruction?
2. Analyze the instructional goal - a step-by-step determination of what people are doing when they perform the goal and what entry behaviours are needed.
3. Analyze learners and contexts - context in which the skills will be learned and the context in which the skills will be used.
4. Write performance objectives - specific behaviour skills to be learned, the conditions under which they must be performed and the criteria for successful performance.
5. Develop assessment instruments - based on the objectives
6. Develop instructional strategy - identify strategy to achieve the terminal objective; emphasis on presentation of information, practice and feedback, testing.
7. Develop and select instruction -using the stated strategy produce instructional materials.
8. Design and conduct formative evaluation - testing of instructional materials in one-to-one, small groups or field evaluations so that the materials can be evaluated with learners and revised prior to distribution.

9. Revise instruction - data from the formative evaluation are summarized and interpreted to attempt to identify difficulties experience by learners in achieving the objectives and to relate these difficulties to specific deficiencies in the materials.
10. Summative evaluation - independent evaluation to judge the worth of the instruction.

The Dick and Carey model is one of the better-known ID models and is used by educators, trainers, and instructional designers. It is certainly not the only model available, nonetheless it is a widely used model that is based on research that has been conducted over many years and principles that have been generally accepted by those in this field. This is not to say that the Dick and Carey model is the "best" model. In fact, there are probably those who feel that any model such as this is too structured and rigid (Dick, Carey & Carey, 2001). Others critics feel that it is too much in the "behaviourist" vein, and as such is not good to use for those who wish to take a constructivist approach to teaching or training. However, there is much to be gained from developing an understanding of a model such as this, even for constructivists.

2.3.3 The Kemp Model

The Kemp model (Kemp, Morrison & Ross, 1994) is cyclic and iterative as shown in Figure 10. Unlike the Dick & Carey model, it lists all the consideration and factors of the learning environment.

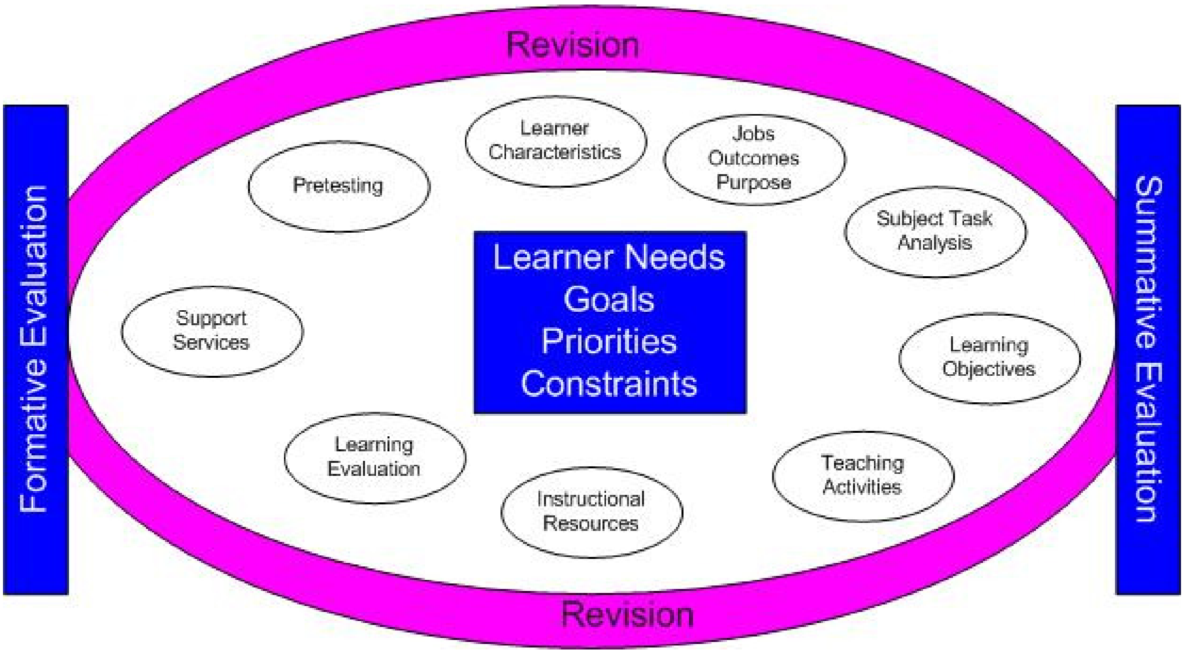


Figure 9: The Kemp Model

(Source: Kemp, Morrison & Ross, 1994)

The oval shape of the model gives the designer the sense that the design and development process is a continuous cycle that requires constant planning, design, development and assessment to ensure effective instruction. The model is systemic and nonlinear and seems to encourage designers to work in all areas as appropriate in order to:

1. Identify instructional problems, and specify goals for designing an instructional program.
2. Examine learner characteristics that should receive attention during planning.
3. Identify subject content, and analyze task components related to stated goals and purposes.
4. State instructional objectives for the learner.
5. Sequence content within each instructional unit for logical learning
6. Design instructional strategies so that each learner can master the objectives.
7. Plan the instructional message and delivery.

2.3.3 The ADDIE Model

ADDIE is an acronym referring to the major processes that comprise a generic Instructional Design process: Analysis, Design, Development, Implementation, and Evaluation. Usually these processes are considered to be sequential but also iterative. They sometimes overlap and can be interrelated.

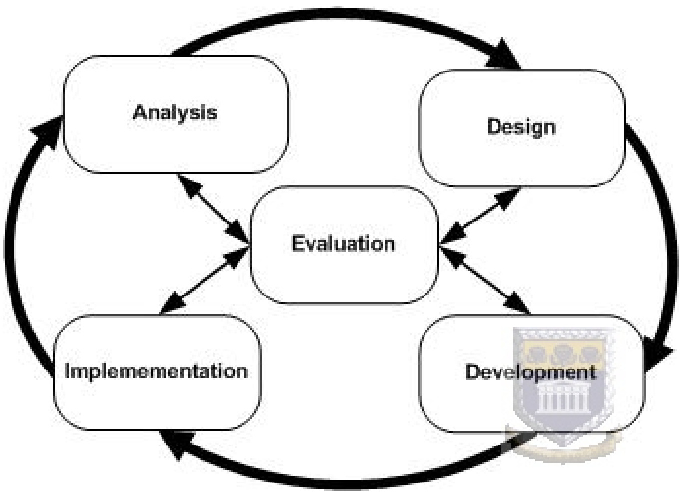


Figure 10: The ADDIE Model

(Source: Author)

The Elements of the ADDIE Model include:

1. Analysis - the process of defining what is to be learned
2. Design - the process of specifying how it is to be learned
3. Development - the process of authoring and producing the materials
4. Implementation - the process of installing the project in the real world context
5. Evaluation - the process of determining the adequacy of the instruction

2.2.4 Bringing the Models Together

The models discussed have some common aspects. First, the design of a course depends in part on the learners' needs and on the desired learning outcomes. The Dick & Carey model and the Kemp model have explicit steps that cater for the learner analysis and learner characteristics. In the ADDIE model, learner analysis is done during the analysis phase. Other aspects that come out in all the models discussed above are:

- Authentic learning activities and assessment strategies can be designed to support learner's needs and desired learning outcomes.
- Instructional design is iterative in nature. All systems are by their very nature interdependent with the other elements within the system. As systems change and as the environment within and about an institution changes, all elements of a system need to be systematically reviewed to be congruent and consistent with one another. This means that the timing of the design at each level must be planned for as well. The design processes is never complete and it's a rotational job.
- The models have some common phases which include user /context analysis, design, development and evaluation.
- Superior learning activities emanate from understanding the target audience, and creating instructional objectives that can be used as a guide and check while iterating through the instructional design process.

For this thesis, the systematic design of instructions is the selected because of how it breaks down the process to deal with the complexity of instructional design. In supporting their systems approach to instructions Dick & Carey (2001) highlighted three features that would lead to the success of this approach:

a) The initial planning and statement of what the learners are supposed to learn during the process of instruction keep the designers of the instructions focused during the process of creating the instructions.

b) The linkage between the various components ensures that the learners get only the information that is relevant to what they are supposed to know and
c) The processes in the systems approach are empirical and replicable making reuse of this approach easy and achievable.

The ADDIE model can be seen as a simplified version of the Dick and Carey model since it reduces the number of steps to follow from ten to five while still maintaining the three features mentioned above.

The design and implementation of instructions, as mentioned earlier, is a complex and overwhelming task involving people from diverse backgrounds with presentational, architectural and behavioural aspects that needs to be considered (Avgeriou et al, 2004). In this light, therefore, systematic and disciplined approaches are needed in order to overcome the complexity and achieve overall product quality within specific time and budget limits. (Avgeriou et al, 2004)

2.4 Instructional Methods

An instructional method (method of instruction) is a component of the instructional strategy defining a particular means for accomplishing a stated objective. A single method can neither meet all of the set learning goals nor accommodate all the different learning styles at once. There is therefore a "need [for] a toolbox of methods, not merely a single tool" that will effectively meet the set objectives (Petrina, 2005). For example, case study method of instruction might be used when there is need to study the complex social phenomenon in a given context while direct instructions can be used where the main aim of the instruction is to enhance recall or revise major ideas and concepts.

Table 3 below gives a summary of instructional methods and relates them to the cognitive levels of the Bloom's taxonomy where they could be more effective. The relationship between an instructional method and the levels of the Bloom's taxonomy indicated below is not prescriptive because of two reasons. One, depending on how a method is used, it can achieve other levels. Secondly, some of the levels build on other levels; the higher levels build on the lower ones. For example, case studies are more effective on the Analysis and Application levels. For learners to be able to apply what is involved in the case studies, they need to know (Knowledge) and understand (Comprehension) the basic facts about the cases. Also, depending on the depth of their cases, the learners might use the higher cognitive levels – Synthesis and Evaluation.

Table 3: A summary of the widely used instructional methods

Method	***Description***	***Bloom's Domain***
Real life/world examples	This is presentation of facts to the learners as applied in their context.	All levels, but mainly caters for knowledge and comprehension
Case studies	An instructional method which focuses on the characteristics, circumstances, and complexity of a single case, or a small number of cases, often using multiple methods. The case is viewed as being valued in its own right and whilst findings can raise awareness of general issues, the aim is not to generalize the findings to other cases. They provide a systematic way of looking at events, collecting data, analyzing information, and reporting the results	Analysis Application
Discussions	Is a formal or informal consideration of a certain topic in an open debate in class setting, either through the use of the discussion forums, group emails, wikis etc	Knowledge Comprehension Analysis
Lecture/Lecture Notes	Lecture is a common method of instruction in college and university courses where an instructor lectures/teaches in a class or presents written or audio restatements of the course or lesson content formally delivered, for the purpose of instruction, by the authority on the topic.	Knowledge Comprehension
Assignments/ Homeworks	Work produced by students, usually out of the normal school hours, and used by instructors for purposes of interaction and also evaluation.	Application Synthesis
Individual projects / Research paper	An individual project is an extended, in-depth investigative activity organized around a particular academic topic or challenge in which a student participates. A formal written report that includes research findings and a student's own ideas is the product of this activity.	Analysis Application Synthesis Evaluation
Group projects	A group project is an extended, in-depth investigative activity organized around a particular academic topic or challenge in which a group of students participate. A formal written report that includes research findings and a student's own ideas is the product of this activity.	Analysis Application Synthesis
Video/slides	A slideshow is a display of a series of chosen images, which is done for artistic or instructional purposes A video is a series of framed instructional images put	Knowledge Comprehension Application

Table 3: A summary of the widely used instructional methods

Method	*Description*	*Bloom's Domain*
	together, one after another, to simulate motion and interactivity. Interactive video can be used where the video technology is combined with computer technology in which the user's actions, choices, and decisions affect the way in which the programs unfold.	
Field trips	A field trip is typically an educational activity undertaken by students outside of their classroom with the aim of observing the subject in its natural state and possibly collects samples.	Application Synthesis Evaluation
Surveys	A survey is a systematic collection, analysis and interpretation of information about some aspects of a study with main aim of understanding the activity under review, identifying significant areas warranting special emphasis, obtaining information for use in interpretation and determining whether further study is necessary.	Application Synthesis Evaluation
Direct teaching (also direct instruction)	An instructional presentation of information, concepts, or principles in large quantities over a small period of time. It emphasizes systematic sequencing of lessons, a presentation of new contents and skills, guided student practice, feedback and independent practice by students.	Knowledge Comprehension
Cooperative learning (also collaborative learning)	An instructional approach in which students work together as a team (of 2-6 students) with each member contributing to the completion of the task or project or problem under the guidance of a trainer who monitors the groups, making sure the learners are staying on task and are coming up with the correct answers. It is a peer learning that involves the act of shared creation and discovery.	Knowledge Analysis Application Synthesis
Lecture with discussions	(cf Lecture, discussion)	Knowledge Analysis Application Synthesis
Panel of experts	An instructional method where a panel composed of authorities in a field gather and present their opinions which provoke a discussion that leads to an understanding of the facts in the field being discussed.	Knowledge Application Synthesis
Brainstorming	Is a problem-solving technique that involves creating a list that includes a wide variety of related ideas. As an instructional method, learners are asked to withhold judgment or criticism and produce very large number of ways to do something such as resolve a problem.	Analysis Application Synthesis Evaluation
Guest speakers (also colloquia)	Is an instructional method where specialists deliver addresses on a topic or on related topics and then answer questions relating to them.	Analysis Application
Values clarification	An expert leads learners through a series of moral and ethical dilemmas to assist them in clarifying their values and moral choices.	All
Simulations	A simulation is a representation of a situation or problem	Application

Table 3: A summary of the widely used instructional methods		
Method	***Description***	***Bloom's Domain***
(also simulation game)	with a similar but simpler model or a more easily manipulated model in order to determine experimental results. As an instructional method, learners engage with something intended to have the appearance or have the effect of something else. It can be in form of a game where learners act out some type of problem or conflict that occurs in real life. It is good for complex and ill structured learning situations where skills, chance and strategy are required.	Synthesis Evaluation
Problem-based learning / inquiry	Is an instructional method and organization of knowledge where learners work purposefully towards a solution, synthesis or a cause. Learning is driven by a question or problem and uses various methods of inquiry research to address the question or problem. Problem-based learning (PBL) is an instructional method that challenges students to "learn to learn," working cooperatively in groups to seek solutions to real world problems. These problems are used to engage students' curiosity and initiate learning the subject matter. PBL prepares students to think critically and analytically, and to find and use appropriate learning resources.	Analysis Application Synthesis
Concept maps	Concept mapping is a technique for visualizing the relations between concepts. Its purpose is to form or assess a person's cognitive map. A concept map is a diagram showing the relationships between concepts. Concepts, like "tree" or "plant", are connected with labelled arrows, for example ("is-a", "related-to" or "part of"). The addition of labelled and flexible links (attached during or after construction) has been found to significantly improve the level of meaningful learning and communication of the concept mapper.	Knowledge Comprehension Analysis Application (Depends on the design of the maps)
Drill and practice	A method of instruction characterized by systematic repetition of concepts, examples, and practice problems, designed to help users remember isolated facts or concepts and recall them quickly.	Knowledge Comprehension
Problem solving	An instructional approach that involves the use of the scientific method and advanced inquiry in solving carefully selected and designed problems. Students play an active role in determining and seeking the critical information needed to solve the problem. Problems often have multiple solutions and relate to the real world.	Analysis Application Synthesis
Focused imaging	An activity in which students are taught to relax and then are guided to use their imaginations to "experience" situations and respond to them.	Analysis Application Synthesis Evaluation
Experiments	Experimental instructional method is where a learner or a group of learners create an environment in which to observe and interpret the results of a question, situation or problem. The operations within the environment are carried out under controlled conditions in order to discover an unknown effect	Analysis Application Synthesis Evaluation

Table 3: A summary of the widely used instructional methods		
Method	***Description***	***Bloom's Domain***
	or law, to test or establish a hypothesis, or to illustrate a known law	
Role playing	Learners take on the role of another person or character to see what it would be like to be that person or character. It is a good method of giving the students an opportunity to incorporate new behaviours and also help them acknowledge that there is seldom one best way to solve a problem or a conflict. It is an excellent method for instructing interpersonal skills used in counselling, management among other fields.	Comprehension Analysis Application Synthesis Evaluation
Storytelling	Storytelling is the skilled delivery of stories use to present anecdotal evidence, clarify a point, support a point of view and crystallize ideas. A story can present material that research data can not. Stories use verbal pictures to spark interest, add variety, and change the pace of a discussion. Stories make dull speeches sparkle. Storytelling is the connecting device between data and reality. Stories can share a "truth" that data can not. Storytelling can help bridge the gap between data and knowledge. It also could be the result of integrating information. A well chosen story gets your audience's attention. Knowledge managers	Knowledge Comprehension Evaluation

2.5 Learning Styles

The term 'learning styles' has no one definition and is often used loosely and interchangeably with terms such as 'thinking styles', 'cognitive styles' and 'learning modalities' (BECTA, 2005; Cassidy, 2004). Cognitive styles from the cognitive theory deals with the personal organization and process of information during thinking, problem solving and remembering while learning styles are concerned with the application of the cognitive styles during the process of learning (Cassidy, 2004). Learning style is the way individuals concentrate on, absorb, and retain new or difficult information or skills (Bohn, Rasmussen & Schmidt, 2004; Dangwal & Mitra, 1999). When people learn, they use learning styles that are uniquely their own, but make adjustments, depending on the nature of the task and the teaching style being used. Learning styles are different ways that a person can learn. Learning styles theory is not included in many instructional design projects. However, a brief of the learning styles are included here because first, there is need to create learning materials and techniques that communicate to learners of all the different learning styles indiscriminately (Sharp, 1999). It is therefore essential for the educators and instructors to be well identified with the different learning styles. Secondly, learning styles, if identified well in advance, can help students understand their learning style problems and this can extend and solve or understand any possible problems and conflicts between the instructors and the learners. Thirdly, learning styles if considered can help in the improvement of interpersonal communication and teamwork (Sharp, 1999). Information regarding the preferred learners' learning styles should be identified at the point of learner analysis (Mehlenbacher, 2002).

Felder (1993) suggests that students can be characterized broadly in terms of the type of information they prefer (sights, sounds, or texts), their preferred modality (visual or verbal), their preferred organization of information (inferred or deductive), their approach to processing information (active versus reflective), and how they move toward understanding (sequentially or holistically). He further outlines five questions about a learners learning style that would lead to identifying with the learners' learning styles. These questions are

1. What type of information does the student preferentially perceive: sensory---sights, sounds, physical sensations, or intuitive---memories, ideas, and insights?
2. Through which modality is sensory information most effectively perceived: visual---pictures, diagrams, graphs, demonstrations, or verbal---sounds, written and spoken words and formulas?
3. With which organization of information is the student most comfortable: inductive---facts and observations are given, underlying principles are inferred, or deductive---principles are given, consequences and applications are deduced?
4. How does the student prefer to process information: actively---through engagement in physical activity or discussion, or reflectively---through introspection?
5. How does the student progress toward understanding: sequentially---in a logical progression of small incremental steps, or globally---in large jumps, holistically? (Felder, 1993: online)

Studies on learning styles show there is a relationship between users' navigation pattern and behaviour with their learning styles (Sheard & Lynch, 2003). For example, a study by Lieglea and Janicki (2004) found out that different learners have different navigational characteristics. In their study, they used two very general groupings of learners according to their learning styles, observers and explorers, and measured their navigational patterns against a quiz at the end of a learning module. Although the research took few attributes of the learning styles that users demonstrate, it gave an indication of the importance of understanding the role played by the learners' learning styles. Assessing students' learning styles provides the instructor with the awareness of their layout and navigational preferences. This knowledge is essential in the design, development, and delivery educational material or resources that are more appropriately tailored to students' expectations, in order to enhance their learning and learning process (Magoulas, Papanikolaou & Grigoriadou, 2003; Wild & Quinn, 1998)

Technology, like the web-based instructional systems "present new challenges and opportunities for accommodating and acknowledging individual differences in styles and preferences through the adoption of appropriate instructional design, learning and support strategies" (Sadler-Smith & Smith 2004:408). They however, state that the same technology can be used to create learning environments and contents that cater for a diverse group of learners. They also underscore the importance of taking learner individual differences into consideration and expanding the need to extend the research to accommodate all the learning styles that can be represented in any learning environment.

Table 4 is adapted from the work of Sadler-Smith and Smith (2004), it summarizes the various constructs that need to be adhered to in the instructional and learning process by the different participants – instructional designers, learners, and learner supporters. Of special focus in this case is the instructional design where the two authors summarize the instructional preferences as

1. Exposure to a diversity of experiences and problem-solving situations to allow learners to sense their preferences.
2. Identification and accessing of others who can provide demonstration, discussion and guided practice (collaborative preference).
3. Making a wider range of learning methods available for learners to sample and gain experience and confidence in using (Sadler-Smith & Smith, 2004: 409).

It is important that the instructional preference adopted be sufficient, appropriate and consistent with the different learning styles of the learners. Finally, content-by-strategy interactions take precedence over learning-style-by-strategy interactions regardless of the instructional style or philosophy of the instructional situation.

Table 4: The actors and associated strategies mapped against styles and preferences

	Construct		
Actor	Cognitive style	Learning style	Instructional preference
Instructional designers' strategies	**Giving structured route through learning (wholist style)** **Giving global perspective of the content (analytical style).** **Verbal presentation of information (verbaliser style).** **Visual presentation of information (imager style).** **Presentation of information dual mode (i.e., pictorial and textual) (verbaliser and Imager style).** **Making structure and scope of content explicit as well as its relationship to other topic areas (wholist and analytical styles).**	**Grounding new learning in a context of experience (development of activist style).** **Providing opportunity for deliberation, reflection, and articulation of knowledge (development of reflector style).** **Access to additional information for in-depth pursuit of conceptual/theoretical bases of taught content (development of theorist style).** **Clear articulation of potential application of new learning (development of pragmatist style).** **Integration of reflection and theory (off-the-job learning) with experience and application (on-the job learning).**	**Exposure to a diversity of experiences and problem-solving situations to allow learners to sense their preferences.** **Identification and accessing of others who can provide demonstration, discussion and guided practice (collaborative preference).** **Making a wider range of learning methods available for learners to sample and gain experience and confidence in using.**
Learners' strategies	Translating pictorial presentation into verbal presentation (verbaliser style). Translating verbal presentation into pictorial/diagrammatic presentation (verbaliser style).	Predisposition to becoming more self-aware. Acknowledgement of individual strengths and weaknesses in learning style. Development of action plan to enhance weaknesses	Predisposition to becoming more self-aware. Acknowledgement of individual preferences and biases. Commitment to exposure to wider range of learning methods.
Supporters' strategies	Identification and understanding cognitive style. Exposition of learning strategies to accommodate cognitive styles. Integration of cognitive styles awareness into a learning contract. Identification of tasks and resources to support learning contract.	Negotiation of learning contracts that integrate reflection and theory (off the- job learning) with experience and application (on-the-job learning). Counselling learners in exploring realms outside their habitual learning style.	Making available wide range of alternative delivery mechanisms. Counselling of learners as to value of methods that may not match their preferences.

