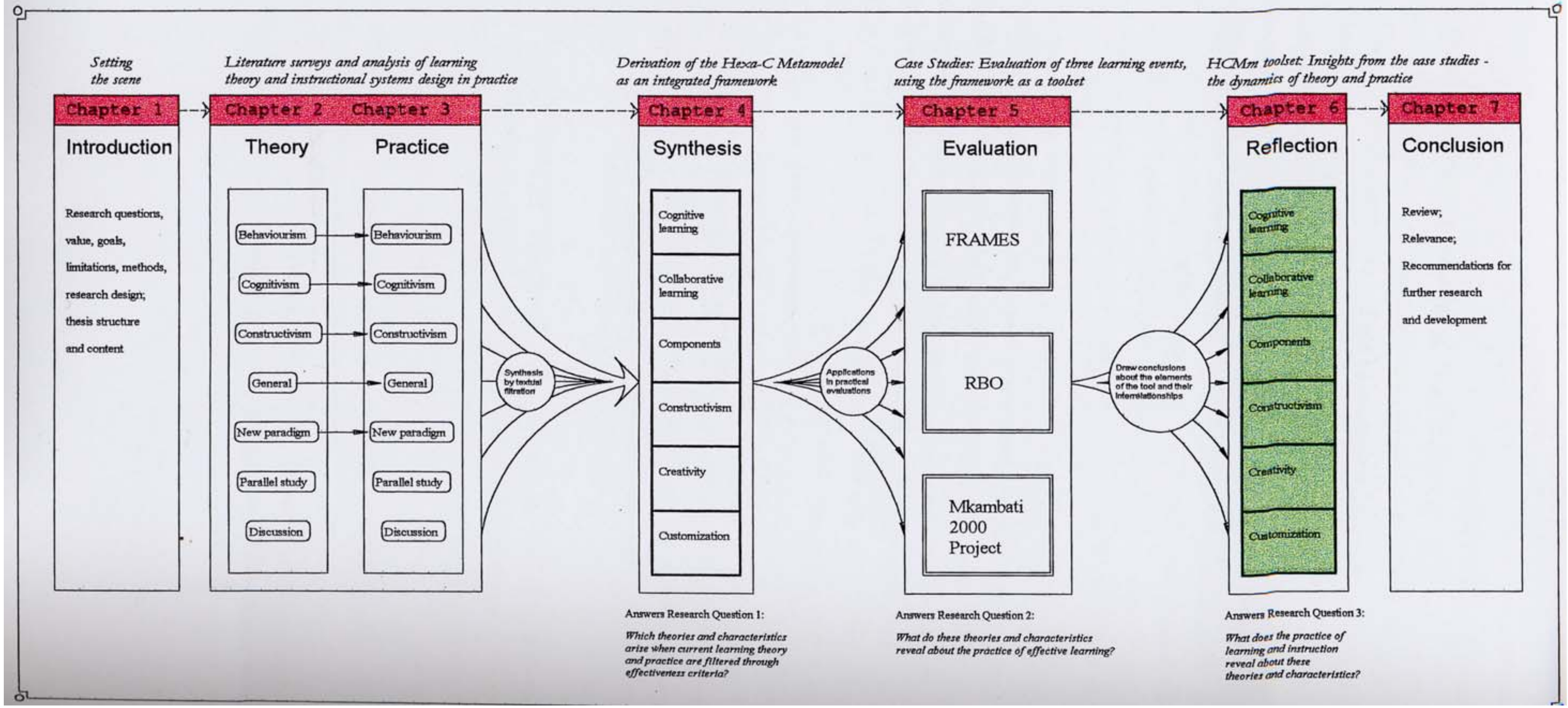
# Structure of the thesis



# Chapter Six

# *Reflection*

## What the case studies reveal about the HCMm toolset

*Tools alter the activity and are, in turn, altered by the activity*
(Jonassen & Rohrer-Murphy, 1999:63).

