THE DYNAMICS OF THEORY AND PRACTICE IN INSTRUCTIONAL SYSTEMS DESIGN

A thesis by

MARY RUTH DE VILLIERS

Submitted in partial fulfillment of the requirements for the degree

Philosophiae Doctor

in the Department of Teaching and Training Studies
of the Faculty of Education
University of Pretoria

Supervisor: Prof. Dr J.C. Cronje
February 2002

ABSTRACT

This study investigates the dynamics of theory and practice in the design of instructional systems, learning events and learning environments, with a view to synthesizing an integrated metamodel as a framework to facilitate effective learning in systems which use computer technology as a tutor, tool, or environment. This framework can be used as a design aid by instructional designers and instructor-designers, or as a tool to examine existing learning events from the viewpoint of learning and instructional-design theory. The research contributes to inquiry into learning theory by an in-depth study of the elements of the framework itself, investigating how they function in different contexts and contents.

Following an extensive literature survey, the researcher synthesizes a concise integrated framework of learning theories and instructional design practice from the cognitive family. This framework, the Hexa-C Metamodel (HCMm), is generated by a process of criterion-based textual filtration through effectiveness criteria, and encompasses the theoretical concepts of *constructivism*, *cognitive learning* and *knowledge/skills components*, as well as the practical characteristics of *creativity*, *customization* and *collaborative learning*. Using mainly qualitative ethnographic methods within the contexts of action research and development research, case studies are undertaken, applying the elements of the HCMm as an inquiry toolset to investigate three diverse learning events to determine what they reveal about the practice of effective and motivational learning. The learning events - a computer-based practice environment, an Internet-based course, and a fieldwork project – were selected due to the researcher's close involvement with each intervention. Information from the evaluations of the learning events is then used to further examine in-depth the theories and characteristics which comprise the tool, as well as their interrelationships and ways of implementing them in domains that differ in context and content - distinguishing particularly between well-structured and ill-structured domains.

Key words:

Instructional systems design and development; Learning and instructional theory; Evaluation; Inquiry tool; Computer-integrated learning; Cognitive learning; Collaborative learning; Components of knowledge; Constructivism; Creativity; Customization; Domains of learning.

ii

ACKNOWLEDGEMENTS

I should like to thank:

My supervisor, *Prof Johannes Cronjé* - for sound, insightful and supportive, as well as consistently enthusiastic and encouraging leadership.

The institutions and academic departments which gave permission for evaluation of the artifacts, course material and learning events investigated in the case studies:

1. Department of Computer Science, University of South Africa – for permission to evaluate the interactive practice environment *FRAMES.*
2. Department of Teaching and Training Studies, University of Pretoria – for permission to evaluate *RBO880*, the Internet-based course on Computer-Assisted Communication and Management.
3. School of Tourism Management, University of Pretoria – for permission to evaluate the *Mkambati Project* of the Ecotourism course.

The academics and students who participated in the three evaluations - for their willing co-operation and contributions.

My young-adult children - for valuable practical assistance. In an unusual variation on the parent-offspring relationship, we mutually support one another in our post-graduate studies. Thank you to:

 Adrian – for the CAD charts
 Dorothy – for editorial assistance
 Gabrielle – for doing the bibliography, and to *JP* for Figure 4.1
 Jonathan – for the diagrams.

My husband *André* - for assistance, both technical and domestic, in the final stages.

I really do appreciate it!

Ruth de Villiers
September 2001

TABLE OF CONTENTS

Chapter Two *Theory*

Learning and instructional theory 22

Chapter Three *Practice*

Learning and instructional systems design in practice 83

Chapter Four *Synthesis*

Towards a metamodel

Chapter Five *Evaluation*

What the HCMm toolset reveals about three learning events   202

Section 5A - Case Study One: *FRAMES*   207

Chapter Six *Reflection*

What the case studies reveal about the HCMm toolset   334

LIST OF TABLES

LIST OF FIGURES

APPENDICES

Terminology

This is not a comprehensive glossary of terms. Rather, it is an overview of some generally-accepted, traditional meanings of certain terms in the domain of instruction and instructional design. These terms set the background for this study and form the context out of which the newer approaches such as constructivist learning environments, problem-based learning, etc. evolved.

- *What is an instructional theory?* (Reigeluth, 1996c, 1999)

Instructional-design theory:
- is design-oriented - focusing on how to attain goals for learning or development, rather than description-oriented - focusing on the effects of given events.