(Source: Sadler-Smith & Smith 2004: 409)

2.6 Theories and Design models

Wilson (1997) identifies three qualities of a good theory as helping in the "envisioning of the new worlds", helping "us make things" and "keeping us honest". He however, warns against the use theories arguing that strict adherence to any particular theoretical viewpoint often filters our perceptions and blinds us to important lessons of reality. These theories are however important as they provide guidance with the methods that best facilitate learning under different situations, learning tool features that best allow an array of alternative methods to be made available to learners, System features that best allow an instructional design team to design quality-learning tools (Reigeluth, 1999).

The behaviourist models will be more focused on the content while the constructivist models will put their attention to the learners. The cognitive models advocate for more reflection and hence there is more support for reflection during the instructional period. The cognitive model articulates the reasoning that the learners should use while engaging in a learning activity.

Table 5 (in the next page) summarizes the three learning theories discussed so far. The summaries are outlined defined by various topics or issues that are considered. The table also shows the alienation of how the different theories approach or define them. Of important concern to the design of an instructional design subsystem is the "Features of ISD products". This stipulates the essential attributes and systems guidelines to guide the designers of the systems throughout the design process.

Table 5: Instructional and learning models: the ISD process

Instructional and Learning models: The ISD process			
Characteristics	Behaviourism	Cognitivism	Constructivism
Objectives	Predefined learning objectives	Performance objectives; integration of multiples objectives	Objectives & negotiated goals emerge across the process – not the same for each learner
Features of design and development process	Linear sequence of steps; independent, discrete phases	Linear process, with feedback and revision; iterated phases	Non-linear, recursive design and development; at times even chaotic
	Design of instructions separate from implementation	More integration; some strategies are selected during instruction	Roles of designers and actual educators converge
	Systematic labour-intensive development methodology	Creativity in design and development	Open system of design and development; Holistic and reflective
Features of ISD products	**Reductionist: components parts decontextualised**	**Integrative: Parts-into-wholes; Transactions**	**Holistic: Construction, complexity and contextual**
	Identify objectives; identify components of performances	**Identify objectives; identify procedures that enable performance**	**Identify case study or problem**
	Deterministic and replicable	**Integrate effective and cognitive issues**	**Unpredictable and indeterministic**
	Pre-planned learning experiences	**Pre-planned options**	**Environments provided with resources and tools; Learners supported.**
	Rigid methods	**Flexibility within the given framework**	**Incorporated subversion**
	Learning designed to achieve outcomes	**Learning design to result in mental processes**	**Designed to stress learning gain**
	Instructional strategies appropriate for the kind of learning	**Cognitive strategies focusing on developing learners' knowledge structures**	**Principles, guidelines**
Evaluation	Emphasis on summative evaluation	Emphasis on formative evaluation	Formative evaluation by learners and experts
Role Players	Expert ID practitioners produce instructions	Professional designers	Participatory, negotiated design, including user-designers and teachers/trainers/instructors
Research approach	Proven strategies; Media comparisons; Empirical analysis; Research-based	Cognitive science information processing theory	Qualitative, real-world effects; subjective analysis

(Source: De Velliers, 2002; Dick et al, 2001)

2.7 Implications to Instructional Design System for the Web and the Way Forward

In this section, the implications that the literature above has on the design of the instructional design subsystem for the web is brought together. As demonstrated, instructional design field, and indeed the process has so many aspects, issues and challenges that should be considered individually and jointly during the design of the said system.

In table 6, the issues that have been tackled in this literature review are tabulated in a continuum. From this tabulation, the pertinent issues to consider in the design of the instructional design subsystem are underscored.

Table 6: Instructional Considerations: All under one umbrella

Centre of control of the instructional process

Instructor Centred ←	→	Learner Centred
Learners have very little directly transferable prior knowledge about a skill or content area.	Learners have some prior knowledge & need more advanced knowledge to solve complex and domain specific problems.	Learners have extensive experience that can be transferred from previous phases of learning and require little guidance

Level of expertise

Ignorance ←→ Expertise

Type of engagement with the learning environment

Delivery of Information be instructors or experts	Students' generation of ideas with instructor guidance	Engagement of student with minimum guidance	Engagement in real life situations with minimum or no guidance

Cognitive Levels of the Bloom's Taxonomy

Knowledge	Comprehension	Analysis	Application	Synthesis	Evaluation

Instructional Theory in use

Behaviourist	Objective-Cognitive	Cognitive	True-Cognitive	Constructivist

Instructional Method

Direct instruction	Interactive Instruction	Indirect instruction	Independent study	Experiential Learning
Lectures Panels Demonstrations Drill and Practice	Guided discussions Cooperative learning Role playing Brainstorming Discussion	Case Studies Problem-based learning Concept maps Problem solving Reflective Discussion	Reports Essays Assignments	Experiments Surveys Field trips Simulations Role playing storytelling Problem-based Learning

Providing information Developing step-by-step skills and strategies Introducing other approaches and methods Teaching active listening and note making	Activating student interest and curiosity Developing creativity and interpersonal skills and strategies Exploring diverse possibilities Forming hypotheses and developing concepts Solving problems Drawing inferences	Activating student interest and curiosity Developing creativity and interpersonal skills and strategies Exploring diverse possibilities Forming hypotheses and developing concepts Solving problems Drawing inferences	Accessing and developing student initiative Developing student responsibility Developing self-reliance and independence	Focusing on processes of learning rather than products Developing students' knowledge and experience Preparing students for direct instruction
Summary of when to use the methods				
Effective in providing students with knowledge of steps of highly sequenced skills and strategies Limited use in developing abilities, processes, and attitudes for critical thinking and interpersonal or group learning Students may be passive rather than active learners	Student motivation and learning increase through active involvement in groups Teacher's knowledge and skill in forming groups, instructing, and guiding group dynamics are important to the success of this approach Effective in assisting students' development of life skills in co-operation and collaboration	Students learn effectively from active involvement Allows for high degree of differentiation and pursuit of individual interests Teacher requires excellent facilitation and organizational skills Focused instruction of content and concepts may be difficult to integrate	Students grow as independent, lifelong learners Student maturity, knowledge, skills, and strategies are important to success Student access to resources is essential Approach may be used flexibly (it may be used with individual students while other students use other approaches)	Students understanding and retention increase Hands-on learning may require additional resources and time
Roles of the teacher				
Teacher ensures a degree of student involvement through didactic questioning	Teacher forms groups, teaches and guides small-group skills and strategies	Role of teacher shifts to facilitator, supporter, resource person Teacher monitors progress to determine when intervention or another approach is required	Teacher guides or supervises students' independent study, teachers knowledge, skills and strategies that students require for independent learning and provides adequate practice	Teacher may wish to design the order and steps of the process

Mode of learning		
Instructor	Instructor facilitates, materials presented activates	Negotiation and collaboration
Determinant of learning		
Behavioural change	Reorganization of internal knowledge structures	Interpretation of meaning from the environment

2.7.1 Web-based Instructional Systems

The use of web in the field of education has evidently changed the approach of learning and teaching. The modes of conveying instructions and presenting them to the learners have seen a lot of improvements in the recent past. Many institutions, corporate and educational, have adopted the use of web-based learning systems (WebCT, Blackboard, and KEWL among others). The numbers of Web-based courses and systems has seen a tremendous increase and improvements (Hanna, 1998). More and more Higher Education Institutions (HEIs) are reaching students globally through the use of the internet. These systems offer stable and reliable ways to present content, however they provide few alternatives for teachers in terms of learning designs (Oliver & McLoughlin, 2003). These systems need to make the instructors' job easy by providing easy to use tools so that they can be used even by inexperienced instructors and at the same time reduce the time and effort spent in creating the course materials (Avgeriou, Papasalouros , Retalis & Skordalakis, 2003). Automating the process of instructional design is not simply a transformation of one specification into another; it involves complex and referential tasks that are required to be done by the instructional designer.

Systems that support the instructor throughout the instructional design process are a promising way to increase the instructor's productivity and the quality of the resulting Instructional materials (Avgeriou et al, 2003). An Instructional Design subsystem is a computer-based application that automates part or whole of the instructional design process. It takes the instructor through all the steps required to come up with a quality instructional material (Berger, 2003). Instructional design is as old as teaching and learning. It has been used in classrooms, military training, work places and distance education. However, with every new innovative technology at play, the instructional design requirements and process are also changing. Web-based instructional design is congruent to instructional design in distance education in terms of the aspects of space, distance and time. Evolution towards technology supported education in distance education has leaped especially because of the use of web technologies.

Although instructional designers have been known over the years to create effective teaching and learning products, introduction of new technology set in new demands, terms and rules to guide the work (Israelite & Dunn, 2003). Web-Based instructional design is a relatively new technology and there is a lot of research going on in this area. For the web-based solutions to play a significant role in the provision of educational material there is need "for significantly improved methodology and tools to guide the design and development of high quality interactive technology-based instructional materials" (Merrill, Li & Jones, 1989:9). The first and most useful ingredient of any online education is the instructional design (Reynolds, 2000). Learning theories and instructional design models need to be modelled in these systems as the basis of the ultimate process. This involves identification and use of the right technologies and tools with the best instructional theories, models and strategies.

Instructional problems are usually recurrent and complex, and always appearing in almost the same contexts or settings. A good instructional design approach should therefore be able to address the problems in their contexts. The approach should be reusable to avoid re-inventing the wheel whenever a similar problem is encountered. It should also be modular to deal with the complexity of the process and at the same time it should be adaptive to new contexts or situations. The approach should also be scalable – have the capability to be easily modifiable to fit and deal with the complexity or the instructional process.

2.7.1.1 Object Oriented Designs

Available technologies influence the way in which instructional designers accomplish their tasks. The web presents a visible evidence of how technology influences the instructional design process (Spector, Edmonds & Geralds, 2002). Innovative improvements to the technology available cannot be underrated. These improvements are usually borrowed from other disciplines and modified to fit the problem situation. Instructional design researchers have acquired some of the known best practices from software methodologies. In the design of instructional materials where modularity is an issue, object-oriented designs have been used.

Object oriented designs have been used in the field of software design as a way of solving complex software problems. A modular design, where a complex task is broken down into smaller solvable units that can be integrated to solve the main task is widely used in most fields. Instructional design being a complex task (Spector et al, 2002), breaking it down into smaller units can be used to accomplish it. This implies that the instructional designers can easily and quickly build and assemble various components of web-based course (Jun & Gruenwald, 2001).

2.7.1.2 Learning Objects

Recent research in the area of instructional design for web-based learning has focused on the use of Learning Objects (LOs), similar to object orientation as used in the software development field. LOs have been defined as "elements of a new type of computer-based instruction grounded in the object-oriented paradigm of computer science" (Wiley, 2000:3). Wiley (2000) further states that LOs will form the next generation of instructional design, development, and delivery, due to the advantages brought about by their object oriented design nature.

Though Learning objects have been described as having a design that is reusable, modular, adaptive and scalable, they have been criticized as neither being simple, compatible or offering any relative advantage over existing teaching practice (Friesen, 2004). There is also lack of instructional and pedagogical principles in the design, standard setting and sequencing of the learning objects to form complete instructional materials (Mohan & Brooks, 2003; Wiley, 2000). The cost in human resource and time for assembling the already available learning objects can be as high as developing new ones (Friesen, 2004; Wiley, 2000).

For the LOs to be used, then some work need to be done in incorporating the pedagogy and creating LO standards. But still this does not guarantee that the LOs will be simple and compatible, neither does it assure the designers that the costs and time involved in their development will be minimized.

2.7.1.3 Design Patterns

As stated at the beginning of this section, a solution to the complexity of instructional design is being sought. The design patterns could be considered here due to their problem-solution combination and their robustness in the approach of dealing with complex tasks. The design pattern approach involves the formation of a common language or mode of solving the recurrent problems in their contexts (Appleton, 2000) during the instructional design process. Design Patterns can be used to formally codify the solutions and their relationship as stated below:

> A design pattern systematically names, motivates, and explains a general design that addresses a recurring design problem in object-oriented systems. It describes the problem, the solution, when to apply the solution, and its consequences. It also gives implementation hints and examples. The solution is a general arrangement of objects and classes that solve the problem. The solution is customized and implemented to solve the problem in a particular context. (Gamma, Helm, Johnson & Vlissides, 1998).

The focus of the problem-solution combination is not on the technology, but on the refinement of the sound principles that are well created and documented (Appleton, 2000). Design Patterns provide greater modularity as a means of controlling the growing complexity of design processes. Instructional material developed using modular approaches will be designed and delivered as components that are not only reusable, but also user customizable, cheap and easy to modify (Roschell, Kaput, Stroup & Kahn, 1998; Henderson, 1998).

The idea of capturing design ideas as a pattern is usually attributed to Christopher Alexander, an American architect according to whom a pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice. The problem – solution combination is presented in such a way that you can judge it for yourself, and modify it, without losing the essence of it(Alexander et al, 1977).

Table 7 outlines main components of a pattern as identified by of Alexander et al (1977):

Table 7: Components of Alexandrian patterns

Component	Brief Description
Name	A name to identify the pattern that clearly expresses the essence of the pattern. The name should be meaningful, as it forms part of the vocabulary for the pattern language, as well as a summary description of what the pattern is intended to do.
Context	The situation(s) where the pattern is relevant. This includes definition of the audience the pattern is targeting the organizations and the environment (context and situation) where the solution is intended to be applied.
Forces	The forces present which may constrain or suggest alternative solutions. When these forces are in tension with one another, the problem is harder to solve and a compromise may be necessary.
Solution	A solution which resolves, as far as possible, the various forces.

(Source: Alexander et al, 1977)

These components were further split and elucidated, using ideas from software engineering, by the 'Gang of Four' (Gamma et al, 1998). Table 8 outlines briefly the components of the patterns.

Table 8: Pattern description according to Gamma et al	
Component	Brief Description
Name & Classification	Convey the essence of the pattern succinctly.
Intent	Statement of answer to: what does the design pattern do? What is its rationale and intent? What particular design issues or problems does it address?
Also Known As	Other well-known names of the pattern, if any.
Motivation	A scenario that illustrates a design problem and how the class and object structures in the pattern solve the problem. Helps in understanding more abstract description of the pattern that follows.
Applicability	What are the situations in which the design patterns can be applied? What are the examples of poor design that the pattern can address? How can these situations be recognized?
Structure	A graphical representation of the classes in pattern using a notation based on the Object Modelling Technique (OMT).
Participants	What are the classes and the objects participating in the design pattern and what are their responsibilities?
Collaborations	How do the participants collaborate to carry out their responsibilities?
Consequences	How does the pattern support its objectives? What are the tradeoffs and results of using the pattern? What aspect of the system structure does it let you vary independently?
Implementation	What pitfalls, hints, or techniques should you be aware of when implementing the pattern? Are there language-specific issues?
Sample Code	Code fragments that illustrate how you might implement the pattern
Known Uses	Example of pattern found in real systems
Related Patterns	What design patterns are closely related to this one? What are the differences? With which other patterns should this one be used?
References	Sources of additional information regarding the use of the pattern

(Source: Gamma et all, 1998)

The pattern description by Alexander (1977) is very abstract and does not give sufficient details for the implementation of a solution. Gamma et al (1998) give a more detailed and complete description although its main focus is on the software design.

2.7.1.4 Instructional Design Patterns

A system that employs instructional design theory and research as was used. This system is a good start towards quality assistance to instructors creating course materials for the web. Good designers do not solve problems using first principles. They use known solutions that worked in the past and adapt them to fit the problem they are tackling at the moment (Gamma et al, 1998). A good instructional design approach should therefore incorporate a wealth of common and good practice from experiences from the past or from expatriates in the field that can be adapted and reused in other situations. Instructional patterns provide mechanisms to capture the best instructional strategies and policies so that they can be used to assist instructors in creating instructionally sound learning content and activities, or learning objects (Wiley, 2000; Frizell & Hubscher, 2002a; Frizell & Hubscher, 2002b; Avgeriou et al, 2004). Although patterns have been in use in engineering and other disciplines for a number of years, in e-learning they have not been widely used. Nonetheless, over the last few years some projects have emerged. This projects provide a good reference for patterns for the this study.

The E-LEN Project (2003), a collaboration of a European institutions embarked on creating a network of e-learning centres and organizations in the learning technologies. Their aim was to develop and disseminate pedagogically informed technology by identifying and gathering "best practices" for effective e-learning experiences. According to the project coordinator, the project is now over (Retalis S, 2005, 11 July, email) having published a number of e-learning patterns.

The Pedagogical Patterns Project (PPP, 2005) aims at capturing "expert practice" of experienced teachers to enable sharing of "effective teaching techniques". It has a collection of patterns for a number of educational scenarios for both teachers and students. The collection of patterns for a "common problem space" may be grouped together to form a pattern language for "solving complex problems". The PPP has been criticized for not including or explicitly addressing the use of learning technology (Derntl & Motschnig-Pitrik, 2004).

2.7.2 An eclectic and pragmatic approach

Can there be a neutral design that considers all the theories and brings them to a compromise or consensus?

At the beginning of this section (2.7) there is a continuum that combines the various aspects of instructions, teaching and learning. As depicted, there are no clear cut conclusions or prescriptions of what are known not work best, and at what situation or using any particular approach. For example, in the case of instructional theories and their relationship with the centre of control of the instructional process, the behaviourist theories are better places for learner that has little directly transferable prior knowledge or skills on the content area. Constructivist theories on the other hand are good in situations where the learners have extensive experience that can be transferred from previous phases of learning and the same time with little or no guidance.

The choice of approach should therefore be intricately crafted taking into consideration all the disjointed factors that contribute and affect the whole instructional design process. Excess care should be observed to base every instructional design action or practice to the theory for without theory experience has no meaning. On the same note, the practice should also inform the theory – although this is beyond the scope of this research.

The issues of complexity of the process need also to be put into consideration. The approach should be such that the complex tasks can be broken down into constituent parts, that can be realized separately, and when knit back together, they jointly offer the required solution. Mapping the complex instructional problems to a working solution through the use of the design patterns is the favoured approach. In specific, the patterns arguments (sections 2.7.1.2 and 2.7.1.3) if adopted, will offer solutions that are modular, reusable and with great control over the complexity of the process. The instructional patterns identified should stem from the existing recurrent practices – what instructors are known to do, over and over again, and be informed by the existing research and theory. The scenarios of the instructional patterns should be well crafted to reflect what the instructors do without dwelling too much on the details that might obstruct them during their work.

A model for instructional design that facilitates the systematic creation of learning materials should be adopted. This should be taken in due recognition and consideration that Web-based instruction is completely different from the traditional lecture-based approach. For this reason, the model that is chosen should be one that can be validated easily and at the same time lead to the efficient creation of learning materials that are in themselves efficient and effective. The approach in the model should considerable reduce the course developers frustration, as well as project costs and development times.

The presentation guidelines, technical and content requirements for the web are also different and unique and the model or approach that should be considered should guide the course creators in creating the content presentations and layouts. Because Web based instructions assumes a more learner-centred approach, it is very important that instructors use or be willing to use strategies that give control of the learning process to the learner. Instructors should be encouraged to use alternative instructional approaches that include a more learner-centred approach. Consequently the model and theories that should be put into place should reflect and use these strategies.

The model should seek to accommodate a variety of learning styles by using multimedia instruction when possible. In line with this, the use of the technology and the media should support learning goals, domains and types of interaction.

There are also some special requirement in web-based instructions with regard to students' assessment and evaluation. The approach adopted should have a variety of evaluation and assessment tools and alternatives that the educators can use.

Finally, the approach should allow for evaluation of the effectiveness of web-based instructions for a particular project as a whole.

2.7.2.1 Patterns used in this study

Specific focus in this case is design patterns for instructional design. We therefore need to look at the components in section 2.7.1.3 and identify components of concern that capture the instructional problem-solution more succinctly. For this thesis the table 9 below details the elements that are used to describe the patterns.

Table 9: Components of the instructional patterns used

Component	Brief Description
Name	The name of the pattern: should convey the meaning of the pattern succinctly
Intent	Statement of answer to: what does the instructional design pattern do? What is its instructional rationale and intent of using it? What particular instructional design issues or instructional problems does it address?
Motivation	A scenario that illustrates an instructional design problem and the pattern seeks to solve the problem. This would give a background of the problem and the instructional theory or research that could be used to implement it. Helps in understanding more abstract description of the pattern that follows.
Solution	A solution which resolves, as far as possible, the various forces that are involved in the instructional design problem.
Consequences	How does the pattern support its objectives? What are the tradeoffs and results of using the pattern? What aspect of the instructional design process does it let the users vary independently?
Known uses	Example of pattern found in real systems.
Related patterns	What design patterns are closely related to this one? What are the differences? With which other patterns should this one be used?
References	Sources of additional information regarding the use of the pattern

For this research, the following tasks are undertaken in forming instructional design patterns:

1. Patterns are identified through a search of the literature on instructional design.
2. These patterns are then validated with expert instructional designers.
3. The recurrent tasks performed by instructional designers for e-learning courses are identified.
4. The tasks identified then form a problem base to work with.
5. A solution is developed for the problems identified through the alignment of instructional design research
6. A context is defined within which they can be applied
7. Patterns are validated by subjecting them to instructional design experts.
8. Finally an instructional design tool is developed based on the identified patterns.

Chapter 4 will give details of all the patterns that were identified and how their implementation can be applied to a web-based learning system. In the next section, the software development approaches that were considered for the implementation of the patterns are considered.

2.7.3 Software development approaches

The design pattern approach discussion above not only deals with the complexity of the instructional design, but also deals with the complexity of the software design process. Each of the patterns identified can be implemented independently from each other. Software engineering as a domain was established in 1968; however software process model appeared in the earlier (Simons, Parmee & Coward, 2003) to incorporate the use of "sound engineering principles to obtain economically viable software that is reliable and works efficiently in real machines" (Simons, Parmee & Coward, 2003: 349). The software design issues that were noted then still remain due to the abstract nature of software, scoping and structuring or ill-structure problem spaces, and the inherent complexity arising from requirements variations that lead to "confusion as to how the software design process my effectively and efficiently iterate" (Simons, Parmee & Coward, 2003: 349).