## 6.1 Introduction

This chapter analyses the dynamics between various current learning theories, instructional systems design theory and -practice, and actual learning events. Using the framework of the Hexa-C Metamodel as a toolset, Chapter Five sets out findings revealed by the tools with regard to the three learning events, events that differ in purpose, content and context. Chapter Six, as indicated in the alternate chapter heading, conversely uses information from **evaluations of the learning events to examine the theories and characteristics which are the elements of the tool**. It answers the third research question in Chapter One, namely:

> *What does the practice of learning and instruction reveal about these theories and characteristics?*

This chapter sets out to extend and amplify the body of knowledge relating to the theories, characteristics, and practices that comprise the HCMm, using practice to inform theory.

Activity theory (Subsection 3.4.3.5; Jonassen & Rohrer-Murphy, 1999) postulates that tools alter the activity and in turn are altered by the activity as they adapt to its specifics - see quotation at header. This, indeed, was the experience in this study**:** When the Hexa-C Metamodel was used as an inquiry tool, information was obtained, not only about the **events evaluated** and the **dynamics of theory-practice**, but also about the **elements of the HCMm framework**, their integral inter-relationships, and ways of implementing them.

The HCMm toolset is investigated in-depth, using the practical applications studied in Chapter Five of the concepts and phenomena of Chapters Two, Three and Four. Notable features of the six HCMm elements are compiled, as well as ways and domains in which they may be implemented.

Section 6.2 contrasts the three learning events in respect of their context, use of technology, and the main thrust of learner- impressions.

The major part of the chapter, Section 6.3, addresses each of the six elements of the HCMm in turn. A critical analysis focuses on certain significant information revealed in the investigations. For each element, information revealed about its implementation and/or manifestation is tabulated - thus expanding and amplifying the body of knowledge. In further tables suggestions are made regarding ways in which the learning theories can (or should not) be applied - ways which differ from domain to domain. Implications and underlying rationale are provided where appropriate. Throughout the section a distinction is drawn between applying the elements of the HCMm in *well-structured* and *ill-structured* domains - a distinction elaborated in the first part of Section 6.3.

In Section 6.4 attention is paid to the way the elements of the model work together, indicating strong synergistic inter-relationships.

# 6.2 The three learning events

An *open system* capitalizes on fluxes, perturbations, and anomalies, and uses them as positive driving forces towards re-equilibrium (Jonassen, 1990). Models for designing instruction should be open systems, using positive, deviation-amplifying feedback to trigger internal changes, to regulate and renew the system. This is in contrast to negative feedback, which takes corrective measures away from erroneous deviations. The evaluations of instructional and learning systems in Chapter Five provide qualitative information, including both positive and negative feedback, illustrating the type of systems which Jonassen terms *becoming* rather than *being*. The findings should lead to **reflection by the instructor-designers** to capitalize on deviations, where appropriate, and adapt where required. This may result in systems functioning in a different manner from that initially envisaged.

**Learning and instructional processes are dynamic systems** and cannot be reduced to predictable, manageable operations (3.4.4.5; Jonassen 1990). Qualitative evaluation techniques help designers and instructors to understand complexity and the dynamics of theory and practice in the design, development, and delivery of instructional systems. The ethnographic research methods of this study reveal **as much about the six learning theories and characteristics** which comprise the framework, as they do **about the evaluated learning events** themselves.

This section commences by contrasting the three learning events, showing in Section 6.2.1 how they differ in context, approach, scope, and methods. Second, the use of technology in each case is examined in Section 6.2.2. Section 6.2.3 follows with a categorization of overriding learner-impressions of the learning events, based on responses to open-ended questions in the surveys and interviews. This integration of the three case studies serves as a background to Section 6.3, which examines ways of applying and implementing the six Cs of the framework in varying circumstances, contexts, and domains.