Instructional-design theory identifies:
- Methods of instruction (ways to support and facilitate human learning and development);
- Situations in which those methods should and should not be used. A major aspect of any situation is the desired instructional outcome (not the same as a learning goal) which sets out the levels of effectiveness, efficiency, and appeal required from the instruction.

 The methods of instruction are:
- Componential, in that they comprise different components or features;
- Probabilistic, not deterministic, meaning that they increase the chances, but do not ensure, attainment of the goals.

- *How does instructional-design theory differ from learning theory?* (Reigeluth, 1996c, 1999)

Learning theories are descriptive, in that they describe how learning occurs but do not identify or prescibe methods for promoting learning. By contrast, instructional-design theories are applied in practice; they are theories that identify methods for use in particular situations. In short, an instructional-design theory comprises *methods* and *situations*, and relates to events external to learners rather than describing what takes place within learners when learning occurs.

- *How does instructional-design theory differ from instructional systems development (ISD) processes?*

Instructional-design theory is concerned with the characteristics of the instruction and its methods, not with the processes an instructional designer or teacher would use to plan the instruction. According to Reigeluth (1999), terms which characterize this distinction are:
- Instructional theory, instructional model, instructional strategies - to represent instructional-design theory;
- Instructional development model, instructional systems development (ISD) process -to represent the actual process and procedures of designing instruction. These processes are, however, closely related to underlying theories.

- ***What is instructional design? What are instructional design theory/models, and what does the instructional design process comprise?***

Instructional design (ID) is the link between descriptive learning theory and prescriptive educational practice (Reigeluth, 1997). ID thus comprises prescriptive instructional-design theories and models which set out methods for developing instruction, along with the conditions under which each should be used to produce a desired learning outcome. Instructional designers should be versed both in descriptive learning theories and prescriptive design theories, so that theory and practice can be integrated.

Reigeluth (1983) in his classic, *Instructional-design theories and models, Volume I* describes *instructional design:*

- As a professional activity, whereby decisions are taken as to what methods of instruction are best for bringing about desired changes in student knowledge and skills in a specific content area, and
- As a discipline concerned with producing knowledge about optimal instructional methods, strategies, and combinations of methods (i.e. whole models).

Reigeluth (1999) proposes that *instructional design theory* describes the characteristics of the instruction, i.e. what methods should be used. Analogous concepts are instructional theory, instructional model, and instructional strategies. *The instructional design process* is what a teacher or designer does to plan and prepare for the instruction, also called an instructional development model or instructional systems development (ISD). However, ID theories and ID processes are closely related.

According to Merrill *et al* (1996c), *instruction is a science* and *instructional design is a technology* founded on this science.

- Instructional science is concerned with discovering the natural principles involved in instructional strategies. Sciences are verified by discovery, so instruction, like other sciences, is verified by discovery.
- Instructional design is a man-made technology using those principles to invent procedures and tools that will promote learning. Like other technologies, ID is extended by invention. Design research involves deriving procedures and processes that incorporate the theory learned from instructional science. So *instructional design* is a technology for the development of learning experiences and environments which promote the acquisition of specific knowledge and skill by students. It incorporates known and verified learning strategies into these instructional experiences and environments, so as to make the acquisition of knowledge and skill more efficient, effective, and appealing.
- *Instructional systems development* (ISD) is a set of procedures for systematically designing and developing instructional materials.

Winn (1990) defines *instructional design* as a set of decision-making procedures by means of which the most effective instructional strategies are developed or chosen.

Willis (1995) uses the following simple and paradigm-independent definitions:

Instructional design refers to the process of designing instructional materials; and

An instructional design model refers to a theory or model that can guide the process of instructional design.

- ▪ ***What is entailed by instruction?***

Instruction involves directing students to appropriate learning activities, guiding them to appropriate knowledge, helping them rehearse, encode, and process information; monitoring student performance; providing feedback to their learning activities and practice (Merrill *et al,* 1996c).

Dick (1991) defines *instruction* as an organized set of methods, materials, and assessments designed to promote competence in defined outcomes.

Both of the above are definitions of what is known as 'direct instruction'.

Models of instruction

Reigeluth (1989) identifies three basic forms for instructional theories and associated models of instruction:

1. *Intact models,* where a different kind of instruction is prescribed for each of a variety of conditions, for example, Merrill's CDT - section 3.3.3.1;
2. *Variations on a model* where there is one general model and variations of it are prescribed for different conditions; and
3. The 'smorgasbord' paradigm, which has *no formal model* of instruction, but prescribes various methods on a mix-and-match basis according to the conditions.