Software designers use various models or frameworks to information systems and software. These frameworks have been referred to as the Software (or System) Development Life Cycle (SDLC). A software life cycle model is either a descriptive or prescriptive depiction of how software is or should be developed (Scacchi, 2002). It either describes the history of how a particular software system was developed as a basis for understanding and improving software development processes, or for building empirically grounded prescriptive models. Prescriptive models prescribe how new software system should be developed – forming the guidelines or frameworks to organize and structure how software development activities should be performed, and in what order. There are many versions of the SDLC, each with their own strengths and weaknesses. The waterfall model of software was defined in the 1970s to cope with the complexity of the software development projects (Davis, Bersoff & Comer, 1988). The use of the waterfall model encourages the specifications of what the system is supposed to do before building it, the planning of the components and how they are going to interact, demands documentation of every process and step. Following all the steps in the waterfall leads to reduced development and maintenance costs and enables the development of a more structured and manageable system.

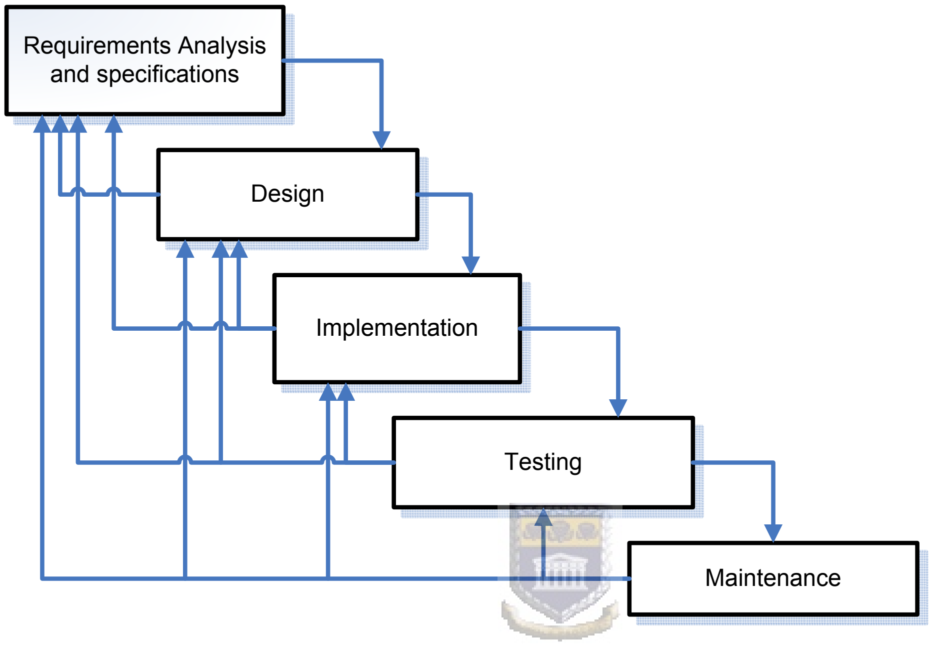


Figure 11: The waterfall model of software development

(Adapted from Davis, Bersoff & Comer, 1988)

The waterfall model is so idealized that it does not march the reality of most development contexts. In most software development projects, it is very difficult to get accurate requirements early in the project because of among other things the changing of user needs as days or design progresses, and the ill-structure of real design project (Boehm 1988).

The prototyping model is a software development process that begins with requirements collection, followed by prototyping and user evaluation. Often the end users may not be able to provide a complete set of application objectives, detailed input, processing, or output requirements in the initial stage. After the user evaluation, another prototype will be built based on feedback from users, and again the cycle returns to customer evaluation. The cycle starts by listening to the user, followed by building or revising a mock-up, and letting the user test the mock-up, then back.

The Spiral model was defined by Boehm (1988) as a solution to the difficulties of using the water fall model. It is a development model combining elements of both the design and prototyping. Spiral development is a family of software development processes characterized by repeatedly iterating a set of elemental development processes and managing risk so it is actively being reduced.

> The spiral development model is a risk-driven process model generator that is used to guide multi-stakeholder concurrent engineering of software-intensive systems. It has two main distinguishing features. One is a cyclic approach for incrementally growing a system's degree of definition and implementation while decreasing its degree of risk. The other is a set of anchor point milestones for ensuring stakeholder commitment to feasible and mutually satisfactory system solutions. (Boehm B & Hansen, 2001:4)

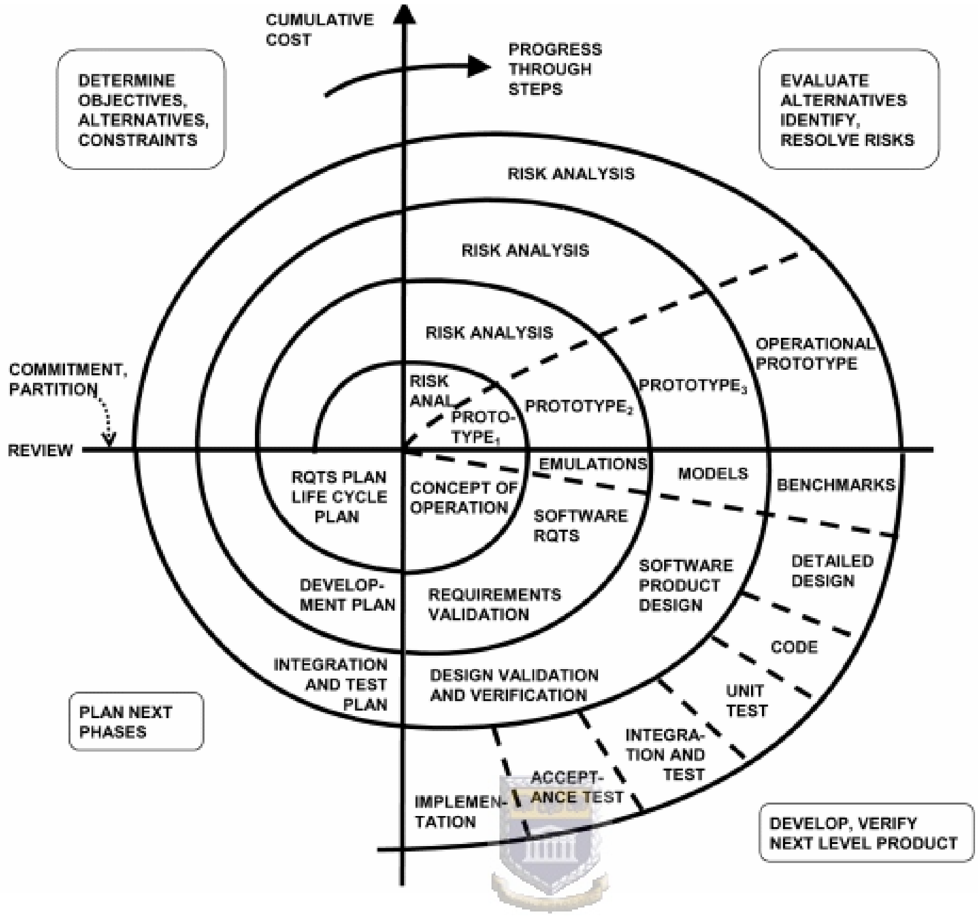


Figure 12: model of the software process

(Source Boehm, 1988:64)

The spiral models is an evolutionary models with its attention one the mechanisms that give rise to changes made in a system. Systems designed using the evolutionary approach evolve in response to actions stakeholders make to make the system suit there needs – making them flexible to changes, and at the same time offering the stakeholders opportunities to do the changes (Scacchi, 2001).

In the project, an evolutionary model was taken into consideration in line with the Open Software development approach. The Open Source development approach is chaotic without any hierarchy or centralized control and based on highly interactive systems which are iterative and evolutionary in nature (Raymond, 1998; Healy & Schussman, 2003). The evolution takes the iterative form of **P**lanning and initial release → **D**eveloping → **T**esting → **S**tabilizing → **R**eleasing with each release being superior to its predecessor.

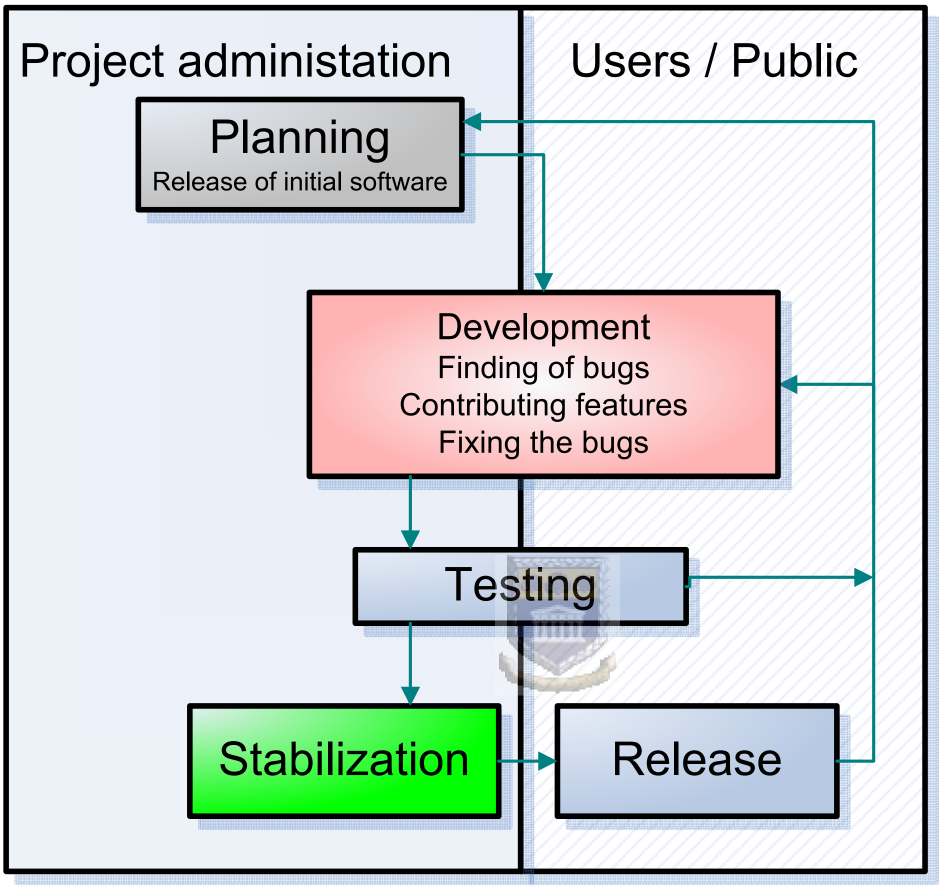


Figure 13: The Open Software development model

(Source: Author)

2.7.3.1 Bringing Design Patterns and the models together

In section 2.7.1.3 the use of design patterns to control the complexity of the design was underscored. This approach can be used as mentioned earlier to control the complexity of the software design process. The patterns identified can be designed and implemented in software individually as modules and then knit together to form the instructional design subsystem. A Software Development Life Cycle that takes into account the pattern approach and the major process in the SDLC: The SDL-pattern was used. The SDL-pattern Pattern approach (SDL-pattern) was used in the design due to the following reasons:

a) the research approach used is iterative and having a lot of stakeholders
b) the design patterns approach used in the study
c) the complexity of the instructional design field
d) the open source nature and philosophy behind the development of the final system.

The SDL-pattern approach "integrates the SDL-based system development with the pattern paradigm" (Geppert & Robler, 2001: 627). It starts with the domain analysis – an investigation of the essential domain concepts in order to minimize duplication of efforts and also to get the requirements and analysis them. The results of the domain analysis are used as the basis for the identification of the patterns that define the problem and (suggested) solutions. In the table (table 10) below, a brief comparison of the Software Development Life-cycle framework and the SDL-pattern are presented as used in this study.

Table 10: Comparison of SDL framework and SDL-pattern

SDL framework	**SDL Pattern**	**Instructional design subsystem**
Requirements	Requirements & domain Analysis	Literature review and interaction with the stakeholders.
Requirements Analysis	Generation a pool of design patterns	Identification of instructional patterns
SDL Design • Requirement models • Systems Analysis	Pattern Based Design • SDL Pattern Selection • SDL Pattern Application • Ad hoc design	Selecting patterns from the identified list and designing each of the patterns identified separately.
System Design		
SDL Design Model	SDL Design Model – specifications and assumptions.	Instructional patterns describing the problems, solutions and when you can apply them
Validation	Validation to show that each of the patterns achieve their objectives	Validation to show that each of the patterns achieve their objectives
Implementation	Selection of the development environment and tools	Selection of the development environments and tools.

Chapter Three

Research Design and Methodology

3.1 Introduction

This chapter outlines the research design and methodology used in this study. The first section describes in details the background and advantages of the research methodology as applied in this study. Section 3.2 explains the developmental research followed by a section on how the actual research was done. A summary of the whole process is provided in section 3.4.

3.2 Developmental research

A developmental research/design experiment approach was used for this study. This was a break from the traditional educational research that does not often lead directly to practical advances or build strong linkages between research-based insights and improved practices. The break was meant to realign educational systems by improving the coordination between research, design, development and practice (Burkhardt & Schoenfeld, 2003). Developmental research, as used in this study, is a process, or a research approach whose intent is to produce knowledge with the main aim of improving the processes of instructional design and development. Developmental researches in general are "those studies that involve the production of knowledge with the ultimate aim of improving the process of instructional design, development, and evaluation" (Richey, Klein & Nelson, 2004: 1099).

The research process in developmental research starts with a researcher choosing methods based on the questions to be addressed. However, the questions, issues or topics of the study themselves may change as the researcher's "conception of the reality of the "world" being studied changes" leading to research methods being "adjusted, expanded, modified or restricted on the basis of the information acquired" (Savenye & Robinson, 2004: 1050). Design-based research or design-experiments are series of developmental research approaches whose aim is to continuously study the learning and instructional theory with the aim of producing new artefacts, theories and practices that have a direct impact on teaching and learning (Barab & Squire, 2004). In this study, the phrases design-based research, developmental research, and design-experiments are used interchangeably.

Figure 14 demonstrates the developmental research process and outlines the roles played by the different stakeholders in the process.

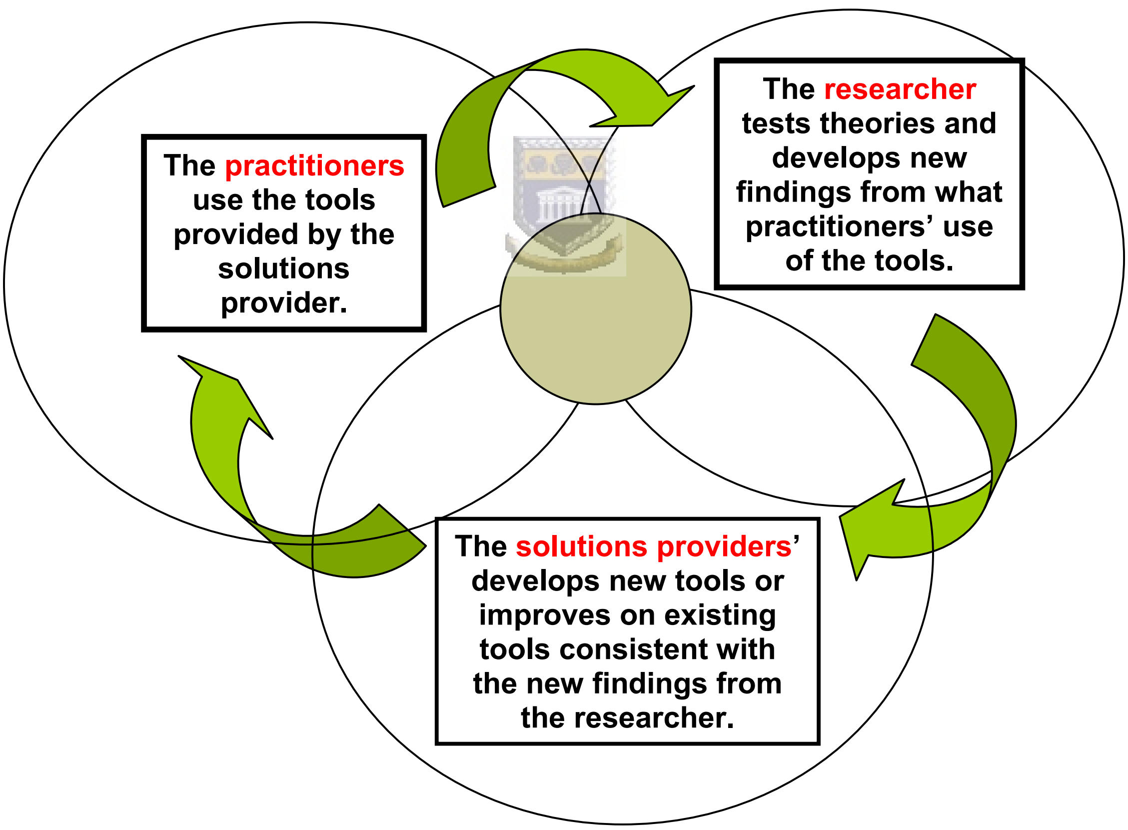


Figure 14: Developmental research

(Source: Author)

Reeves (2000) advocating for the use of developmental research in instructional technology identified three problems with the current and existing research in the field. The problems are noted as the difference between basic and applied research, the poor quality of instructional and educational research and disappointing research syntheses that leads to disappointing results that leave both researchers and practitioners in the field confused.

Reeves (2000) further details the research goals commonly pursued by researchers in the educational and instructional field. He identifies six goals as summarized in the table 11.

Table 11: Instructional research goals and corresponding research methods

Research goal	**Focus**	**Research Method**
Theoretical	Explain phenomena through analysis and synthesis of theories, principles, and the results of other research forms.	Long term synthesis, generalization, and theory construction
Empirical	Determining how education works by testing conclusions related to theories of teaching, learning, performance, assessment, social interaction, instructional design among others.	Experimental; Quasi-experimental; Causal-comparative; Correlational; Descriptive
Interpretivist	Portraying how education works by describing and interpreting phenomena related to teaching, learning, performance, assessment, social interaction, instructional design among others.	participant observation; interviews; conversational analysis; grounded theory; Case studies; conversational and textual analysis; expansion analysis
Postmodern	Examining the assumptions underlying contemporary educational programs and practices with the ultimate aims of revealing hidden agendas and/or empowering disenfranchised minorities.	Ethnography; deconstruction; textual analysis
1. Developmental	**Dual objectives of developing creative approaches to solving human teaching, learning, and performance problems while at the same time constructing a body of design principles that can guide future development efforts**	**Observational; Correlational; Experiments; Quasi-experiments; grounded theory; Case studies;**
Action	Focuses on a particular program, product, or method, usually in an applied setting, for the purpose of describing it, improving it, or estimating its effectiveness and worth	Observational; Correlational; Experiments; Quasi-experiments; grounded theory; Case studies;

(Source Reeves, 2000)

The notion of "developmental research" by name is still unclear and more often being confused with research concerned with the study of human growth and development. Richey et al (2004), in a bid to clear the confusion, described the simplest form of developmental research as used in instructional design as either:

- the study of the process and impact of specific instructional design and development efforts; or
- **a situation in which someone is performing instructional design, development, or evaluation activities and studying the process at the same time**; or
- the study of the instructional design, development, and evaluation process as a whole or of particular process components. (Richey, Klein & Nelson, 2004: 1099)

Either or both the qualitative and quantitative forms of inquiry can be chosen to explain or study a certain aspect of the complex context. In this study, a qualitative form of inquiry was used.

Although design experiment approach might look like formative research or action research, Barab & Squire (2004) have identified their main differences by stating that:

> what separates design-based research in the learning sciences from formative evaluation is (a) a constant impulse toward connecting design interventions with existing theory, (b) the fact that design-based research may generate new theories (not simply testing existing theories), and (c) that for some research questions the context in which the design-based research is being carried out is the minimal ontology for which the variables can be adequately investigated (implying that we cannot return to the laboratory to further test the theoretical claims). (Barab & Squire, 2004:5).

An understanding of developmental research can only be gotten from the understanding of the development and research and its purpose, focus, and techniques. The next section is devoted to expand and explain in details the characteristics of developmental research. Section 3.2, describes the development research approach used in this thesis.

3.1.1 Characteristics of Developmental Research

The main characteristics of developmental research can be understood from the purpose, focus and techniques of the research.

The purpose of development research is to optimize and gain a sound basis for instructional development activities. This is achieved through the design of a prototypical instructional products/tools/systems and designing of methodological directions of their design, development, evaluation and refinement. Richey, Klein and Nelson (2004) identified two types of developmental research:

- Type 1 where the study's emphasis is on "the product development process used in a particular situation … and [the] final product is evaluated … and the lessons learned….facilitate" the formation of "context-specific conclusions" (p 1102).

- Type 2 where the study's emphasis is "oriented towards the general analysis of design, development, or evaluation processes addressed either as a whole or in terms of a particular component" and lessons learned facilitation the formation of "generalized conclusions". (p 1103)

The Type 1 developmental research leads to context-specific conclusions for suggested improvements of the design, defining the 'best practices' or conditions for use of the product or tool, the impact of such a tool or product to the general understanding of the whole process, and the conditions that are conducive for the efficient design development and evaluation of the instructional program or product. The Type 2, in its conclusion addresses the issues of the validity and/or effectiveness of a particular technique or model, conditions and procedures that facilitate the successful use of a particular technique or model, explanations of the success or failures encountered in using a particular model or technique, a synthesis of events and/or opinions related to the use of a particular technique or model, and a new or enhanced design, development, and/or evaluation model.

The focus of the developmental research is to reduce human problems or complexities in their daily life or work processes through the design of a product or an activity. As stated earlier in chapter 2, instructional design is a complex task, the focus of this study is therefore to design a web-based instructional system that can ease or reduce the complexities of the instructional design activities.

The techniques used are mainly extensive search and refinement of the existing descriptive research that would lead to streams of knowledge that can be used in the design, development and production of the product. The techniques often start with the evaluation of descriptions of the problem and what document research has about the problem. This gives the current state of the problem and its inconveniences are derived, assessed and documented. It is during the evaluation of the descriptions that the data collection, analysis and reporting are discussed and also a model of the proposed final state is developed. The second phase is the definition of the characteristics of the final states. This, when put in congruent with the model developed usually forms a plan of what need to be done and when. The third phase is the actual development which is also incorporates testing and production of the developed product. The final phase deals with the use and decision making regarding the use of the product together with its future improvements.