## 6.2.1 Contexts of the learning events

This study was enriched by investigating ways in which the six C-elements were applied and implemented in three **completely different learning events/environments**. Table 6.1 summarises the major learning contexts, conditions, and environments of the three events, supplementing their internal details set out in Table 5.1 in the introductory section of Chapter 5.

**Table 6.1**
**Contexts, conditions and circumstances of the three learning events**

| **FRAMES** (Section 5A) | **RBO** (Section 5B) | **Mkambati 2000** (Section 5C) |
|---|---|---|
| Distance-learning | | Contact-teaching |
| Discrete mathematics<br><br>Department of Computer Science | Course in Internet-based Learning<br>Department of Teaching and Training Studies | Ecotourism<br><br>Department of Tourism Management |
| Computer-assisted learning system | Internet-based learning | Field work and project with class-based background |
| Procedural, well-structured domain | Ill-structured domains | |
| Not ideal for constructivism | Scope for constructivism | |
| Isolated learning, supplemented in some cases by co-operative pairs | Individual and collaborative learning | Collaborative groups |
| Customized by learner-options | Auto-customization | Customized by each learner's expertise and input |
| Full-time and part-time learners | Part-time learners | Mainly full-time learners |
| Undergraduates | Postgraduates | |
| No grading -<br>a supplementary learning aid | Formal university courses - grading is compulsory | |

### 6.2.2 Use of technology in the learning events

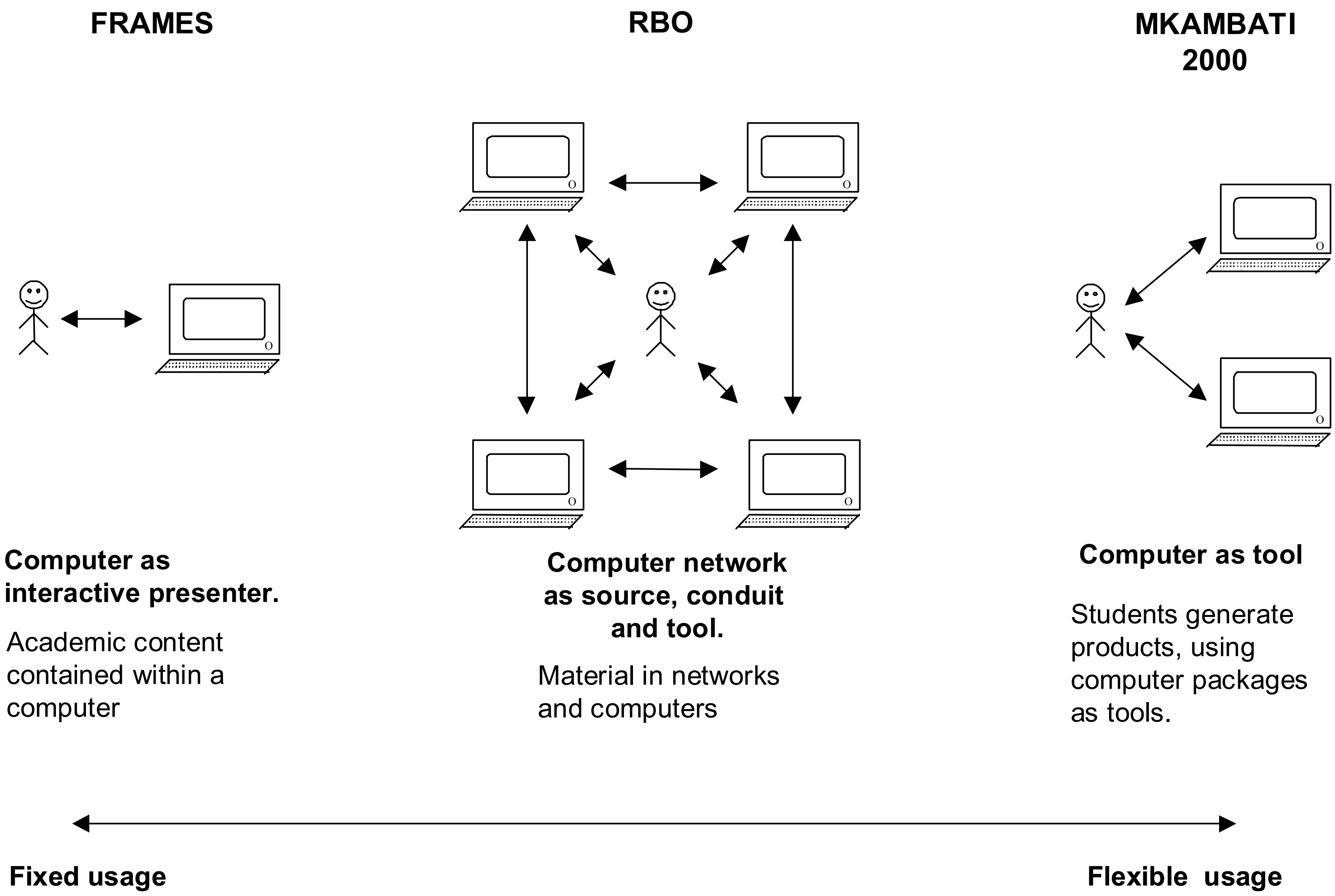
Table 6.2 categorises computer usage in the three learning events, showing the learner-content relationship according to Winn's (1992) *full* and *empty* instructional technologies (Section 3.4.1.1), and Figure 6.2 demonstrates the different ways in which the events make use of computers and software packages. None is inextricably coupled to a single computer system. Table 6.2 and Figure 6.2 are closely inter-related.