3.1.2 Developmental Research Process

Richey, Klein and Nelson (2004) outline the methodological direction of developmental research as follows:

a) Defining the problem
   - Focusing the Problem
   - Framing the Problem
   - Identifying limitations

b) Review of related literature

c) Research procedure
   - Participants
   - Research Design
   - Data Collection, Analysis and Reporting

d) Results and conclusions

This process and how it is used in this study is discussed in details in section 3.3.

3.2 Developmental Research in this Study

The aim of this study is to create web-based tools to assist instructional designers in developing web-based instructional materials – using the best instructional design principles and theories – without requiring extensive training. The methodology chosen therefore sought to identify the best theories and principles, integrating these principles and theories with the web technologies, and at the same time evaluating both the theories and the new innovation (in the technologies) through reflective inquiry for subsequent revision and refinement. As already mentioned, the developmental research approach is a highly cyclical and iterative process, each iterative sequence forming a basis for refinement, as shown in figure 15.

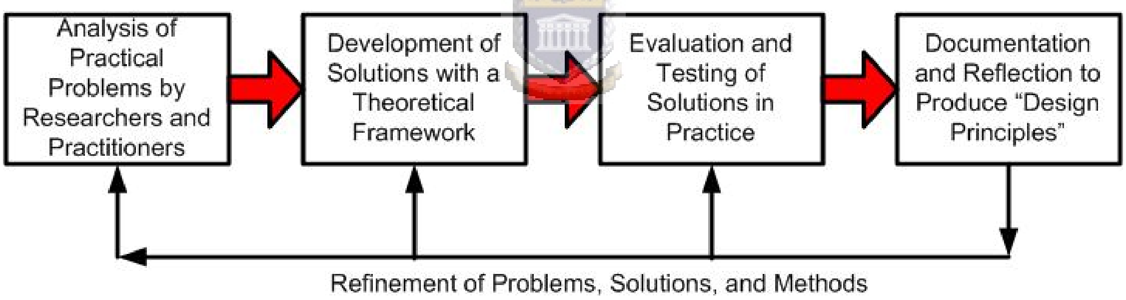


Figure 15: Developmental approach to instructional design system development

(Source Reeves, 2002)

Developmental research used took the form of design experiments. A "Design experiment" as first described by Brown (1992) as an eclectic approach to educational research. It is a series of new approaches to research whose development leads to the realization of new theories, artefacts and practices that improve the learning and teaching in real contexts (Cobb, Confrey, deSessa, Lehrer & Schauble, 2003). A design experiment is a developmental research methodology. Design experiments "have both pragmatic bent - "engineering" particular forms of learning – and theoretical orientation-developing domain specific theories by systematically studying those forms of learning and the means of supporting them."(Cobb et al, 2003:1). With the main aim of engineering an innovative instructional design subsystem and/while simultaneously conducting experimental studies on their innovation (Cobb et al, 2003; Brown, 1992). In essence the choice of this approach can lead to a contribution of both theory and the practice of instructional design. This approach ensured checks and balances and at the same time enabling improvements to the project as new insights and ideas were realized (Naidu, 2003). A design experiment provides practitioners with theory-based guidance on the design and implementation while at the same time providing researchers with a number of theory-based principles that are subject to empirical validation (Jones, et al, 2003).

The critical characteristics of design experiments are:

- Addressing complex problems in real contexts in collaboration with practitioners (Reeves, 2000: 9),
- Integrating known and hypothetical design principles with technological affordances to render plausible innovative solutions to these complex problems (Reeves, 2000; Cobb et al, 2003),
- Conducting rigorous and reflective inquiry to test and refine innovative learning environments as well as to define new design principles. (Reeves, 2000; Dede, Nelson, Ketelhut, Clarke & Bowman, 2004)
- Their goals are in the of design of learning environments and developing theories or 'prototheories' of learning are intertwined (Dede et al, 2004; Cobb et al, 2003),
- Development and research take place through continuous cycles of design, enactment, analysis, and redesign(Dede et al, 2004, Cobb et al, 2003),
- Research leads to theories that communicate relevant implications to practitioners and other designers(Dede et al, 2004), and
- Research relies on methods that can document and connect process of enactment to outcomes of interest.

The design experiments approach is more pragmatic and deals with complexity of contexts, for example, the identification of the theories, assumptions, and methods underlying instructional design whose outcome is a practical visible action or tool. It is open-ended and multi-perspective with its meaning being usefully realized and considered within the contexts it is being applied.

The research design applied in this study had four iterative phases viz, analysis phase, model design phase, model implementation phase and model try-out and evaluation/validation phase. Detailed literature review is done during the analysis phase in chapter two. The result of the analysis phase was used to design and implement the subsystem while the tryout was scheduled to take place when the implementation is complete.

Implications of the design experiments approach in an instructional design subsystem as outlined by Jakovljevic, Ankiewicz & De Swardt (2003) are:

- Contribution to technological problem solving as instructional designers are actively involved in evaluating and testing the instructional strategies and techniques.
- Enhancement of innovative strategies that aid the instructional designer in facilitating the improvements of the subsystem
- The changing instructional methodology through the design experiments suits the “dynamic and complex” nature of instructional design.

3.3 Research Design

This section outlines the actual steps that were followed during the research process. The research design used in the study followed the developmental research approach discussed in section 3.1, thus the research process is discussed under: Defining the problem; Review of related literature; Research procedure; and Results and conclusions.

3.3.1 Defining the Problem

The focus of this study is on the design, for eventual development and implementation of the instructional design process. The research topics focused on the main area of instructional design in web-based learning management systems: analysis, design, development, and implementation and to some extent evaluation of model or process, program, or tool; and identification of the general development principles of situation-specific recommendations. Three major items are discussed under the problem definition and these are focus of the problem, framing of the problem;and identifying limitations.

3.3.1.1 Focusing on the problem

Focusing on the problem involved giving the research project a "development twist" by concentrating on a particular aspect of the design, development, implementation and evaluation process, without focusing on the variables, or the type of media to be used (Reeves, 2000). This established the research parameters, determined how the research was to be conducted, and how much of the design process was to be addressed. Section 3.3.3 gives details of the research procedure used in this study.

The process of instructional design is labour intensive – requiring so many hours to create instructional material (Casey & McAlpine,2003; Frizell & Hubscher, 2002). It is more laborious to create instructional materials for the web-based systems because of their nature and elaborate requirements. Although there is a wealth of research materials and time-tested instructional design principles that could be used to salvage the situation, they have not been incorporated in the web-based instructional systems (Armani et al, 2004; Wiley, 2000; Frizell & Hubscher, 2002). Most of the instructors involved in creating materials for web-based courses are more often task oriented, and do not always have much time to learn and incorporate the instructional design strategies referred to in the literature. The use of the available Web-Based Learning Management systems have been limited due to lack of:

- Web-based instructional systems that are based on well grounded research (Armani et al, 2004; Hardre, 2003; Locatis, 2001; Roschell, Kaput, Stroup & Kahn, 1998).
- An in-built expert instructional design module to guide instructors during the creation of the learning materials. Most parts of the process for these systems are realized from outside these systems. Many instructional developers creating instructional content attempt to do their instructional design at the online authoring stage of the design process (Henderson, 2002; Roschell et al, 1998).
- Sequential and modular way of going through the instructional design process - guidance for interaction and navigational flow to represent the logical sequence of the instructional design process (Oliver & McLoughlin, 2003; Narduzzo & Rossi, 2003; Ullrich, 2003; Henderson, 2002).
- Time saving features and structures to ease the instructional designers work during the course development process (Carmean & Haefner, 2003; Jun & Gruenwald, 2001)

3.3.1.2 Framing the Problem

The nature of developmental research, usually describes the process that are used to explain its goals, and the research questions as opposed to hypothesis are used to serve as the organizing framework of the study. This tactic is appropriate also when there is no firm base on the literature that can be used as a basis for formulating a hypothesis (Reeves, 2000).

Framing the problem in this case involved looking for means to counter the limitation identified in section 3.3.1.1. These limitations always turn users' initial incentive and enthusiasm to frustration, exhaustion, and disappointment (Carmean & Haefner, 2003). Framing the problem was not an easy task and it took a lot of discussion with peers and mentors. After the discussion, there were positions that were made clear and identified that should be included in the problem statement. While the approach to the solutions was the implementation of a web based instructional design subsystem that implements and uses the existing theory and models on instructional design, issues about reporting on a system and the evaluation of the completed system and learning materials developed through its processes were contentious. However, with the agreement that the aim of the research was to come up with a designed product that uses research on instructional design that could be used to help instructors during the process of creating learning materials for the web, initially the following question was chosen:

> How can the instructors be assisted in building instructional material in Web-Based Learning Management Systems to save time during the process, and also allow them to create instructional materials – based on best known instructional design strategies - without requiring extensive training in instructional design and web based authoring?

For clarity and to check that all the issues especially the contentious ones were addressed, the main question was split into several questions that would jointly accomplish it. These questions are:

1. Can an instructional design model be adopted and used to automate the process to come up with instructional materials that are based on pedagogically sound and proven instructional design principles?
2. What instructional design model can achieve the optimum results for web-based instructions?
3. How can the instructional design model be abstracted into computable formats or modules
4. How can this abstraction be realized in a modular way to allow for reuse, generalizability and adaptability, and user customization?
5. What other time saving features can be incorporated in the design?

With the best instructional design practice being informed by principles that are derived from theory (Morrison, 2003), answers to these questions were the guidelines or leads that would culminate to an approach to solve the problem of the instructional design process for web learning management systems.

The research question was however deemed to be very long and the researchers and mentor's feelings were that the question should be made short enough without loosing its nucleus due to over simplification. The revision came up with the following question which was adopted as the main research question for this study:

> **How can instructional design for web-based learning be optimized through the use of existing research?**

When this question was tested against the five questions, it was found out that the question did not lose its original meaning. Questions 1, 2 and 3 were well taken care of by the phrase "existing research" in instructional design while the term "optimizing" took care of questions 3, 4 and 5. Problem definition process in itself also confirmed the changing nature of research problem in developmental research as new insights, findings are encountered during the research process.

3.3.1.3 Identifying limitations of the study

Identifying the limitations of the study was as contentious as identifying the problem itself. Of particular interest in developmental based researches are the unique conditions or limitations that arise due to the context specific nature of this kind of research. These limitations affect the extent to which the generalization of the conclusions of the study may be done (Reeves, 2000).

Did the limitations here mean the limitations of doing the study, and the designing of the system, or limitations that would arise during use of the system developed or the limitations that should arise if the research that existed could not be implemented on a system and hence could not be tested? However, as stated earlier, the aims of identifying limitations in developmental research are to recognize the unique conditions or confines that arise due to the context specific nature of this kind of research. These limitations affect the extent to which the generalization of the conclusions of the study may be done. With this in mind, the following assumptions were identified: a

1. The system designed will improve the modularity, quality, speed, and ease of developing reusable learning materials for web based courses.
2. Though there might be no time to test the quality of the learning materials developed, it is projected that the resultant learning materials will be of high quality, and will improve the efficiency and effectiveness of learning.
3. An instructional design model to be designed will be identified from literature. The identification of the model will be through critical evaluation and examination of the models available. This will be followed by identification of the best model that can be adopted to design and implement the instructional design subsystem.
4. The model identified will be ideal or adaptable and generalizable for use in the design of instructional materials for all the disciplines and subjects which have the potential of being offered online.
5. The instructional design model identified can be abstracted and reduced to simple computable modules. These modules can be generalized and developed separately and integrated to form the complete subsystem.
6. All the other subsystems required for integration and eventual use together with the instructional design subsystem will be ready and working at the time of completion of the instructional design subsystem.

During the progression of the study these limitations were taken into consideration at all stages and are reviewed at the conclusion of this thesis for the impact on the outcome of the work:

3.3.2 Review of related literature

Review of the literature dwelt on:

- the instructional and learning theories – the different paradigms used in the design of learning and instructional materials (Section 2.2);

- the instructional models - the various ways researchers and practitioners have tried to give a structure or systems or an approach to the process of instructional design (Section 2.3);
- the widely used instructional methods (Section 2.4);
- the various learning styles and learner preferences for web learning (Section 2.5);
- the theories and the models of instructional design together taking into considerations the instructional methods and the various issues of the learners' learning styles (Section 2.6); and
- the implication the whole literature that has been identify has for the design of web-based instructional design system (Section 2.7).

3.3.3 Research Procedure

Even though developmental researches occurs in natural environments and enhance credibility of the research, it creates some methodological dilemmas to researchers. Therefore, the following three areas are considered: a) the participants, b) the research design and c) the data collection, analysis and reporting procedures and mechanisms (Reeves, 2000).

3.3.3.1 Participants

Participants in developmental research are the sources of data. The participants in this study were as identified in table 12 and their different roles are summarized in the table below.

Table 12: Participants and their roles

Participant	Role
The researcher	The researcher tests theories and develops new findings from what practitioners' use of the tools. Worked as the gateway between the solution providers and the educators and instructional design.

Solution developers	Persons will be or were involved in designing and implementing the actual software. They included: • the developers of the software (software designers, programmers) • the financiers who funded the research and the development • the providers of facilities and materials that will be used by the instructional designers and educators and the researcher • the personnel engaged in implementing and testing the software.
Educators/Instructional designers	These are actual beneficiaries of the product. The use of the system will ease their work.

3.3.3.2 Research Design

Developmental researchers are always confronted with methodological dilemmas because of the requirement to account for contextual variables which are difficult to control (Reeves, 2000). In some cases, where the researcher is also a participant in the study, it is hard to ensure objectivity. Another problem identified is in the maintenance of the integrity of the data.

3.3.3.2.1 Creation of a Developmental Context

The initial instructional design subsystem was derived from the models that will were identified during the literature review. In particular, the researcher was in favour of a modification of the generic ADDIE model as discussed in the chapter 2 section (section 2.3.3). A graphical layout of all the processes and procedures that were envisaged was made on paper and then submitted to the instructional designers/educator for their review and comments. The design was made on paper to avert the feeling from the participants that a lot has been put into the design of the subsystem, and as such, their comments would be limited so as not to give the designers a lot more work to do,.(A simplified computer generated layout of the designs is attached at the annex IV). After every review with the experts, the results were communicated and discussed with the solution developers.

Where formal meetings were scheduled, such was minuted (See Annex III). This ensured that the design of the system was on track and took into considerations all the three participants.

The model was first presented to the instructional designers and later to the application developers who do the actual implementation of the system. This was aimed at formalizing the design. Figure 16 shows the developmental approach used in creating developmental context.

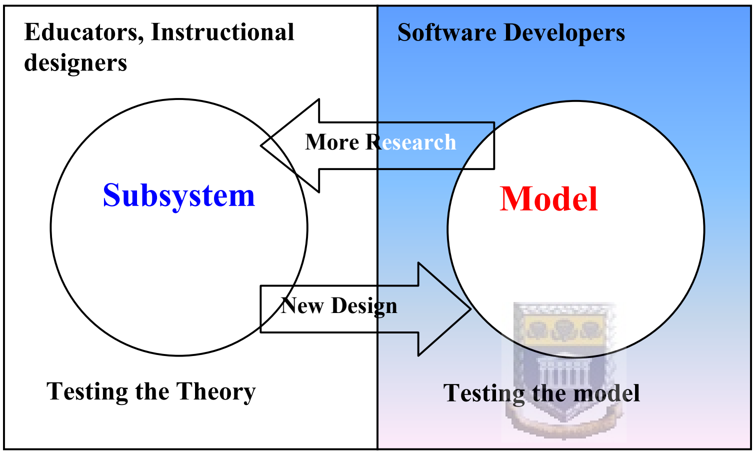


Figure 16: Creation of a Development Context

(Source: Author)

A number of issues arose during the process and they include:

- Educators and instructional designers were expecting to see a 'product' they can use while on the other hand the software developers wanted to get the full specifications at once so that they can start working on the system.
- Even the expert instructional designers do not subscribe to one approach or model of instructional design.
- There was a great deal of iteration, mainly on instances where the participants had to validate/compromise what they thought.

- A number of the instructional designers were reluctant to use any of the models but instead wanted to adopt “what works best for them”. Most of the instructional designers consulted their existing content to form the instructional strategy and base their approaches on the content.
- A number of instructional designers and educators did not know what they want until they were presented with the model. This prompted their thoughts and they contributed towards what they saw as a desired model.
- The time taken during this phase was considerable and the management in charge of the software development thought a lot of resources were being tied up for quite sometimes.
- The development team was concerned that most of the proposed features for the instructional design subsystem could have been dealt with without necessary writing a completely new subsystem.
- At on time the project manager of the development team was concerned that the process of gathering the specifications for the instructional design subsystem was taking too long and it needed to be hastened.

However, against all odds the system is being implemented now and there was a consensus among all the participants on what to include in the system. This is what was considered for the design of the subsystem as discussed in chapter 4.

3.3.3.2.2 Design of initial system

Initially, the design was adopted from the literature review (section 2.7). This design was printed on paper and then taken to expert instructional designers for criticism, comment and review. After a consensus model was arrived at, the design of the system was made using design patterns as discussed in section 2.7.1 and the patterns are elaborated in chapter 4.

Initial inquiry: revision, refinement and modification

The initial inquiry into the subsystem was done during the formalization of the design and alignment with the literature when it was subjected to the expert instructional designers in the process explained in section above. The aim of this initial inquiry was to

a) Derive a design that can be used for the instructional design subsystem
b) Compare the design with the original design from the existing literature and
c) Provide detailed functional specifications for the resultant instructional design subsystem.

Data Collection

In the first iteration, interviews with educators and instructional designers were conducted to provide information on how the instructional designers view their work process in relation to the model designed from the literature review. The instructional designers were given a design sample in order to determine their reaction to a typical design scenario.

Data Analysis

Initial analysis was done from literature and then corroborated by educators and the instructional designers. This lead to the validation of the model in the design of the subsystem. The analysis explored details on the specific educator/ instructional designer knowledge and skills and the design task that could be supported and improved in the system.

The data collected during the iterations was analyzed to come up with a generalized view of how the instructional designers go about their work, and determin their initial reactions to the designed model.

The design agreed upon did not show much difference from what was from the literature. The only major difference that was recorded is that even though a model may be specified, instructors and educators do not always subscribe to it – neither do they follow all the distinct steps as set out in the model.

Revision, refinement and modification of the subsystem

The initial design was refined, through modification and revision following agreements was reached with the expert instructional designers. The iterations will be continuous. Based on the main observations of the preceding iteration and data analysis, the subsequent subsystem will be refined and modified to accommodate the computable views and improvements suggested by the instructional designers (subjects). Before the actual modifications are made, the results of the existing state of the subsystem will be subjected to the expert instructional designers who were used in the first iteration for review and also weighed against the existing literature for identification of generalized improvements or modifications that can be made.

3.3.3.2 Data Collection, Analysis and Reporting

Data was collected from the literature review, instructional design profiles and from instructional designers. The literature was from documentations of design, research journals on instructional design and related fields, software engineering, instructional design and technology, web design among others.

3.3.4. Results and conclusion

Developmental research contributes to instructional design as field of knowledge based on understanding of the new procedural models, generalizable principles or the lesson learnt in a particular project. This research can identify two results, the research design and the instructional patterns discussed in chapter 4.

Managing the scope of the work was a challenging task because of a number of issues:

1. The research approach used has both the research and design intertwined. This meant that there was a great deal of iterations and revisions before a final design could be reached.
2. Identification of patterns for the instructional design process features arrived at, giving the 'problems' identified as core to the process a 'solution' that could be generic. This was a challenging task because the problem-solution pair had to be unique and at the same time computable.
3. The complexity of the instructional design process, and the relationship between the instructional theory and instructional practice proved a challenge to getting all the requirements for the design of the subsystem easily.
4. The limited research in the area of web instructional systems – partly due to the fact that the web is a relatively new technology and the research is taking shape in the area, led the researcher in adopting the existing theories to come up with an 'eclectic' (section 2.7) approach to the design of the web instructional design subsystem.

3.4 Conclusion

As clearly demonstrated in this chapter, in developmental research, design and research efforts are intertwined, with research efforts being typically iterative and successive efforts focusing on different aspects of learning, instructional design, development and evaluation, and the whole instructional system or product change.

Design experiment approaches utilized qualitative research methodologies, by creating and testing new ways to collect data and analyze – through interaction with the literature, experts and practitioners in the field of instructional design and educational material development at large. The iterative nature advocated in these approaches allowed questions of various scope and complexity – in the instructional design field to be studied.

The findings of successive implementations can form a rich base of information to refine theories about instructional design. The procedures of a design-experiment methodology used entailed creation of a developmental context for the web-based instructional design subsystem, creation of the initial model based on the existing knowledge (instructional design models, theories and paradigms) and technologies (in this case web-based technologies), testing and implementation of the model and finally an iterative inquiry into the effectiveness of the model. The results of the inquiry phase are used to revise, refine and modify the model iteratively over several rounds. (For more details see chapter 4).

Chapter Four

Results, Discussions and Reflections

4.1 Introduction

This chapter discusses the design, development and implementation recommendation of the initial system. In chapter 2, an eclectic approach to designing the instructional design system making use of a pattern approach was adopted for this study. In this chapter, the specific patterns adopted are outlined. The discussion starts with the presentation of major parts of the instructional design system as represented in the process diagram shown in Figure 17 (in the next page).

It is worth noting that the process diagram represents the major issues that go on during the design of an instructional project, starting from the gap analysis all through to the evaluation of the learning process, students' progress and learning materials. The various steps within the process will be discussed separately in the areas covered by the patterns for the particular step. The list of instructional patterns discussed here is by no means exhaustive, however, the major patterns that form an argument for an instructional design system have been considered. Also, due to the developmental approach this research undertook, it would be possible to identify and incorporate more patterns as and when they are discovered or identified.

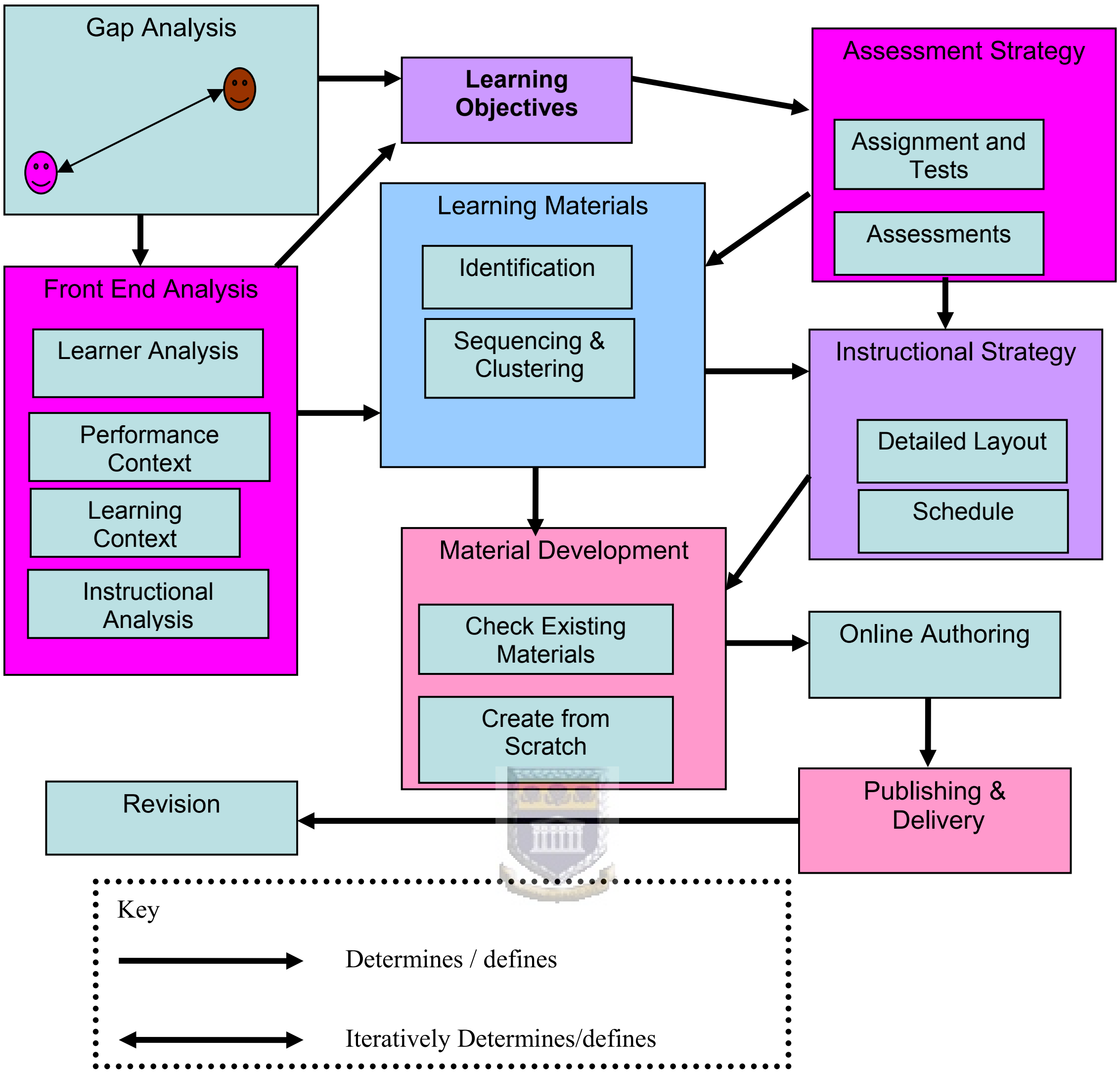


Figure 17: Instructional design process, an integrated model

(Source: Author)

4.2 Towards an instructional design subsystem

The selection process involved first the formation of a basic cell: the 'unit of learning' which is the atomic part of any instructional project. A unit of learning (UoL) is defined as any delimited piece of education or training, such as a course, a module, a lesson (Paquette, 2004) that can be instantiated and reused many times for different persons and settings in an online environment (Koper & Olivier, 2004). The UoL idea was first coined in the design of Learning Objects (LOs) but ideally it can be extended and employed in an instructional design project of any size and magnitude, from a topic to a complete curriculum. In the case of complex projects simple UoLs can be used recursively to define more complex UoLs. The UoLs are designed to fulfilling known objectives, taking care of the behavioural paradigm, or to extend and construct the learners' knowledge towards – constructive paradigm - a prerequisite of a higher order UoL while at the same time ensuring learners retention and processing of the knowledge acquired is well taken care of – cognitive paradigm. Instructors always create UoLs using unique procedures and processes that are known to achieve the prescribed learning objectives or to extend learners knowledge to facilitate the construction of new knowledge. The components of a UoL are:

- Learning objectives to be achieved and/or prerequisites being advanced.
- Activities to be performed by the learners to aid them in achieving the learning objectives or extend their knowledge or facilitate creation of new knowledge.
- The structure and sequence of tasks to be presented to the learners.
- Support services and levels of interaction the instructor should give to the learners through reinforcements or facilitation.
- The environment created from (by) the activities and support mechanisms and how it facilitates learning.
- Learning materials being availed through the environment to the learners.
- The UoL assessments that will test the degree to which the learning objectives have been achieved or the prerequisites have been advanced by the learners or how well learners have constructed new knowledge.

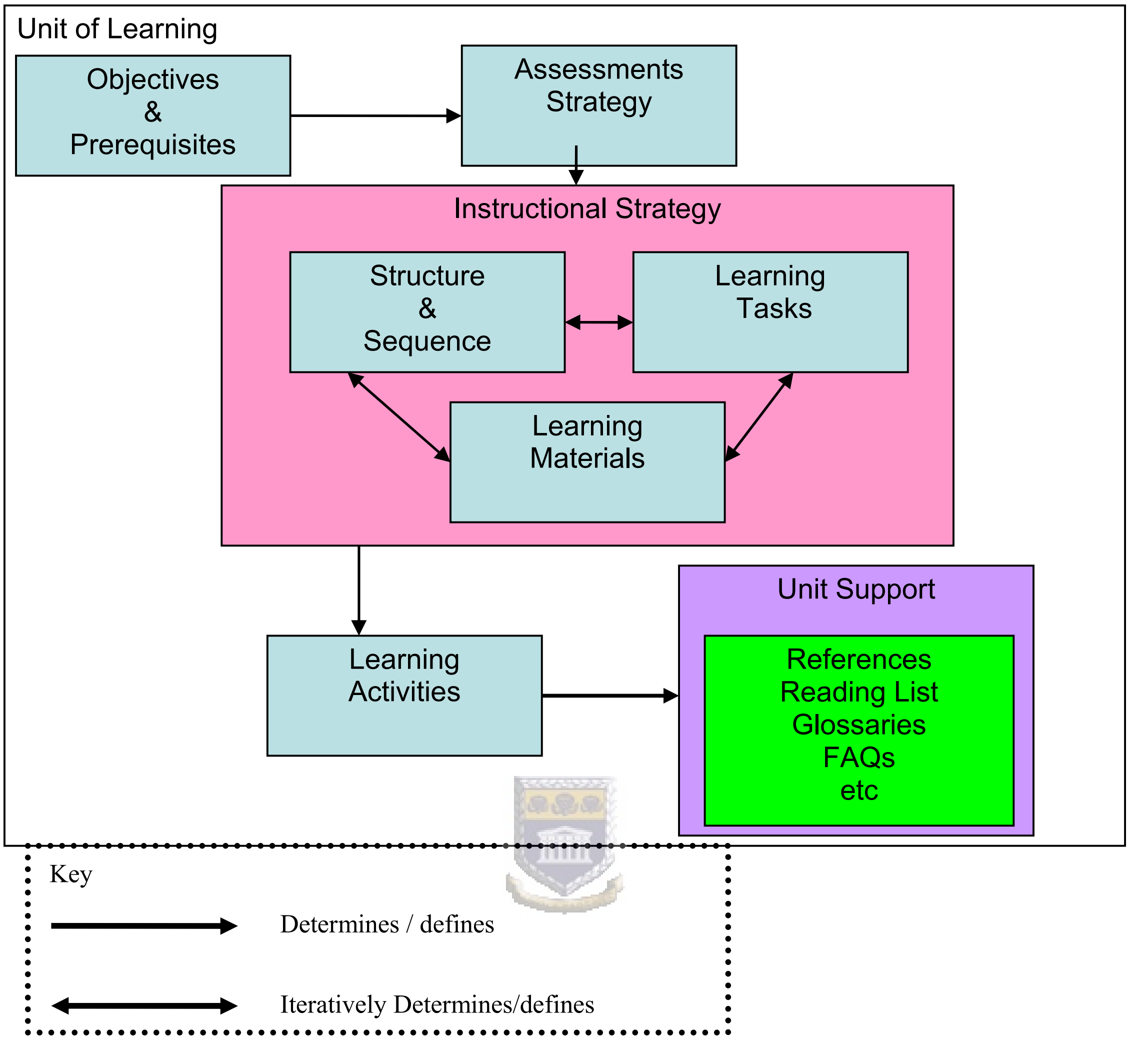


Figure 18: Unit of learning design

(Source: Author)

From the figure above, we can see that a well designed UoL largely depends on the relationship between the essential components – objectives and prerequisites, assessments, learning, teaching and instructional strategies, learning materials, and support to learners. As stated in Section 3.3.3, there is a great deal of iteration, during the design of the learning materials and the processes in figures 17 and 18 above are not rigid, rather instructors follow an iterative process like the one shown in figure 19 below.

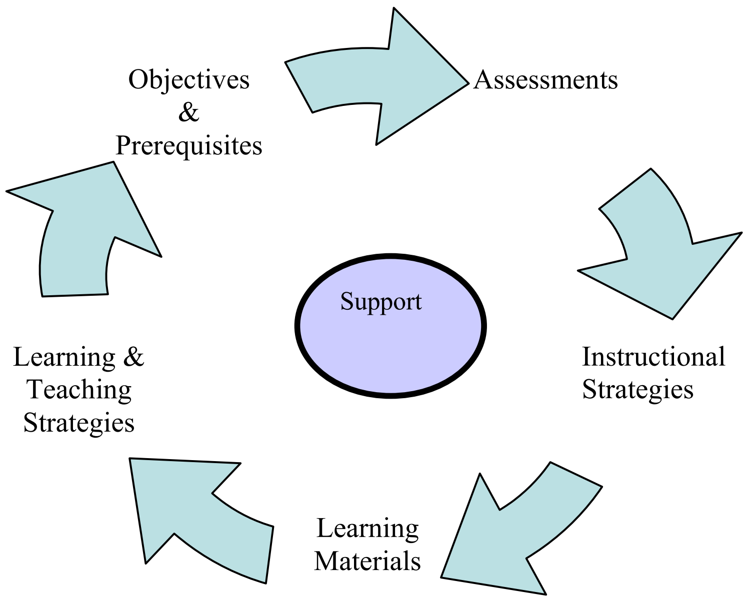


Figure 19: Typical navigation around a unit of learning design process

(Source: Author)

We can see, for instance, that if the aims and objectives of a course stress on analysis and problem solving, it is most likely that the instructor will look for an instructional strategy that orders learning materials in a way that helps students sift through the facts, recognize issues, make judgments, and apply their reasoning to given problems. The learning and teaching strategies will aim at developing requisite skills in analysis and problem solving, and might be of the form of applied activities that step them through these processes, with supporting feedback to enable them diagnose errors and sharpen their skills. An assessment option could include a case study or problem scenario that provides opportunities for students to demonstrate their developing capacity to analyse the facts, apply them to a lifelike situation, and argues a case for its solution.

4.3 Selection Process: Defining the Patterns

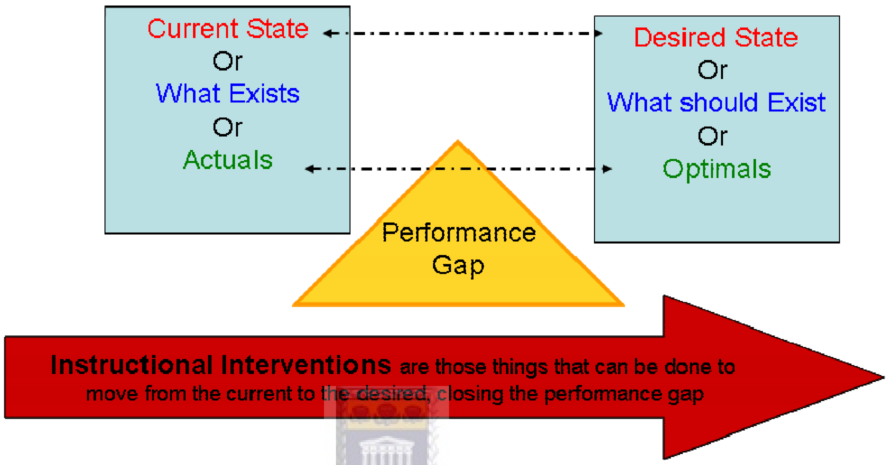
The basic identification and selection of patterns therefore revolved around the tools that enable the instructor to design and knit together the relationship between the basic components of the Unit of Learning discussed above. The instructional design task cannot be complete without the design of support patterns. The support patterns extend the basic patterns so that they can encapsulate as much as possible the eclectic approach discussed in section 2.7.2 and ensuring that the best practices in instructional design are enhanced.

For example, following the process flow of the unit of learning shown in figure 18 might appear to favour the behaviourist paradigm (Conditioning). Adding a discussion forum pattern to allow the participants within a Unit of Learning to collaborate and cooperate during the learning process introduces the constructivist paradigm while the use of the Bloom's taxonomy during the formulation of the learning objectives ensures that the cognitive approach is taken into consideration. The classification of patterns, just like the classification of the instructional theories, is not rigid and some patterns that might appear basic in the design of a specific unit of learning might be considered as secondary in the design of another. In the next sections the patterns identified are described starting with the basic patterns in section 4.3.1 followed by the support patterns in sections 4.3.2.

4.3.1 Basic patterns

4.3.1.1 Gap analysis pattern

Component	Brief Description
Name	Gap analysis pattern
Intent	This pattern aims at assisting the instructors in formulating the knowledge gap between what their target learner audience knows and what they should know. It builds on what the instructors know about their target audience, and what they require, or is required to be known by the target audience.
Motivation	The process of determining and evaluating the variance between what the students know, and what they are supposed to know. It is the difference between what is needed and what

	is available. Gap Analysis identifies the gap in knowledge and proposes solutions to bridge the gap, in this case, instructional solutions. Determines if the gap can be eliminated through an effective training/instructional program. Gap analysis leads to creation of a goal for a certain instructional tasks Instructional goals are problem-solution combinations stated in terms of skills, knowledge or attitudes the learners should show after an instructional process. Goal analysis turns abstract statements into concrete tasks that can be taught. The goal is a quadruple consisting of the learners, the performances the learners are to do, the performance context or environment and the tools that are required.  **Figure 20: Gap analysis model** (Source: Author) The aim of the gap analysis is to analyze the information on gaps between ideal and status quo in order to identify discrepancies. The final product is a “Statements of needs” that clearly states what the gaps are – if they exist, information on nature of problem (gaps), and also states if the problem(s) identified are actually instructional problems.
Solution	A template-based approach that allows the instructors to identify the gaps – presented as states. For the instructor to use this pattern he should have an idea of what the learners are and they should be. The use of this pattern leads to the formulation of a goal statement of the instructional project
Consequences	Instructors can use this pattern to identify what the current situation of the learners in terms of knowledge is. From this, the instructors can be able to compare that with what the learners are expected to know to come up with a goal statement. The situations are defined as states, current being what the students – or current knowledge situation is. The desired state is what the desired knowledge the student should have.
Known uses	Gap analysis; also know as goal analysis is done during the feasibility stages of any project. It is not restricted to the instructional projects. In instructional projects, it is important to do an instructional gap analysis because a problem might not necessarily need instructional intervention to be solved. If there is a gap in performance or knowledge, the gap analysis identifies it and always prescribes the best way to bridge the gap.
Related patterns	The gap analysis pattern is closely related to the learner analysis and objectives formulation pattern. The learner analysis module analyses the audience characteristics, and might form inputs for the current state. The learner objectives pattern gets inputs from the gap analysis pattern if there is need for an instructional intervention.

References	Southern Cross University, 2004, Pathways to Good Practice A guide to flexible teaching for quality learning [Online], Available from: http://www.scu.edu.au/services/tl/pathways/ [24 October 2005]

4.3.1.2 Learner analysis pattern

Component	Brief Description
Name	Learner analysis pattern
Intent	The learner analysis pattern identifies the important instructional variables that my affect the learner, and strategies of instructions to enhance the learning process. Instructors should be provided with templates for capturing and summarizing information about their learners.
Motivation	A learner analysis can reveal important instructional variables that may affect the learner, and strategies of instruction that can enhance the learning process. The results provide educators with information or data about key learner characteristics, as well as prior and prerequisite skills. The learner analysis process involves two main steps • Identifying and describing key characteristics of the learner population. • Applying techniques for acquiring additional information about the learner population if necessary. The learner analysis module allows instructors to gather as much information about the learners as possible. After all the information of the learners has been collected, the module allows the instructor to create a summary of what the learners are. The information to be gathered is; • General Characteristics (background) - Grade, age, ethnic group, sex, mental, emotional, physical, or social problems, socioeconomic level, etc. • Entry Competencies (experiences) -prior knowledge, skills, and attitudes. It could include the understanding of the knowledge related the initial stated problem. Also issues related to their perception of the instruction to address the problem that could be of benefit for the designers to understand the learners' perspective on how they place themselves in the learning context. It is important for designing instruction that will be appropriate to the learner's level of knowledge, and therefore enable for learning to take place from a constructivism theory perspective. Also the assessment of previous knowledge along with the content analysis will be crucial for definition of minimum requirements for enrolment in the learning sessions. In case of extreme variation of the knowledge among the learners or potential learners/users, instruction with different levels of entry might be considered for delivery of the instruction, such as advanced, intermediate and beginners. • Learning Styles and Preferences - Visual, Auditory (hearing/verbal), Kinesthetic (hands on/physical). Those will include the media preference for instance, and could draw n the assessment of the previous design items. As for instance, depending on the level of computer expertise and confidence of the target population, the choice of computer technology to be used will consider the appropriate media for delivery of the instructions in different formats. It is important for supporting the identification of the media that is better accepted by the target population. Other preferences could include also a guide for decisions related to availability, location, place and time, and even length of instruction in some situations. • Learner Expectations and goals of instruction - Learner expectations include the issues related to the problem as well as the ones involved with the process for designing, development, and delivery of the instruction. In analyzing learner's expectations, the goals and objectives of the instruction should be also taken in

	consideration as the central focus of the changes to be generated by the instruction. The learners could offer valuable suggestions when referring to their expectations, especially from the perspective of the objectives as a gap of what the learners do not know and want to know. Learner analysis is required because the instruction to be designed should take place considering the characteristics of the learners - the learners' profile - to enable learning and therefore achieve the objectives and goals of the instruction. A piece of instruction centred on the learners is a designer's choice as well as the owner's of the instruction.
Solution	The learner analysis module gathers the essential information about the learners. This information is later used during the formulation of learning outcomes, assessments and learning materials
Consequences	Because of the complexity and the number of variables that can be considered, the approach in this pattern captures most of the unique features that have a bearing on what is to be taught, assessed or availed to learners in the form of learning materials.
Known uses	Instructors creating courses always need to understand who their target audience is.
Related patterns	Gap Analysis pattern, Learning Outcomes Pattern
References	Dick W, Carey L & Carey J O, 2001, The systematic design of instruction (5th ed.). NY: Addison-Wesley Southern Cross University, 2004, Pathways to Good Practice A guide to flexible teaching for quality learning [Online], Available from: http://www.scu.edu.au/services/tl/pathways/ [24 October 2005]

4.3.1.3 Learning Outcomes Pattern

Component	Brief Description
Name	Learning outcomes pattern, also known as instructional outcomes pattern, instructional objectives pattern, learning objectives pattern, or the objectives pattern.
Intent	This pattern aids the instructor in the formulation of the learning objectives. It is a template based pattern that allows an instructor to identify the various components of a well written instructional objective and formulate it. Instructional objectives are always hard to formulate, good objectives are even harder. Well stated objectives, if identified in advance of the instructional design process sets as a guide to the assessments and learning materials to be used.
Motivation	Instructional objectives module creates a process that assists instructional designers to generate or formulate instructional objectives for an instructional project, for instance a course. It builds upon some other modules and templates like the Bloom's module and the Analysis templates. Instructional objectives are an integral component of the instructional design process. They are also referred to as learning objectives, learning outcomes or instructional outcomes. Learning objectives are stated in performance terms. These are specific skills and knowledge the learner is required to master after going through some instructional material. They define what the learners (not the teachers/instructors) should be able to do, after going through some instructional material or course. The learning outcomes help the instructor in mapping out a teaching/learning strategy guide for sequencing and chunking learning materials and activities, as well as provide a checklist of what is to be presented to learners and to what levels of details. Course activities, assessment tests, and assignments are a direct product of the learning outcomes and are used to measure how well the students met the identified objectives. The process of learning outcomes formulation and assessment writing are usually done in parallel or iteratively.

Learning objectives are derived from the broad goals and are stated at the beginning of the instructional unit. They are stated in clear, precise, accurate and unambiguous statements. They are arranged according to the learning domains hierarchy proposed by Gagne's Learning Categories and the Bloom's Learning Taxonomy.

Dick and Carey (2001) stated that objectives "are critical to the design of instruction" because they "guide the designer in selecting content and developing the instructional strategy" for the course. Dick and Carey (2001) also pointed out some other reasons for writing objectives that can be related to Computer Based Training (CBT) development which are stated below.

- They provide a clear description of what the students would cover thereby helping to prevent instructional gaps
- They indicate to administrators what the students are being taught
- They establish criteria for evaluating student performance when instruction ends

Alessi and Trollip (1991) stated that "well-written objectives can demonstrate the relevance of material to the student", thus contributing greatly to their motivation for learning. According to them, the objectives stated must be:

- Specific - they should not only help the instructor make sound instructional decisions during Instructional Design, but also guide the learners on what to focus on.
- Measurable - they should describe tangible outcomes that can be observed
- Outcome (not process) oriented - they should describe what the learners would be able to achieve, but not how it is achieved.
- Learner (not instructor) oriented – they should describe in clear terms what is expected of the learners, that is describe the learners' performance

Mager (1997) identified the following components of effective instructional objectives:

- Performance - a description of the expected learner's behaviour that is measurable and observable. That is, what the learner must demonstrate to show mastery of an objective. It is stated as a verb that is measurable.
- Conditions - a description of the circumstances and contexts under which the performance will be carried out. That is, what would be available for the learner to perform the desired behaviour.
- Criteria - a description of the criteria for acceptance of the performance as sufficient enough to indicate a mastery of the objective in terms of speed and accuracy.