**Table 6.2**
**Computer usage in the three learning events, categorised according to *full* and *empty* instructional technologies**

| Case study | Type of computer usage |
|---|---|
| FRAMES | **Computer as presenter:**<br>A *full* technology containing information to be transferred interactively to students |
| RBO | **Computer network (Internet and WWW) as source, conduit, and tool:**<br>The source of directives and basic information is a website<br>For learner-generated products, the Internet functions as an *empty* shell which supports exploration, communication, and construction.<br>RBO's Internet-based learning is transparent - learner-generated material is placed on the Web, available for fellow-learners to view, share, and access the underlying HTML code. |
| Mkambati 2000 | **Computer as tool**<br>Project-based learning, involving limited online exploration and communication;<br>Major use of computers as separate, *empty,* offline tools. |

Figure 6.2 graphically portrays similar information, depicting how the learners interact with computer technology in each event. In FRAMES the computer serves as an *interactive presenter* of a custom-built system; in RBO learners operate in an *immersive* (Harmon and Jones, 1999) Internet environment; while learners participating in the Mkambati project used commercially-available software *as tools* for manipulation and documentation. The three types of usage are situated on an axis indicating a spectrum of use from *fixed* to *flexible*.

**Figure 6.1 Computer usage in the three learning events**



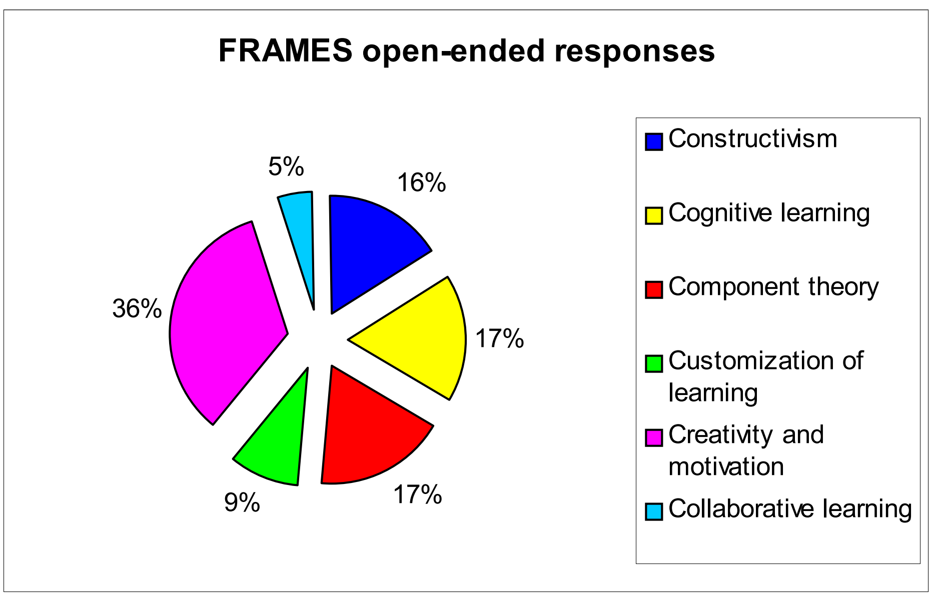
### 6.2.3 Learner-responses related to elements of the metamodel

The questionnaire surveys and interview questions for the three studies made considerable use of qualitative open-ended questions, which elicited spontaneous comments and insightful information. These spontaneous responses (most of which are also incorporated in Chapter Five) are categorised under the element of the HCMm framework to which they relate the most (although strong areas of overlap exist). Percentages are shown in the three pie-charts which comprise Figure 6.2.

***Note:*** These charts categorize **open-ended descriptive responses** only, i.e. spontaneous, non-prompted impressions relating to elements of the HCMm. They do not represent answers to the kind of question that prompt learners with options that refer directly to elements of the framework. For example, the information in Table 5B.5 (see 5B.2.2.3), which indicates the large extent to which learners see constructivism in RBO, is not included in Figure 6.2.2, since this information was extracted from a question where learners selected from specified options. The extent of constructivism in RBO is therefore greater than indicated in the chart of Figure 6.2.2.

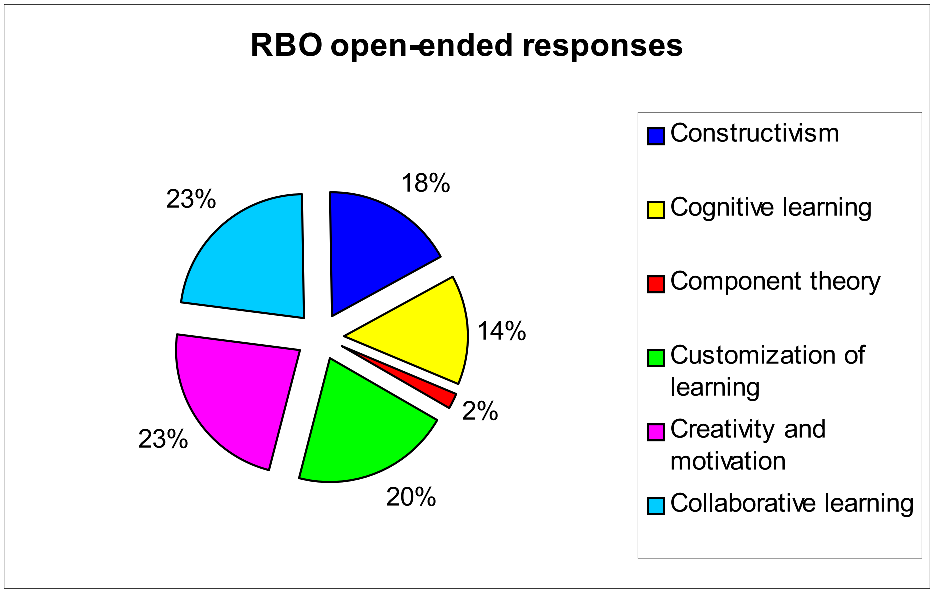
The open-ended responses in the FRAMES evaluation show the creativity of the environment and the way it motivated learners to be the learners' strongest impression (36%) - see Figure 6.2.1.