Example:

The student will (show {P}), the (relationship between the demand and supply of sugar in a given region {C2}) using (the law of demand and supply {C1})

where

{P} = Performance, {C2} = Criteria, and {C1} = Condition

The objectives also have the who part which defines who must meet the objective

The whole syntax is as follows:

	{Who?}{Under what Conditions?}{verb} {Performance} {Using what Criteria?} The performance part could be further split into functions, viz: {what the learners will do} and the processes {how they will do it}. Consequently, the student {who}, when provided with a list of subjects and predicates {Conditions}, will match every subject in the list with a predicate {Performance}, so that every subject agrees with its chosen predicate {Criteria}. A complete learning outcome, therefore, defines who the learners are, what they should be able to do, perform, or accomplish and the context and tools for accomplishing it. Prior to writing the instructional objectives, the module would seek to identify the levels of the instructional project, and its attributes in relation to the Bloom's taxonomy. This would influence the way the instructional objectives are set. This would lead to an understanding of the types of objectives and learning outcomes/objectives to be developed.
Solution	The solution sought is one that would allow the instructor to identify the components of a good objective: Criterion, condition and competence and assist him/her in formulation of an objective. In this case, the instructor is assured to get a better stated objective
Consequences	The use of the objectives generator will lead to instructors creating good objectives that are based on research. The objectives created also would guide the instructors in creating assessments and learning activities. However, If the objectives developed are not of required standards the consequent assessments and learning activities might not be of standards too. Though the templates used would provide all the essential information for the formulation of the objectives, the onus is with the instructor to edit and state the objective in a grammatical-correct sentence. The instructor would be able to define the competences, criteria, conditions of the course and merge them to form an objective.
Known uses	Instructors creating courses always create objectives of the courses.
Related patterns	The pattern is closely related to the gap analysis pattern, blooms pattern, and learner analysis pattern. The gap analysis pattern informs this pattern and the instructor can verify that the objectives being formulated meet, or move towards meeting the stated goal of the instructional project. The blooms pattern provides the keywords for use in the objectives. An understanding of the learners assists the instructor to stay focused in the type of the competencies the learners have and what they are required to have.
References	Alessi SM & Trollip SR, 1991, Computer-based instruction: Methods and development, Englewood Cliffs NJ: Prentice-Hall. Dick W, Carey L & Carey J O, 2001, The systematic design of instruction (5th ed.). NY: Addison-Wesley Mager, RF, 1997, Preparing Instructional Objectives. Atlanta, GA. Center for Effective Performance. Southern Cross University, 2004, Pathways to Good Practice A guide to flexible teaching for quality learning [Online], Available from: http://www.scu.edu.au/services/tl/pathways/ [24 October 2005]

4.3.1.4 Assessment-Objective Map Pattern

Component	Brief Description
Name	Assessment-Objective map pattern
Intent	Good assessment items emanate from the stated objectives. Assessments also define what learning materials and activities should be presented to the learners. A map showing the link and relationship between the objectives and the assessment, and assessment tools to be used should

be put in place to help the instructor.

Motivation

Appropriate and well thought-out assessments help the instructors in determining what objectives have been met and what have not. They stem from the objectives and the instructional activities.

Anderson (2002) identified four advantages of aligning the assessments with the content and objectives:

the "need to be more concerned with what students have learned as a result of their schooling experience than with what they know and can do regardless of the source of that knowledge or those skills." (Anderson, 2002: 259)

Enables the instructors to understand the differences in the effects of schooling on student achievement.

Helping the instructor estimate the effect of instruction on learning and

Improve the educational accountability in terms of what is to be taught.

Criterion-referenced tests are aimed at finding out whether the criteria set out in the objective has been achieved. They closely link the instructional goals to the performance objectives and give the instructor an opportunity to evaluate performance and revise the instructional strategy. They are also called objective-referenced tests or domain-referenced tests. There are various types of criterion referenced tests depending on the stage of the instructions they are administered for instance we have Entry behaviour; pre-test; practice test; and post test.

The diagram below shows the relationship between course objectives, instructions and assessments. The assessment in the relationship are criterion referenced.

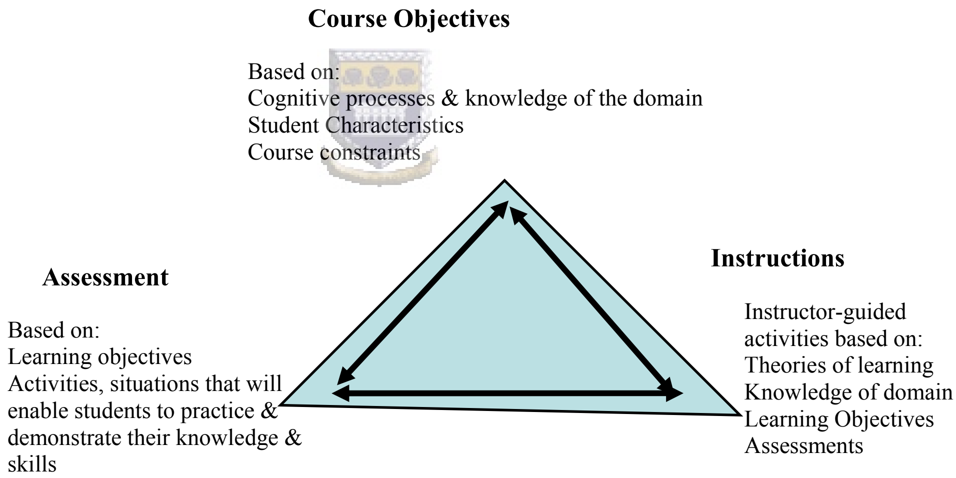


Figure 21: The Relationships Among Objectives, content, and Assessments

(adapted from Anderson, 2002)

A number of assessment items can be considered for an online course. These include Essays; fill-in-the-blanks; completions; multiple choice questions; matching; and checklists among others. In choosing the test items one considers

- The type of behaviour specified in the objectives and
- The testing environment and its requirements.

Mager (1997) outlines the following steps in writing test items:

	1. Identify performances from the objectives 2. Draft a test to ask the learners to exhibit that performance 3. Note the conditions for the achievement of the objective 4. Write the conditions into the test items 5. Describe the assumptions/approximations for conditions that cannot be fulfilled 6. Create more than one item for an objective if • The range of conditions is so great that one performance will not tell that the learner can perform under all conditions • The performance could be correct by chance The number of assessment items and the assessments types is determined by the number necessary to achieve the mastery of an objective.
Solution	Provide a means to create assessment tools for measuring to what extent the learning objectives have been achieved by the learners. The solution should assist the instructor in identifying the elements to be evaluated from the learning outcomes, paraphrasing them, sequence them, selecting the type of judgment to be made by the evaluator and finally determine how the instrument will be scored.
Consequences	The assessments designed using this module will emanate from the objectives created. The assessment will reach to measure how well the objectives set are being tested. Good assessments also would define what kind of learning activities and to what level of details the instructors would create.
Known uses	Assessment strategy formulation in LMSs
Related patterns	Learning outcomes pattern, Content-Assessment Map Pattern
References	Anderson LW, 2002, Curricular Alignment: A Re-Examination, Theory into practice, 41(4), pp 255-260 Dick W, Carey L & Carey J O, 2001, The systematic design of instruction (5th ed.). NY: Addison-Wesley Mager, Robert F. (1997). Preparing Instructional Objectives. Atlanta, GA. Center for Effective Performance. Southern Cross University, 2004, Pathways to Good Practice A guide to flexible teaching for quality learning [Online], Available from: http://www.scu.edu.au/services/tl/pathways/ [24 October 2005]

4.3.1.5 Content-Assessment Map Pattern

Component	Brief Description
Name	Content-Assessment Map
Intent	As presented in the Assessment-Objective map pattern, good instructional content emanates from the set assessments and objectives. Instructional content should therefore be a consequent of the stated objectives and assessment goals and there should be a map showing the link and relationship between the objectives and the assessment, and content to be used should be put in place to help the instructor.
Motivation	Novice instructional designers might have the domain knowledge that is required to create learning materials for a particular instructional project but lack on how to knit the knowledge with the expected outcome and hence the assessment aims of the project As depicted in figure 20, content should be related to the learning objectives and the assessments. This relationship ensures: • Accurate task analysis – Helping the instructors pinpoint the knowledge and skills that need to be addressed. • Relevant practice activities –Helping the instructors to design guided and independent practice activities that are better aligned with the desired outcomes.

	• Lucid Expositions – Helping the instructors provide clearer explanations to students regarding the purposes and goals of the instructional and assessment activities. The content-assessment map starts with the identification of content for each assessment goal. They might have more than one content item for each goal.
Solution	A template-based approach that assists the instructors to do a mapping for each statement will offer the required solution. An instructor, who have identified the required objectives for an instructional project, and defined the various assessment goals for the instructional project can start identifying the various learning contents for the project.
Consequences	The use of this pattern will lead to content that is informed by the objectives and the assessment goals of the project. The pattern is best suited in suited for reflexive, criterion-referenced learning content.
Known uses	Instructional design systems, KEWL
Related patterns	This pattern is related to the learning outcome pattern, assessment-objective map pattern and the mind mapping pattern.
References	Anderson LW, 2002, Curricular Alignment: A Re-Examination, Theory into practice, 41(4), pp 255-260 Dick W, Carey L & Carey J O, 2001, The systematic design of instruction (5th ed.). NY: Addison-Wesley Mager, Robert F. (1997). Preparing Instructional Objectives. Atlanta, GA. Center for Effective Performance. Southern Cross University, 2004, Pathways to Good Practice A guide to flexible teaching for quality learning [Online], Available from: http://www.scu.edu.au/services/tl/pathways/ [24 October 2005]

4.3.1.6 Instructional Design Flow Pattern

Component	Brief Description
Name	Instructional design flow pattern, workflow pattern
Intent	The process flow of the instructional design process should be controlled and coordinated. An instructional design flow pattern achieves this by controlling the flow and the execution of the other patterns. This pattern ensures that the process of instructional design is taken from the beginning to the end, following the established model flow, knitting together all the patterns identified. This pattern works like a generic workflow system for the instructional design process. A workflow system defines, manages and executes workflow processes through the execution of software whose order of execution is driven by a computer representation of the workflow process logic (Wade & Muldowney, 2000:214).
Motivation	An instructional design flow is the process and the tasks that are done to come up with instructional materials. It starts right from the gap analysis through to the evaluation of both the learning materials and the learners. The instructional design pattern envisaged here would implement one or an abstraction of one the instructional design models discussed in section 2.3. For instance, the workflow in the instructional design environment might follow the following crucial steps that are necessary during the process of instructional design:- 1. Gap analysis 2. Learner analysis 3. Learning outcomes/objectives formulation 4. Assessment strategy formulation 5. Content sequencing, structuring and instructional method selection 6. Content authoring 7. Evaluation 8. Revision The instructional design flow pattern should seek to streamline the instructional design

	process, improve the efficiency of the whole process, automate certain tasks that do not need human intervention, and construct a customized instructional design process for the web-based instructional design system to deal with its intricate requirements.
Solution	The instructional flow pattern provides a controlled process that implements the basics of an instructional design model. The sequential execution of the various patterns involved in the larger instructional design ensures that the instructional designer follows a prescribed path during the design of instructions. It is assumed that learning materials created through this process would be of high quality.
Consequences	The pattern safeguards the novice and inexperienced instructional designers from the need to first learn before creating learning materials by providing easy step-by-step guidance through the process. One constraint that might appear through the use of this pattern is the limited number of options that are available for the instructional designer in the process. An identification of all the options might not be possible because of the varying needs of the different stakeholders, their disciplines, and other related issues. However, with the provision given of the basic steps and guides, an instructional designer would be able to incorporate and add-on some required features in the final product. Instructional designers would be able to use this flow to execute the various patterns that are defined in it thereby forming a sequential process/model of designing instructions
Known uses	Instructional design model
Related patterns	This pattern is related to all the other patterns discussed here.
References	Wade VP & Muldowney S, 2000, Experience representing, integrating and automating telecom business processes in a workflow engine environment, Information Services & Use, 19(3) pp 211-225

4.3.1.7 Content Layout Pattern

Component	Brief Description
Name	Content Layout
Intent	Can a plan or layout be achieved that would enable instructors to schedule the main elements within the learning materials or the learning process?
Motivation	Plan a framework or layout that can be used in the instructional development process. Identification and alienation of the key features and procedures that are involved in the process and creating patterns that can be used to accomplish them. The processes and procedures are based on and grounded by research. How can the instructors be assisted in building instructional material in Web-Based Learning Management Systems to save time during the process, and also allow them to create instructional materials – based on best known instructional design strategies - without requiring extensive training in instructional design and web based authoring?.
Solution	The content layout pattern provides the instructor with a framework which he can use together with the work flow engine to knit together the other patterns of instructional design.
Consequences	The use of this pattern would assist the instructor in coming up with well structured instructions. However, the pattern can only be used with the workflow pattern.
Known uses	Course creation.
Related patterns	This pattern is related to all the other patterns discussed here
References	none

4.3.1.8 Mind Mapping Pattern

Component	Brief Description
Name	Mind-mapping pattern, Free mind
Intent	How can instructional designers use visual tools that stimulate and organize idea generation? When instructors are creating learning materials, a mind map could be used to form the layout of the whole learning content. This is especially advantageous because of the iterative nature of the instructional design.
Motivation	Mind maps and concepts maps are graphical (or visual) representations of the relationships between various objects. Maps are used to stimulate and organize idea generation, and are believed to aid creativity. For example, concept mapping is sometimes used for brain-storming. Although they are often personalized and idiosyncratic, concept maps can be used to communicate complex ideas.
Solution	As one of the patterns in the instructional design, it can be used to link the various constructs and process (as identified in the other patterns). Some of the constructs and process that can be achieved are: - • Assessment-to-learning activities mapping • Learning activities-to-learning materials mapping • Learning objectives-to-assessment strategy mapping • Learning style-to-instructional method mapping
Consequences	The use of this pattern would make it easier for instructors to author and structure their web courses. However, the link to other patterns might not be that clear and it needs a lot of logic – at the development level.
Known uses	Course creation.
Related patterns	This pattern is related to all the patterns identified as basic patterns
References	Farrand P, Hussain F & Hennessy E, 2002, The efficacy of the 'mind map' study technique, Medical Education, 36(5), pp426-431 Mento AJ, Martinelli P. & Jones RM, 1999; Mind Mapping in Executive Education: Applications & Outcome, Journal of Management Development, 18(4) pp390-407.

4.3.2 Additional Support Patterns

4.3.2.1 Bloom's Taxonomy Pattern

Component	Brief Description
Name	Bloom's Taxonomy
Intent	How can instructors be supported during the creation of learning materials for the web especially during the formulation of learning objectives?
Motivation	The Bloom's taxonomy is one of the most widely used abstractions of questions that commonly occur in educational settings. It provides a useful structure in which to categorize learning activities, assessments and instructional objectives. Bloom identified three taxonomies as: Cognitive – knowledge-based, having the knowledge and ability to work with the knowledge; Psychomotor – skills-based; ability to do tasks related to the field of study; and Affective – ability to organise, articulate and work using the values and capabilities achieved. Each of the three taxonomies has levels or a taxonomy explaining the levels of expertise required to be portrayed in order of their level of complexity. (See Annex I for a table

	representing a summarized Bloom's taxonomy). The Bloom's taxonomy has been widely used by many instructional designers during the design and development of learning materials. By developing an instrument based on Bloom's Taxonomy of Educational Objectives that assesses a student's cognitive abilities, one is able to isolate specific learning outcomes. Specifically, the instrument can be used to assess the effect of instruction on learners' inert and dynamic knowledge and to assess the effect on cognitive abilities classified under this taxonomy (Feinstein, 2004: 33). Instructional designers should therefore be presented with a means of linking the Bloom's taxonomy and its philosophy to the various aspects and tasks undertaken during the design of learning materials.
Solution	The Bloom's taxonomy pattern could allow the instructional designers manage the knowledge about the Bloom's taxonomy. The pattern will provide information to other instructional design patterns like the instructional outcomes pattern and the assessment map pattern. The information will range from the Bloom's taxonomy literature, keywords, description of keywords, how to use them and sample questions and activities which an instructor can use as a guide to creating his or her own.
Consequences	When developed this pattern will be used hand in hand with the Instructional outcomes pattern and the assessment map patterns and will allow the instructional designer create authentic learning materials. The pattern allows the instructors to choose from an already existing database the keywords to use when formulating the objectives, the type of question that can be asked for that particular keyword and an explanation on how it is used.
Known uses	Instructional objectives for web-based learning management systems.
Related patterns	This pattern is closely related to the Instructional outcome pattern, the assessment pattern, the instructional methods pattern and the workflow pattern.
References	Curriculum Committee: Ohlone College, nd, Bloom's Taxonomy Classification of Instructional Objectives, Available Online http://www.ohlone.edu/org/capac/docs/blooms-tax2.html [10 October 2005] Bloom BS, Engelhart MD, Furst EJ, Hill WH & Krathwohl DR, 1956, Taxonomy of educational objectives: The classification of educational goals. Handbook 1: Cognitive domain. New York: David McKay. Feinstein A H, 2004, A model for evaluating online instruction, Development in business simulation and experiential learning, vol 31, 32-39 Krathwohl DR, 2002, A Revision of Bloom's Taxonomy: An Overview, Theory into Practice, 41(4), pp. 212-218

4.3.2.2 Instructional Methods Pattern

Component	Brief Description
Name	Instructional Methods Patterns
Intent	Instructional Methods pattern would provide the instructors with the various methods and options they can use to accomplish an instructional goal. It would pull all the known instructional methods together, and avail details about their advantages, when and how to use them, and where possible an example.
Motivation	An instructional method, also called "method of instruction"is a component of the instructional strategy defining a particular means for accomplishing a stated objective. For example, case study method of instruction might be used when there is need to study the complex social phenomenon in a given context. Instructional methods pattern gives details of the different instructional methods that would be used during the design phase of the instructional design process. This is a static module and it is only managed by an instructional design expert.

Solution	The pattern would provide as much information about an instructional method as possible. Although, the pattern would not go in as far as presenting patterns of the actual methods, it would provide the details of how and when to use the various instructional methods.
Consequences	The use of this pattern would provide instructional designer with alternatives when it comes to the type of instructional method or option to use to accomplish a certain instructional goal. The foreseeable tradeoff is that the methods presented have not been developed or incorporated to the overall collection of instructional pattern.
Known uses	Instructional design systems.
Related patterns	Instructional methods pattern is closely related to the Instructional design flow pattern, workflow pattern, content scheduler, and mind mapping patterns.
References	Petrina S, (in press), Curriculum and Instruction for Technology Teachers. Petrina S, 2004, The politics of curriculum and instructional design/theory/form. Interchange, 35(1), 81-126

4.3.2.3 Questionnaire/Survey Pattern

Component	Brief Description
Name	Questionnaire Pattern/ Survey Pattern
Intent	How can web-based questionnaires and surveys be created, delivered and graded/analyzed?
Motivation	Instructors sometimes need to get information from their students ranging from course evaluations to gathering information regarding particular aspects about the students and their environments. It would be an overwhelming work for an instructor to go through hundreds of students who might be geographically dispersed soliciting for this information. Creating a means to captures data on online questionnaires and surveys can ease an instructors work.
Solution	Provide a mechanism for the creation of on-line questionnaires and surveys comprising of closed-end questions with predefined answers, that are able to be automatically graded/analyzed and open-end questions that need to be graded by an instructor. Generate web reports of the analyzed questionnaires.
Consequences	Instructors can use the questionnaire pattern to get information from learners quickly and easily even if the learners are geographically dispersed.
Known uses	LMSes
Related patterns	Learner analysis pattern, content pattern, mind mapping pattern
References	Avgeriou P, Papasalouros A, Retalis S & Manolis Skordalakis, 2003, "Towards a Pattern Language for Learning Management Systems", IEEE Educational Technology & Society, 6(2), pp. 11-24. Avgeriou P, Papasalouros A & Retalis S, 2003, "Patterns For Designing Learning Management Systems", proceedings of the European Pattern Languages of Programming (EuroPLOP) 25th–29th June 2003, Irsee, Germany. Synodinos NE, 2003, The "art" of questionnaire construction: some important considerations for manufacturing studies, Integrated Manufacturing Systems 14(3) pp. 221-237.

4.3.2.4 The Glossary Pattern

Component	Brief Description
Name	Glossary Pattern
Intent	The glossary pattern provides an explanation or meaning to the learners of certain words

	or phrases as defined by the instructional designer. The explanations are given where the word or phrase is encountered within the text the learner is going through.
Motivation	A glossary is a list of terms with the definitions. There are terms or words within an instructional project that the instructional designer would like to provide a fairly detailed meaning/explanations. These explanations would be accessible where the words appear and therefore all words that are in the glossary could be hyperlinked and a layer with their definition could be made visible. The hidden layer should also include a link to look up the term in an online dictionary or an external source. A glossary should exist for each and every instructional project. This will make sure that a learner is presented with only the terms that are relevant to her line of study. This will also minimize confusion in cases where a word can have more than one meaning, depending in the context. For example: Line in mathematics is the shortest distance between two points (e.g. A→B); in literature it might mean a row of words or characters; in programming a command making up an executable instruction (e.g. line of code); in electricity and electronics it might mean a connection (e.g. telephone line).
Solution	The glossary pattern provides a service to other patterns, and accepts a string as input, and returns the string with the glossary items linked as described above.
Consequences	Instructors can be able to generate a glossary of terms used in their learning materials easily and efficiently.
Known uses	Definitions of terms, acronyms.
Related patterns	Course creation, Mind mapping patterns
References	E-LEN project, 2003. http://www.tisip.no/E-LEN/. [10 October 2005]

4.3.2.5 The FAQ Pattern

Component	Brief Description
Name	FAQ, Frequently Asked Questions
Intent	To provide a catalogue of the frequently asked questions and the replies that have been given
Motivation	Learners going through instructional materials experience some difficulties and challenges and the send questions to the instructor. More often, students might be having the same question, or questions relating or circulating around the same issue. Emails from students can quickly fill up an instructor's email account. Its sometimes become increasing taxing for the instructor to provide timely and effective personalized replies to the questions. Also, students' work hours may be different from instructors' hours. This in effect can lead to frustration of the learners because the communication loop is breaking or not complete. It has been noted that some learners can not proceed with their study if they have unresolved issues with certain parts of a course. Students need a quick response. The However, this study takes note of the tact that the Frequently asked questions (FAQs) might be time and/or context sensitive for example in cases where learners would want to know the date of the next class exercise or the due date of submitting assignment
Solution	Develop a mechanism for assigning answers to asked questions.
Consequences	Providing the answers to the frequently asked questions would ensure that the learners get timely responses to some of their queries at the same time minimizing the number of learner queries the instructor has to deal with. The instructor can be able to enter questions that learners ask, and over time there can be a good repository of all questions that the learners might ask.
Known uses	Support systems, helpdesk
Related patterns	This pattern is related to the glossary, the forum and the Content-Assessment map
References	E-LEN project, 2003. http://www.tisip.no/E-LEN/. [10 October 2005]

4.3 Implementing the Patterns in KEWL.NextGeneration

The patterns identified are being implemented in the Knowledge Environment for Web-based Learning, the Next Generation (KEWL.NextGen or KNG).