**Figure 6.2.1 Categorization of FRAMES open-ended responses**



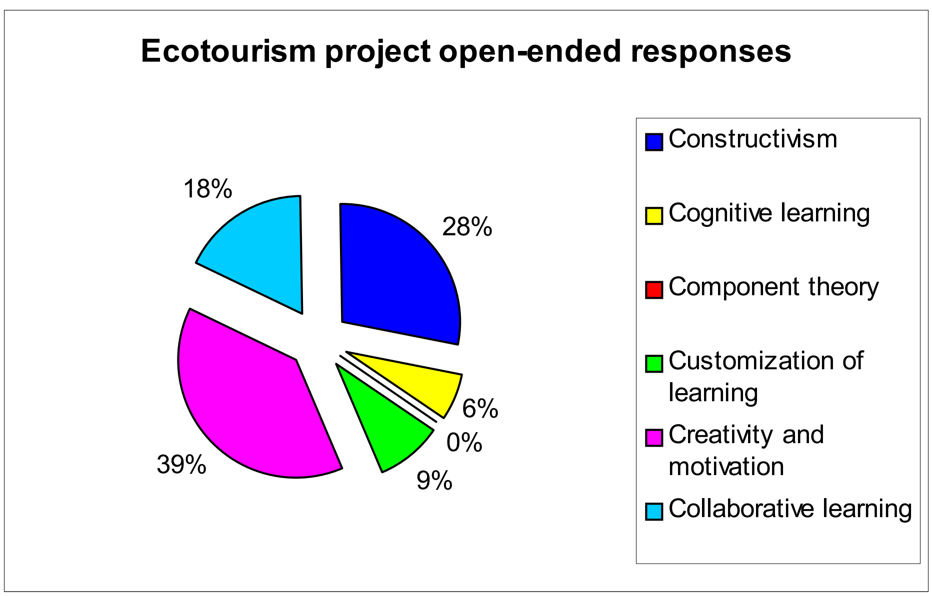
In the RBO evaluation (Figure 6.2.2), collaborative learning (23%) and creativity (23%) were jointly the aspects most frequently mentioned in open-ended responses, followed closely by constructivism (20%), which is actually an under-representation (see *Note* preceding the charts). The 2% recognition of components refers to the hyperlinks to tutorials and other basic resources.

**Figure 6.2.2 Categorization of RBO open-ended responses**




Among the Ecotourism students, 39% of the open responses related to the innovative nature of the project and the motivation and engagement experienced by learners. Constructivism follows, being the subject of 28% of the comments.

**Figure 6.2.3 Categorization of MKAMBATI open-ended responses**



## 6.3 The Hexa-C elements - investigating the investigation tools

Practice informs theory - as information elicited from the evaluations described in Chapter Five is used in a discussion of the Hexa-C Metamodel and its elements. Knowledge about the six elements of the toolset and ways in which they enhance learning and instruction is extended and amplified, incorporating variants noted in the study. The study was enriched by the differences between the learning events, as well as by the qualitative and descriptive research methods, which reveal aspects and insights that would not been recorded in a multiple-choice survey.

Under each of the next six headers is a series of tables with information from the evaluation study. The tables do not incorporate every possible aspect of the six elements, but rather focus on certain notable, less-known or specialized facets, including concepts from recent literature, occurrences of which were found in the evaluations. References are given in certain tables - both to previous discussion of a concept and/or its occurrence in the three learning events, but much of the information revealed by this study goes beyond descriptions in the literature. References to learner-responses in Chapter Five serve merely as an indication, and are not comprehensive, since substantiations of the findings are distributed throughout Sections 5A, 5B, and 5C.