4.3.1 Brief information about KEWL.NextGen

KNG is an advanced Learning Management System (LMS) being built as part of a collaborative Africa Virtual Online Initiative and Resources (AVOIR) project. The collaboration is among various African universities, but also taking advantage of open source developers all over the world. KNG is a precursor to Knowledge Environment for Web-based learning (KEWL), an open source software that was developed at the University of the Western Cape (UWC). Besides improving the functionality of KEWL KNG is also a modern reengineered and modular architecture that follows best standards for scalable free and open software.

KNG takes advantage of the latest thinking in education, hence the instructional design subsystem, as well as many other disciplines like computer science, medicine, and philosophy.

The application framework of KNG is the Model-View-Controller (MVC) pattern which separates an application's control logic data model, and user interface into three separate components as show in figure 22 (KNG Developer Manual).

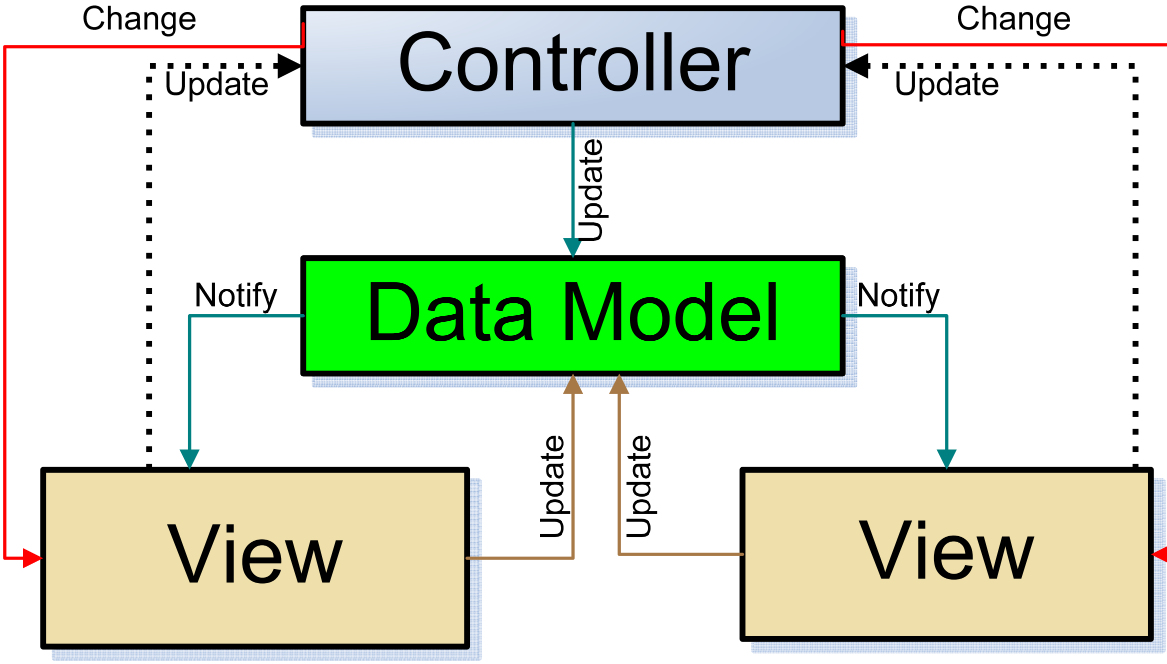


Figure 22: MVC framework used in KNG

(Source: KNG Developer Manual)

The MVC-pattern approach makes it easy for one of the components of the framework to be changed, altered or modified without affecting the others.

The modular approach of the framework ensures that the patterns identified can be written as modules within KNG. In designing a module within the framework, there is a rigorous process discussed below:

1. Writing of whitepaper and uploading it to a common repository. A whitepaper for KNG development explains what a proposed design or a design feature is supposed to do and how it will achieve its objectives. In the case of instructional design, a white paper would describe a pattern identified to a level of detail that is sufficient for its implementation within KNG, giving its constraints, validations, screen layouts, proposed data structure and a brief background or motivation. The whitepaper is uploaded to a common repository so that the other stakeholders can review and critic

the whitepaper, after every stage the whitepaper is updated to reflect what has been done.

2. Reviewing of the whitepaper. The content and structure of the whitepaper is reviewed for conformance to the standards of practice within KNG, check if its proposed features and functionalities can be achieved by extending an existing feature or module, setting timelines and priorities for the implementation of the module, or aiming at improving it so that its features can be enhanced and extended.
3. Formulation of the project plans are for the module. Depending on the outcome of the review, a timeline of implementation and expected deliverables or milestones are set.
4. Setting and reviewing timelines for the development of the module. The project plans sets up review timelines for the implementation of both the code and design and the output or functionalities of the features.
5. Design of the database if the module entails the design of a module and actual writing of the code. The design starts with the screen layouts and databases design followed by the actual writing of code.
6. Code review by peers. To ensure that the code conforms to the set standards, the peer review is continuous process as the code is being written.
7. Interface reviews by information architects and usability experts. The overall layout and functionalities are reviewed by experts to ensure that their usability is of the laid down standards.
8. Developers testing. Other developers from the project test the module. These are people who are well vast with the technical aspects of KNG.
9. End-user testing. After the developers, testing and final improvement of the module, it is taken for testing by the end users. This testing is also used as an acceptance testing as well as a usability testing.

The learning outcomes pattern (section 4.3.1.3) is the sample design is presented in the appendices. The whitepaper for the pattern as it appears in its latest form is attached (see Annex II). Annex V shows the screenshots of the look-and-feel of the latest implementation of the pattern.

4.4 Challenges, Discussions and Reflections

The designing of the subsystem using the research approach relies on enormous review of literature. Consequently, reducing the findings from the literature to design patterns whilst maintaining the value of the research was a challenge. Instructional designers and educators do not subscribe to any one given theory, neither do they follow a given instructional model in the design of instructional materials. Educators and instructional designers apply theories (or a theory) by first considering the problem at hand – making the approach problem-centred as opposed to theory-centred. This not only shows the complexity of the instructional design as a process, but also the complexity in the relationship between the instructional theory and professional practice. In retrospect, it was difficult to elicit all the requirements necessary for the design of the subsystem.

This complexity raised challenges and questions on how to design a system that is 'eclectic' enough – taking the best of all theories, and using it to inform the practice – at any given situation. Directly linked to this is the varied and contrasting expectations and results. The difference between 'what we want/need', 'what is there' and 'what can be realised'. Certainly it is impossible to satisfy the needs of all, at all situations. This meant that the design features for the initial system design were presented in a way that it is easy to accommodate and integrate more than one theory and at the same time leaving a window for extension should the need arise.

Web learning field is relatively new. The research especially on the instructional design for the web is relatively scarce compared to other approaches to education and delivery of learning. This means that there might be a missing link, between what the 'actuals' should be – in the field of instructional design for the web, and what is actually there. This study has done some work in establishing and creating the links – through the review of the literature on instructional design and related fields and the design of an instructional design subsystem. However, a lot needs to be done.

4.5 Conclusion

This chapter started off with an explanation of the instructional design process. The instructional design process has several distinct phases that are followed. These phases are similar for different instructional projects of differing magnitudes and complexities. Using a modular approach, the complex project can be broken down into small simple modules; UoLs that can be achieved separately. Each of the UoLs has the unique features that form the primary instructional design patterns. This chapter identified and defined the basic patterns. For effectiveness of the primary patterns, some support patterns were identified. All the patterns identified have been presented and discussed through giving their theoretical background and their application in web-based instructional system. The process of the patterns implementation into KNG and their integration is also discussed briefly.

Chapter Five

Conclusions and recommendations

5.1 Introduction

This chapter finalizes the research by briefly:

- Describing the achievements of the research
- Reviewing the research question at the centre of the research and its answers
- Assessing the research design approach used for the research
- The software development process
- Detailing the relevance of the study in the design of web-based learning systems
- Giving directions for future research.

This thesis set out to studied the transformation of theory into practices (T→P) and their relationships in instructional systems for web-based learning systems. The aim of the study was to develop an argument for instructional design based on current instructional and learning theories and philosophies, good practices and effective approaches to the design of learning materials, to design an instructional design subsystem for web-based learning. The argument formed was intended to shape a framework – using a developmental method of research that would facilitate the design and development of an instructional design sub-system that would offer effective and efficient ways for creating web-based learning materials to instructors. It also aimed at examining the relationship between the theory and practice of instructional design with particular emphasis on instructional design for web-based learning materials with the intent of enriching and improving them. Initially the theory was to inform the design of the system, with the system's use informing and improving the theory – and vice versa.

5.2 Achievements of the research

The aims of the research were to look for means of easing the instructional designers work in creating course materials that are based on established instructional design strategies, using a guided approach throughout the process and integrate the whole process of instructional design in a web learning management system. In this regard the study contributed:

- To an in-depth inquiry into learning and instructional theories, the different paradigms
- To studying how the theories can be used to inform the design on an instructional design subsystem.
- In reducing and capturing the main components of a generic instructional design model into patterns that can be designed and implemented separately in an LMS and later knit together to form a complete instructional design subsystem.
- To the actual implementation of some of the patterns that were identified in chapter 4 in the LMS, KEWL.NextGen.

5.3 Research question and answers

The research had aimed to find an answer to the research question "**How can instructional design for web-based learning be optimized through the use of existing research?**" as stipulated in chapter 3. The research question was further split into 5 questions. Table 13 summarizes the five questions and shows how and where in this thesis they were addressed. As discussed in section 3.3.1.2 "Framing the Problem" the two main areas of the research used were **existing research** and **optimizing** the research for use in the instructional design for web-based instructional design subsystem.

Table 13: Research questions: where and how they were addressed		
Question	Where Addressed	How it was addressed
1 Can an instructional design model be adopted and used to automate the process to come up with instructional materials that are based on pedagogically sound and proven instructional design principles?	Chapter 2	Chapter 2 provided the literature on the background and research of learning instructional theories that formed the basis for the implementation of the web-based instructional design system. This chapter provided the foundation to a framework for the design of an instructional design subsystem – that is based on sound pedagogy and proven instructional principles following an instructional model. In particular, section 2.1 through to section 2.6 dealt with the theories, models , principles and pedagogical issues while section 2.7 dealt with the implications (of these sections) to instructional design system for the web and the way forward
2 What instructional design model can achieve the optimum results for web-based instructions?		
3. How can the instructional design model be abstracted into computable formats or modules	Chapters 2, 3 and 4	The latter sections of chapter 2 described the way forward in the design of the instructional design subsystem. It proposed to use the design pattern approach to abstract the main components of the instructional design subsystem. Specifically the pattern approach was favoured because of the recurrent nature of instructional design Problem-Solution and the robustness of design patterns in the approach of dealing with complex tasks. Issues of generalizability, customization, adaptability and reusability of design patterns were discussed in section 2.7. Chapter 3 described the research approach – developmental approach of realizing and reaping the best from both the practice and the theory. Chapter 4 described the various patterns identified and the software process used to design, develop and implement the patterns. All through, effective and efficient means of accomplishing a task were used.
4 How can this abstraction be realized in a modular way to allow for reuse, generalizability and adaptability, and user customization?		
5 What other time saving features can be incorporated in the design?		

5.4 Assessment of research approach

This study used developmental research design and methodology which involved undertaking a literature review with an aim to exploring, analyzing, integrating and synthesizing the broad field of learning and instructional theories, paradigms and best practices for the design of the instructional design subsystem. The complacent cases were abstracted and used in the design of the subsystem. The web-based technology, is a moving target. Web-based learning and teaching technology is being used and developed at a rapidly using diversity of methods. These methods should therefore be adaptable to the changing features of technology as well as a guiding methodology to select which technology features should be fixed or flexible in the design. The design-experiments perspective enabled the making of principled design approaches informed by knowledge of instructors' particular generalizing processes and the research in instructional design. It could be improved by rigorous attention to the formulation of theory, if more iterations are used, each leading to revision, refinement and modification of the instructional design subsystem and perhaps increasing the appeal of the theory in-use. Techniques borrowed from design-experiments can improve the theory and practice of instructional design.

5.5 The software development process

Several software design approaches were discussed in section 2.7.3, with the argument leading to a software development life cycle that uses both the convection SDLC and the design patterns approach as used in this study. This approach offers a promising way of deal with the complexity of both the software development processes and the instructional design field in line with the Open Source nature and philosophy. It starts with the domain analysis – an investigation of the essential domain concepts in order to minimize duplication of efforts and also to get the requirements and analyse them. The results of the domain analysis are used as the basis for the identification of the patterns that define the problem and (suggested) solutions. These patterns can in turn be designed and developed in software.

5.6 Relevance and implications of the study

With the current trend towards web-based instructions expectations from the wider community of learners is growing. The instructors in turn, overwhelmed by the instructional design task need to be assisted in the creation of web-based learning materials. The practicality and eventual realization and completion of this study will offer instructor-tools for creating web-based courseware. The completed instructional design system is of immediate use to instructors, especially in higher education institutions.

This instructional design theory and approach can be used in the design and development of not only web-based courseware, but also other forms of learning materials such as for face-to-face instructions, distance education and other forms of computer based instructions.

The research methodology foci can be used in the future and continuous improvements, refinements, revisions and modifications of the subsystem. This over time can be used to enrich and inform both the theory and the practices of instructional design – especially for web-based learning. In addition, the research methodology discussed the developmental research, can be adopted and adapted for use in other areas of educational research for example, in the formulation of national curriculum. Apart from the education field, the methodology can also be used in product design and improvement where theories about a product are used to design the initial product and when the product is released to the markets, its effects are studied using developmental approach its performance is used to guide its future directions and innovations. In market product design, this methodology is related to arteology.

5.7 Conclusion

This thesis reports on a study aimed at transforming the research of instructional design into practice. It designed an instructional design system with the hope of providing an argument for its implementation. The argument is intended to form a framework – using a developmental method of research that can facilitate the design and development of an instructional design subsystem for the web to offer effective and efficient ways for creating web-based learning materials to instructors.

The study started by examining the various paradigms, theories and practices of instructional design with particular intent of using them in enriching and improving the practice of instructional design in web learning. It undertook to thoroughly and systematic review of the literature on instructional design, then using the findings from the literature to design the system. The literature was to satisfy the first goal of the research which is aimed at “examining the field of instructional design to find instructional design principles, constructs and theories that can be used to design a web-based instructional design system” The examination of the literature has also identified the relationship between the theories and practices of instructional design through the corroboration of the findings from the literature review and the ‘what instructional designers do’. The design approach made use of successful patterns of design (design patterns) that can be implemented and used – to satisfy the third goal of designing, developing and implementing an instructional design system using the information derived from the research and findings of the first objective. Instructional design patterns we identified in this study as the recurrent problems or processes instructional designers go through while creating instructional materials, whose solutions can be reused over and over again.

The research methodology employed in this study is an iterative developmental research process of finding and modeling an instructional design process that follows and builds on existing research on instructional models, theories and strategies. This ensures that the same methodology could be used to test the theories from the design and hence improve both the research and the design.

5.8 Directions for further research/work

The area of web-based instructional design is wide and this research cannot cover it all. Time allowing, it would have been good to see automation of the process of using the various instructional methods outlined in section 2.4. Though in KEWL.NextGen there is the problem based learning and the discussion forum implementations, it would be good to extend these tools to cover more instructional methods.

The complete study of the relationship between the patterns, their implementation within KNG, and how they could be designed in other systems – and the impact they would have on the efficiency and effectiveness of the instructional design process for web-based learning systems is still to be done. This study had dwelt at large on the literature and design of an instructional design system.

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Annexes

Annex I: The Bloom's Taxonomy

Learning outcome is defined as the type of behaviour the student is expected to exhibit as a result of the learning objectives have been organized into three areas or domains: cognitive, affective, and psychomotor. The cognitive domain includes those behaviours of objectives dealing with intellectual outcomes such as knowledge, understanding, and thinking skills. The affective domain includes those objectives that emphasize feelings and emotions such as interest, appreciation, attitudes, etc. The psychomotor domain deals with those objectives that emphasize motor skills such as doing, practicing, demonstrating, etc.

Descriptive of Categories	Examples of Behaviours
Cognitive Domain (Ideas)	
Knowledge. Knowledge is defined as the remembering of previously learned material. This may involve the recall of a wide range of material, from specific facts to complete theories, but all that is required is the bringing to mind of the appropriate information. Knowledge represents the lowest level of learning outcomes in the cognitive domain.	Define, Identify, Label, List, Match, Memorize, Name, Outline, Recall, State, Repeat, Relate, Record, Underline
Comprehension. Comprehension is defined as the ability to grasp the meaning of material. This may be shown by translating material from one form to another (words to numbers), by interpreting material (predicting consequences or effects). These learning outcomes go one step beyond the simple remembering of material and represent the lowest level of understanding.	Defend, Describe, Discuss, Explain, Generalize, Give example, Identify, Infer, Locate, Paraphrase, Predict, Receive, Recognize, Report, Restate, Rewrite, Summarize, Tell, Translate
Application. Application refers to the ability to use learned material in a new and concrete situation. This may include the application of such things as rules, methods, concepts, principles, laws, and theories. Learning outcomes in this area requires a higher level of understanding that those under comprehension.	Apply, Change, Compute, Demonstrate, Discover, Dramatize, Employ, Illustrate, Interpret, Manipulate, Modify, Operate, Practice, Predict, Prepare, Produce, Relate, Schedule, Shop, Show, Sketch, Solve, Translate, Use
Analysis. Analysis refers to the ability to break down material into its component parts so that its organizational structure may be understood. This may include the identification of the parts, analysis of the relationships between parts, and recognition of the organizational principles involved. Learning outcomes here represent a higher intellectual level than comprehension and application because they require an understanding of both the content and the structural form of the material	Analyze, Appraise, Break down, Calculate, Categorize, Compare, Contrast, Criticize, Debate, Diagram, Differentiate, Discriminate, Distinguish, Examine, Experiment, Illustrate, Identify, Infer, Inspect, Inventory, Outline, Point out, Question, Relate, Select, Separate, Solve, Subdivide, Test
Synthesis. Synthesis refers to the ability to put parts together to form a new whole. This may involve the production of a unique communication (theme or speech) a plan of operations (research proposal), or a set of abstract relations (scheme for classifying information) Learning outcomes in this area stress creative behaviours, with major emphasis on the formulation of new patterns of structures.	Arrange, Assemble, Categorize, Collect, Combine, Compare, Compile, Construct, Create, Design, Devise, Explain, Formulate, Generate, Manage, Modify, Organize, Plan, Prepare, Propose, Rearrange, Reconstruct, Relate, Reorganize, Revise, Rewrite, Set up, Summarize, Tell, Write
Evaluation. Evaluation is concerned with the ability to judge the value of material (statement, novel, poem, research report) for a given purpose. the judgements are to be based on definite	Appraise, Assess, Choose, Compare, Conclude, Contrast, Criticize, Describe, Discriminate, Estimate, Evaluate,

criteria. These may be internal criteria (organization) or external criteria (relevance to the purpose) and the student may determine the criteria or be given them. Learning outcomes in this area are highest in the cognitive hierarchy because they contain elements of all of the other categories plus conscious value judgements based on clearly defined criteria.	Explain, Interpret, Judge, Justify, Measure, Rate, Relate, Revise, Score, Select, Summarize, Support, Value
Affective Domain (Attitudes)	
Receiving. Receiving refers to the students' willingness to attend particular phenomena or stimuli (classroom activities, textbook, etc.). From a teaching standpoint, it is concerned with getting, holding, and directing the students' attention. Learning outcomes in this area range from the simple awareness that a thing exists to selective attention on the part of the learner.	Ask, Choose, Describe, Discriminate, Follow, Give, Hold, Identify, Listen, Locate, Names, Observe, Point to, Prefer, Realize, Reply, Select, Use
Responding. Responding refers to active participation on the part of the student. At this level, he not only attends a particular phenomenon but also reacts to it in some way. Learning outcomes in this area may emphasize acquiescence in responding (reads assigned material), willingness to respond (voluntarily reads beyond assignment), or satisfaction in responding (reads for pleasure or enjoyment). The higher levels of this category include those instructional objectives that are commonly classified under "interests"; that is, those that stress the seeking out and enjoyment of particular activities.	Answer, Assist, Assume, Comply, Conform, Consider, Contribute, Cooperate, Discuss, Display, Engage, Enrich, Exhibit, Explore, Extend, Greet, Help, Label, Obey, Participate, Perform, Practice, Present, Read, Recite, Report, Respond, Select, Tell, Volunteer, Willing, Write
Valuing. Valuing is concerned with the worth or values a student attachment to a particular object, phenomenon, or behaviour. This ranges in degree from the more simple acceptance of a value (desire to improve group skills) to the more complex level of commitment (assumes responsibility for the effective functioning of the group). Valuing is based on the internalization of a set of specified values, but clues to these values are expressed in the student's overt behaviour. Learning outcomes in this area are concern with behaviour that is consistent and stable enough to make the value clearly identifiable. Instructional objectives that are commonly classified under "attitudes and appreciation" would fall into this category.	Accept, Assume, Responsible, Complete, Continue to desire, Describe, Devote, Differentiate, Enable, Examine, Explain, Feels, Follow, Form, Grow, Influence, Initiate, Invite, Is loyal to, Join, Justify, Participate, Prefer, Read, Report, Select, Share, Study, Work
Organization. Organization is concerned with bringing together difference values, resolving conflicts between them, and beginning the building of an internally consistent value system. Thus the emphasis is on comparing, relating, and synthesizing values. Learning outcomes may be concerned with the conceptualization of a value (recognizes the responsibility of each individual for improving human relations) or with the organization of a value system (develops a vocational plan that satisfies his need for both economic security and social service). Instructional objective relating to the development of a philosophy of life would fall into this category.	Adhere, Alter, Arrange, Combine, Compare, Complete, Crystallize form, Defend, Explain, Generalize, Identify, Is realistic, Judgement, Judge, Modify, Order, Organize, Prepare, Regulate, Relate, Synthesize, Weigh
Characterization by a Value or Value Complex. At this level of the affective domain, the individual has a value system that has controlled his behaviour for a sufficiently long time for him to develop a characteristic life style. Thus the behaviour is pervasive, consistent, and predictable. Learning outcomes at this level cover a broad range of activities but the major emphasis is on the fact that the behaviour is typical or characteristic of the student. Instructional objectives that are	Act, Approach, Arrive, Change, Discriminate, Display, Examine, Find, Influence, Is Conscientious, Is Consistent, Judge, Listen, Modify, Perform, Plan, Practice, Propose, Qualify, Question, Ready, Rely, Revise, Serve, Solve, Use, Verify, View

concerned with the students' general patterns of adjustment (personal, social, and emotional) would be appropriate.	
Psychomotor Domain (Skills)	
Observing. This type of behaviour deals with the watching process; paying attention to steps or techniques and to finished product or behaviours and may include the reading of directions.	Find, Locate, Observe, Recognize, Sort
Imitating. This type of behaviour deals with following directions, carrying out steps with conscious awareness of efforts.	Build, Construct, Demonstrate, Draw, Express, Measure, Mend, Operate, Perform, Play, Run, State, Use, Write
Practicing. This type of behaviour deals with the repetition of steps until some or all aspects of the process becomes habitual, requiring little conscious effort.	Build, Construct, Demonstrate, Draw, Express, Measure, Mend, Operate, Perform, Play, Run, State, Use, Write
Adapting. This type of behaviour deals with making individual modifications and adaptations in the process to suit the worker and/or situation.	Adapt, Administer, Construct, Create, Draw, Manipulate, Mend, Plan, Produce, Promote, Regulate, Research, and Teach

Source: Curriculum Committee: Ohlone College, nd, Bloom's Taxonomy Classification ff Instructional Objectives, Available Online http://www.ohlone.edu/org/capac/docs/blooms-tax2.html [10 October 2005]

Annex II: Sample Whitepaper: The Learning Outcomes Pattern

Instructional Objectives module for KEWL.NextGen

Document history

2004 05 25	Document created	James Kariuki Njenga
2005 08 28	Document modified	Olusola Abidogun

Purpose of this document

The purpose of this document is to describe the instructional objectives feature of KEWL.NextGen to a level of detail sufficient to guide developers in the creation of the module. It also serves as part of the workflow design process for the development of an instructional design module that is based on research. In addition, the document is intended to offer initial inputs to researchers and experts in the area of instructional design and teaching material development.