Throughout this section, a distinction is drawn between applying the elements of the HCMm in *well-structured* and *ill-structured* domains (Hannafin, 1999; Jonassen, 1999) - concepts already introduced in this study (see 3.4.1.1:1, 3.4.2.5:1; 3.4.3.5, 3.4.4.2, and 3.4.4.3):

- Well-structured or 'closed' domains contain concepts and problems which are termed tightly-defined / well-formed / procedural, etc. Examples are the exact mathematical and physical sciences, procedural learning, and syntactical disciplines, all of which entail tractable problems.
- Ill-structured or 'open' domains contain problems which may be termed ill-defined / poorly structured. Complex, ill-structured knowledge is found in the social sciences, the humanities, and the design-and-development disciplines, where problems have multiple solutions and some aspects emerge only during the problem-solving stage.

Landa (1998) terms the well-structured domains 'algorithmic', and the poorly structured 'heuristic' - terminology which refers to the type of mental processes used for learning or solving problems within them. The algorithmic cases are solved by well-defined universal principles/processes, whereas heuristic situations can be addressed by a content approach, using reflective practice and heuristic, expert-type knowledge, which may entail using 'rules of thumb'.

### 6.3.1 Constructivism

Analysis of constructivism in the three varying learning events touches on the roles that active participation, real-world context, negotiation of project topic/content, peer support, positive use of errors, etc. play in personal knowledge construction. It was shown how these factors lead to higher motivation and a greater extent of work, despite the occurrence of 'constructivist frustration'. The discussion distinguishes between implementation of constructivism in well- and ill-structured domains. True constructivism was evident in two of the cases investigated in Chapter Five, where the problems were typically open-ended and unstructured. FRAMES, on the other hand, illustrates how constructivist variants can be effectively used in procedural objectivist environments, where there is a single solution to each problem or a tightly-defined defined problem-solving process.

The series of tables (Tables 6.3.1 to 6.3.3) shows factors from the investigations into constructivist manifestations in learning events, and addresses some of the *nuggets* of constructivism, 'nuggets' being particularly notable findings that emerged from the inquiries into constructivist manifestations in the three learning events. Some are manifestations of phenomena described in the literature; others are occurrences revealed by this research. Table 6.3.1 sets out information which amplifies and extends the body of knowledge on constructivism-in-practice.

| Table 6.3.1 Information revealed about constructivism | | |
|---|---|---|
| **Concept** | **Reference (within this study and/or original source)** | **Occurrence (or negation) revealed in evaluations** |
| ***Active participation and high interaction levels*** to engross learners<br><br>***Multiple presentation and varying perspectives*** to consolidate learning, | Section2.4.2.1;<br>5A.2.2.3<br>5B.2.2.3: Tab 5B.5,<br>5C.2.6.3: Tab 5C.11<br><br>5A.2.3.3,<br><br>5B.2.3.3,<br><br>5C.2.6.3 and<br>Table 5C.12 | **All three case studies**: Learning and problem-solving embedded in authentic contexts with support available to help learners comprehend theory actively and inductively, i.e. from practice-to-theory.<br>This was shown to be a commonly-preferred learning style.<br><br>**FRAMES**: Visual representations, opportunities to synthesize examples, use of examples and non-examples to illustrate real-world relationships.<br>**RBO**: Multi-media resources on WWW and Internet; viewpoints of peer-learners.<br>**Mkambati**: Presentations by peers, viewpoints of experts and stakeholders, paper-based and multi-media resources. |
| Negotiated ***personal learning goals*** and objectives | Section 3.4.2.1;<br><br>5B.1.4: Fig 5B.4;<br>5B.2.2.1,<br>5C.2.6.3 | Could be determined in respect of some or all of the following: context, topic, content and extent.<br>**RBO and Mkambati**: Overall goals and context imposed, but content open-ended. |
| ***Flexible assessment*** and ***strategic exploration of errors***<br><br>***Assessment of constructivist collaboration; Complexities of constructivist grading*** | Section 3.4.2.2; Lebow, 1993<br>5C.2.1.3<br><br>Section 5A.2.5.3<br><br>Section 2.4.2.2<br>Cunningham, 1992<br>5B.2.4.2, 5C.2.2.4 | **RBO and Mkambati**: Learners capitalized on personal recovery from errors - identifying, exploring, & modifying invalid lines of approach.<br>**FRAMES**: No exploration of errors - errors were system-diagnosed; remedial feedback was triggered.<br><br>**Mkambati and RBO**: How to assess how much each learner contributed? Assessment that is not criterion-referenced. |
| ***Problem drives the learning*** | Section 3.4.4.2, 5B.2.2.1 | **RBO:** Some learners tackled problems from their work environments. |