Intended audience for this document

This is a technical and an academic whitepaper, as such it is intended for workgroup leaders, project managers, software developers, database administrators, as well as educational and instructional design experts.

Similar functionality in KEWL 1.x

None

Module status

Instructional objectives module is a required module, and links to a variety of content and organizational modules. It is one of the foundation modules in the instructional design module.

Background Information

Instructional objectives module creates a process that assists instructional designers to generate or formulate instructional objectives for an instructional project, for instance a course. It builds upon some other modules and templates like the Bloom's module and the Analysis templates.

Instructional objectives are an integral component of the instructional design process. They are also referred to as learning objectives, learning outcomes or instructional outcomes.

Learning objectives are stated in performance terms. These are specific skills and knowledge the learner is required to master after going through some instructional material. They define what the learners (not the teachers/instructors) should be able to do, after going through some instructional material or course.

The learning outcomes help the instructor in mapping out a teaching/learning strategy guide for sequencing and chunking learning materials and activities, as well as provide a checklist of what is to be presented to learners and to what levels of details.

Course activities, assessment tests, and assignments are a direct product of the learning outcomes and are used to measure how well the students met the identified objectives. The process of learning outcomes formulation and assessment writing are usually done in parallel or iteratively.

Learning objectives are derived from the broad goals and are stated at the beginning of the instructional unit. They are stated in clear, precise, accurate and unambiguous statements. They are arranged according to the learning domains hierarchy proposed by Gagne's Learning Categories and the Bloom's Learning Taxonomy.

Dick and Carey (2001) state that objectives "are critical to the design of instruction" because they "guide the designer in selecting content and developing the instructional strategy" for the course. They also point out the following reasons for writing objectives that can be related to Computer Based Training (CBT) development:

- They provide a clear description of what the students would cover thereby helping to prevent instructional gaps
- They indicate to administrators what the students are being taught
- They establish criteria for evaluating student performance when instruction ends

Alessi and Trollip (1991) state that "well-written objectives can demonstrate the relevance of material to the student", thus contributing greatly to their motivation for learning. According to them, the objectives stated must be:

- Specific - they should not only help the instructor make sound instructional decisions during Instructional Design, but also guide the learners on what to focus on.
- Measurable - they should describe tangible outcomes that can be observed
- Outcome (not process) oriented - they should describe what the learners would be able to achieve, but not how it is achieved.
- Learner (not instructor) oriented – they should describe in clear terms what is expected of the learners, that is describe the learners' performance

Mager (1997) identify the following components of effective instructional objectives:

- Performance - a description of the expected learner's behaviour that is measurable and observable. That is, what the learner must demonstrate to show mastery of an objective. It is stated as a verb that is measurable.
- Conditions - a description of the circumstances and contexts under which the performance will be carried out. That is, what would be available for the learner to perform the desired behaviour.
- Criteria - a description of the criteria for acceptance of the performance as sufficient enough to indicate a mastery of the objective in terms of speed and accuracy.

Example:

The student will (show {**P**}), the (relationship between the demand and supply of sugar in a given region {**C2**}) using (the law of demand and supply {**C1**})

where

{**P**} = Performance, {**C2**} = Criteria, and {**C1**} = Condition

The objectives also have the who part which defines who must meet the objective

The whole syntax is as follows:

{**Who**?}{**Under what Conditions**?}{**verb**} {**Performance**} {**Using what Criteria?**}

The performance part could be further split into functions, viz: {what the learners will do} and the processes {how they will do it}.

Consequently, the student {who}, when provided a list of subjects and predicates {Conditions}, will match every subject in the list with a predicate {Performance}, so that every subject agrees with its chosen predicate {Criteria}.

Some examples of learning outcomes formulation are as stated below.

1. The learner will be able to perform {tasks} under {conditions} to meet {standards}
2. The learner will be able to perform {task} given {conditions} and therefore training is to meet {standards}.
3. Given {conditions} the learner should perform {tasks} being performed as {standards}
4. The learner will {action verb} {task} with {conditions} by {standards}

A complete learning outcome, therefore, defines who the learners are, what they should be able to do, perform, or accomplish and the context and tools for accomplishing it.

The learning outcomes are discrete, measurable, clear, unambiguous statements.

Key Steps in Creating Instructional Objectives

Step 1: List (performance) - what the students need to be able to do in order to achieve the objective.
Step 2: List the environment, circumstances and contexts (condition) under which the performance will be carried out.
Step 3: Determine the level and amount or quality (criteria) that is acceptable for each performance to be considered acceptable for that objective.
Step 4: Using the performance identified, condition, and the amount of that behaviour required, combine and write objectives worded from participants' point of view.

Prior to writing the instructional objectives, the module would seek to identify the levels of the instructional project, and its attributes in relation to the Bloom's taxonomy. This would influence the way the instructional objectives are set. This would lead to an understanding of the types of objectives and learning outcomes/objectives to be developed.

Key features

Instructional objectives module allows users to carry out the process of generating instructional objectives of a course. It builds upon the some other modules and templates like the Bloom's module, the analysis templates.

Links to other modules

This module depends heavily on the Blooms module, Gap analysis module, and learner analysis module.

Validation

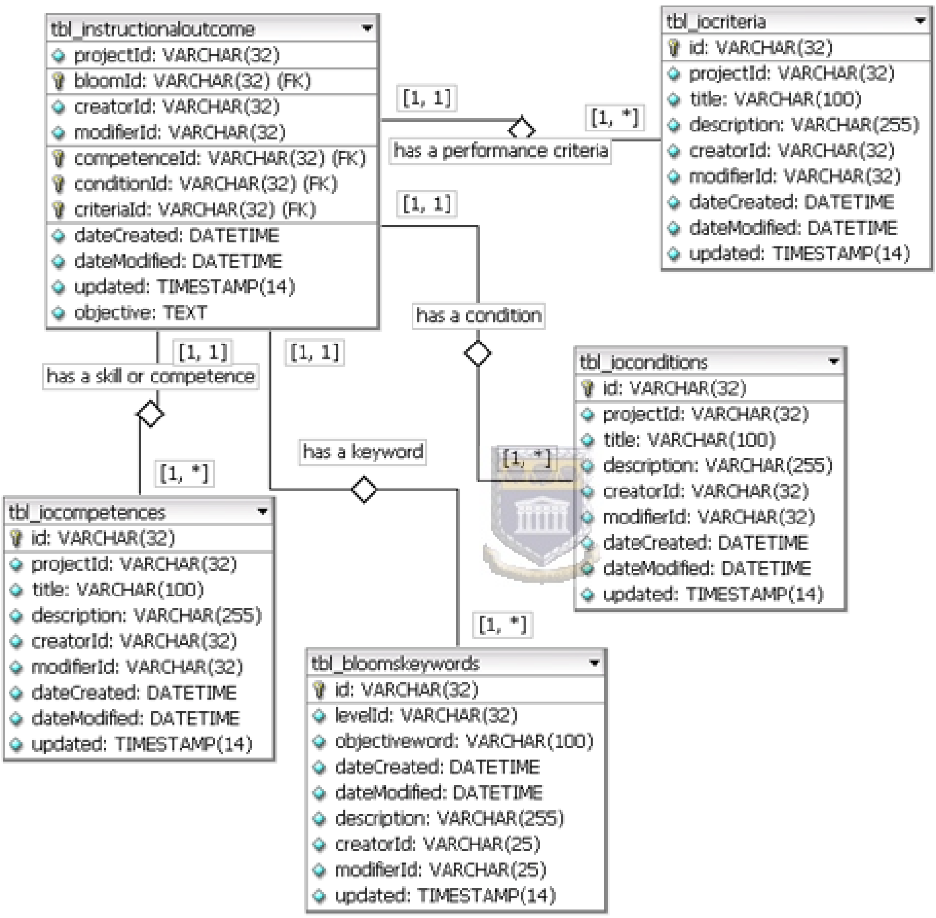
Validation is provided for all essential data using the validation tools found in htmlElements.

References

1. Dick W, Carey L & Carey, 2001, The Systematic Design of Instruction
   Knowles M, 1978, The adult learner: A neglected species. Houston, TX: Gulf Publishing Company
2. Alessi S, & Trollip S, 1991, Computer-based instruction: Methods and development. Englewood Cliffs NJ: Prentice-Hall.
3. Mager R, 1997, Preparing Instructional Objectives. Atlanta, GA. Center for Effective Performance.

4. Bloom BS, Engelhart MD, Furst EJ, Hill WH & Krathwohl DR, 1956, Taxonomy of educational objectives: The classification of educational goals. Handbook 1: Cognitive domain. New York: David McKay.
5. Krathwohl DR,2002, A Revision of Bloom's Taxonomy: An Overview, Theory into Practice, 41(4), pp. 212-218
6. Veronin M & Patry R, 2002, Instructional Objectives: What They Are, What They Aren't, Pharmacy Education, Vol. 1, pp. 207–213

Data structure



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Annex III: Sample Minutes of Review meetings

Meeting between the Instructional Design Team at UWC with the researcher

Meeting: Instructional design
07 June 2005 @ 10:00.

Attendants
Juliet Stoltenkamp
Zulfa Philander
Carolynne Kies – Taking notes
James Kariuki

Aim of the meeting:

The aim of the meeting was to identify the bear minimum essentials that an instructional design system must contain when designing an online course. This is following the alignment of the training to be done in instructional design and the modules being developed in the KEWL.Nextgen, and the research in the field of instructional design.

Instructional Design:
The ADDIE (Analysis Design Development Implementation Evaluation phase) a generic model, which is used throughout the world.

1. **Introduction** and broad overview of Instructional design. A list of acronyms and glossary to inform the user what they can expect when using the LMS tool within KNG.

2. **Analysis Phase**
   The purpose or scope of the whole course and how it fits into the Curriculum.
   Needs Analysis: Learning Profile and Learning Context/Environment.

3. **Design Phase**

   Instructional Plan is very important and should be outcome driven rather than content driven.

   1. Learner Outcomes 2. Assessment Strategy 3. Content Structure

   - Formulating Learning Outcomes for the whole course
   - Formulating Assessment Strategy
   - Content Structure in terms of the following points:
     i. reading list (optional)
     ii. Sequence
     iii. Outline
     iv. Instructional strategy
     v. Additional resources

   Instructional strategy:
   Chapter Outline
   Chapter Objective
   Chapter Assessment
   Chapter Timeline

4. **Development Phase**
   Content development (put content into context) in terms of media, web links, lessons and topics
   Assessment Development for example: MCQ's, essays and assignments.

Assessment Guidelines must be revisited

Chapter Sample
Introduction
Topic
Topic Assessments (throughout each chapter each section or at the end of the course)
Summary at end of the chapter (optional)

- Juliet has forwarded the team's current workbook to James. He is reviewing it and selecting what he can possibly use for the instructional design template.

Action Points:

- James must take the above mentioned points into consideration when developing the instructional module within KNG.

Meeting between the development team and the researcher

AVOIR
African Virtual Open Initiatives and Resources

Date: 24 June 2005
Venue: Goldfields
Time: 12:00

Present:

	Kevin Cyster	Candice Adrian
Wesley Nitsckie	Jeremy O'Connor	Regina Monyemangene
Prince Mbekwa	James Njenga	Tohir Solomoms
Hadi Fakier	James Scoble	Paul Scott
Marisca Smith	Jonathan Abraham	
	Warren Windvogel	

Absent:

Melisse Benn	Shadley Wentzel	Sola Abidogun

Agenda:

1. Status on Interns
2. Report from Individual developer
3. General discussions

Item 1. Status on Interns

Discussions from the meeting
All the modules that the interns are working on are functionally complete and they should be tested for on Wednesday 29 June 2005.
Megan and Paul will be doing developer testing for the Wiki module, Jonathan and James will be concentrating on the Find and Replace module and University Module will be tested by Wesley and Jeremy.

Item 2. Report from Individual developer

Discussions from the meeting
All updated tasks should reflect on Collab.
Wesley is working on the NetTel site trying to replace the editor.
Paul is working the back up module, which he intends to complete by Wednesday 29 June 2005.
Prince is making progress on the ongoing module SCORM, which has now been listed on the EXE site.
James Njenga will be teaming up with Donavan's team and the Knowledge tree team to work on Instructional Design. Proper documentation needs to be generated for this project and placed on the CVS as a separate folder called ID. Njenga is to present the documentation to the FSIU team on Monday 27 June 2005. [formatting added]
Jeremy is working on the Chat Robot module.
Kevin working on the workflow module and also assisting Wesley with NetTel. He is using the NetTel database to create a server for Nettel.

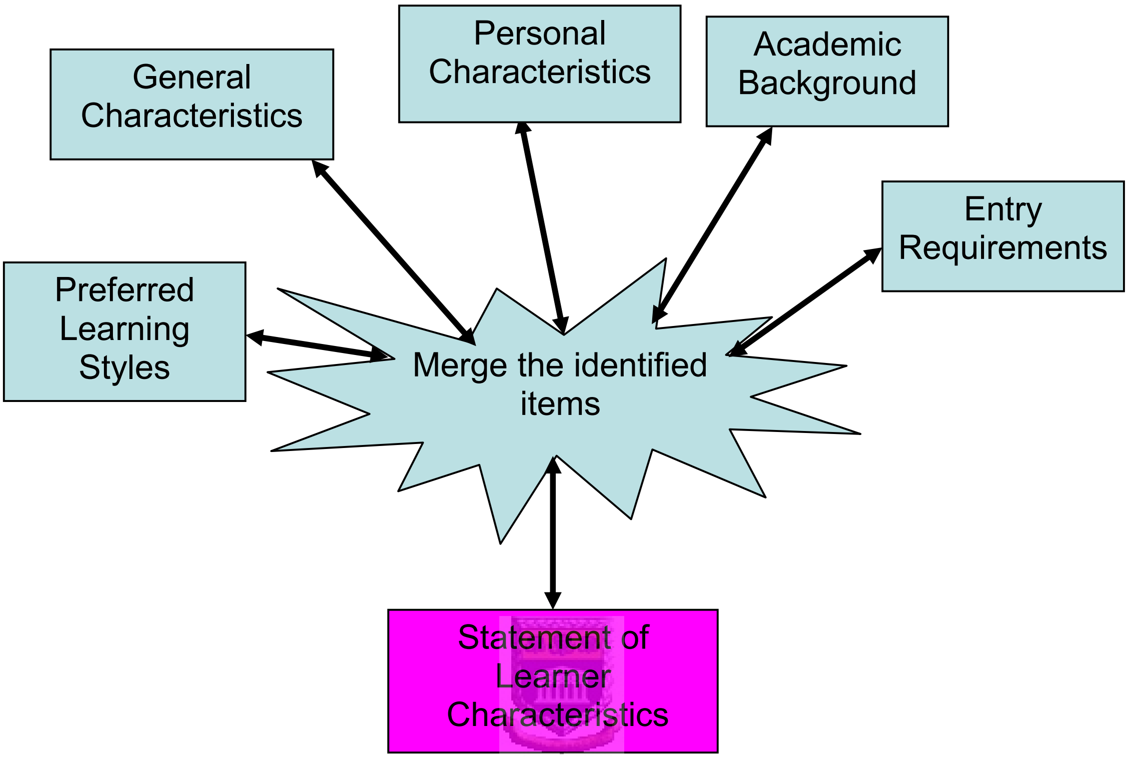
Megan is working on PGT.
Tohir was involved in the end user testing that was conducted during the week, and is going to send a report to the various developers concerning the end user testing. He is also busy with the Brawam Siswam project. The style sheets for KNG skin is untouched and the others are cleaned up.
Marisca had a meeting with LRS project leaders this week and she is also working on the Brawam Siswam project.
Candice has been creating banners for various sites.
Hadi is working on viewlets.
James Scoble will complete the Alumni site by Wednesday 29 June 2005 and he is also working on SQL patching.

Item 3. General discussions

Discussions from the meeting
New modules are needed for the UWC developers, Non UWC developers and the interns.
Until the non-UWC developers are paired up with the senior UWC developers for code review each developer should assist with code reviewing.

Annex IV: Sample of initial designs – learner analysis

Mind map showing what the learner analysis entails – agreed upon with the instructional designers.



Form showing how the one of the components (learning styles and preferences) identified in the mind map would be captured on the web.

Step 3: Learning Styles and Preferences

Step 3: Learning Styles and Preferences

This step deals with your learners' learning style preferences. Learners can have more than one preferred learning style, so it is not important to have them add vertically.

The numbers do not need to be accurate but be a reflection of your learners.

1. Sensors vs Intuitors

Sensory [# of Students] [Percentage %]

- Practical, looks for facts and observations
- Procedural, Careful and Slow

Intuitive [# of Students] [Percentage %]

- Imaginative, looks for concepts and interpretations
- Doesn't mind complexities (without details or repetition)
- Quick and Careless

2. Visual vs Verbal

Sensory [# of Students] [Percentage %]

- Practical, looks for facts and observations
- Procedural, Careful and Slow

Intuitive [# of Students] [Percentage %]

- Imaginative, looks for concepts and interpretations
- Doesn't mind complexities (without details or repetition)
- Quick and Careless

3. Inductive vs Deductive

Sensory [# of Students] [Percentage %]

- Practical, looks for facts and observations
- Procedural, Careful and Slow

Intuitive [# of Students] [Percentage %]

- Imaginative, looks for concepts and interpretations
- Doesn't mind complexities (without details or repetition)
- Quick and Careless

4. Active vs Reflective

Sensory [# of Students] [Percentage %]

- Practical, looks for facts and observations
- Procedural, Careful and Slow

Intuitive [# of Students] [Percentage %]

- Imaginative, looks for concepts and interpretations
- Doesn't mind complexities (without details or repetition)
- Quick and Careless

5. Sequential vs Global

Sensory [# of Students] [Percentage %]

- Practical, looks for facts and observations
- Procedural, Careful and Slow

Intuitive [# of Students] [Percentage %]

- Imaginative, looks for concepts and interpretations
- Doesn't mind complexities (without details or repetition)
- Quick and Careless

[<< Update Details and Move to Previous Step] [Update Details] [Update Details and Move to Next Step >>]

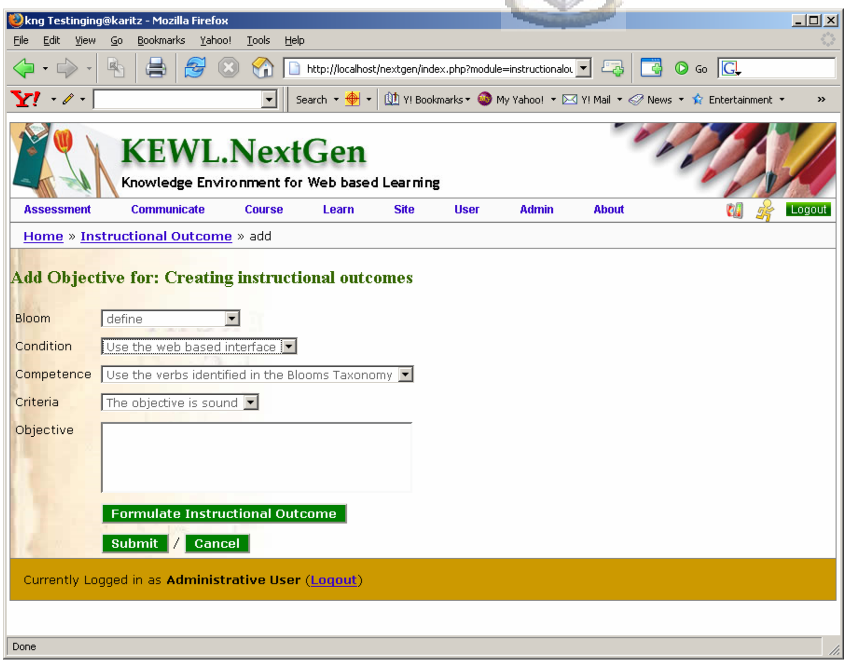
Steps: General Characteristics | Entry Compentencies | Learning Styles | Learner Expectations | Learner Statement

User needs to be alerted that form information could be lost when they click on the link.

Use JavaScript Confirm – OK – save/submit form move to next. Cancel don't save, but move to requested page.

Annex IV: Screenshots of the learning outcomes

Instructional outcomes pattern 'homepage'



Formulating an instructional outcome from the conditions, competences and criteria set for the course "creating instructional outcomes".