| **Table 6.3.1** continued ... **Information revealed about constructivism** | | |
|---|---|---|
| Perceptions (whether correct or erroneous) used as positive stimulants to create ***disequilibrium***, leading to ***reflection and restructuring*** on the part of learners | Section3.4.2.2<br>Lebow, 1993<br>5B.2.1.3, 5B.2.4.3<br>5C.2.1.3 | **RBO and Mkambati**: Constructivism comes into its own where knowledge is complex and ill-structured and the domains are open-ended. This involves challenge, lack of boundaries, experiential learning, and self-responsibility for learning. Learners explored their ideas and provisional products; projected, reflected, and debated; and determined themselves whether or not they were on the right track. |
| ***Evaluation not criterion-referenced***;<br>But aimed at assessing learning gain, making use of multimodality, portfolio, self-evaluation, and peer- evaluation. | Sections 2.4.2.2 and 3.4.2.6;<br>5B.2.2.4; 5C.2.2.2<br><br>5A.2.3.3 | **RBO and Mkambati**: More constructivist then FRAMES, yet ironically had the less constructivist assessment, since both are compulsory units of formal study, requiring grading to measure and rank learners, in line with university policy.<br>**FRAMES**: An optional, supplementary learning aid, its single purpose is learning gain, and it has no scoring facility. |
| ***Incorporated subversion***<br><br>Participatory design, learner-experimentation, and ***adaptation of directives/material*** for own use | Section 2.4.5.3;<br>Squires, 1999;<br>Sections 3.4.2.5:2, 3.4.3.1<br>Willis 2000<br><br>5B.2.2.1, 5B.2.5.4<br><br>5A.2.2.3<br><br>5A.2.4.1, 5A.2.4.3 | **RBO**: Constructivism-in-practice manifested incorporated subversion as learners, revelling in the lack of boundaries, generated innovative artefacts and produced unanticipated variations. Freedom to use learning event in the learner's own style resulted in:<br>* Innovative artefacts and deliverables;<br>* Extent of work beyond normal expectations; and<br>* Totally subverted use in a negative way.<br><br>**FRAMES**: Unanticipated incorporated subversion in the interactive practice environment as learners:<br>* Improvised variations on standard features of the environment, using activity components in unexpected ways;<br>* Co-operatively used activities designed for individual learners |
| ***Freedom from constraints*** | 5B.2.4.3 | True constructivism entails a lack of boundaries, which can impact negatively on other aspects of learning - for example, self-paced work is a constructivist feature that can obstruct collaborative work, particularly distance collaboration. |

| **Table 6.3.1** continued ... **Information revealed about constructivism** | | |
|---|---|---|
| Constructivism engenders ***cognitive conflict***, ***cognitive complexity,*** and initial ***learner-frustration*** when designers and instructors withhold explicit teaching and direct solutions,<br>i.e. ***Constructivist frustration***<br><br>Real-world activities enforce high standards beyond the norm for academic efforts, thus demanding superior efforts | Perkins, 1991<br>Sections 2.4.2.1 and 2.4.3<br><br>5B.2.1.1, 5B.2.2.1, 5B.2.2.3 and Table 5B.6, 5B.2.6.3:<br>Table 5B.13 'new tools'<br><br>5C.2.1.3 and Table 5C.5<br>5C.2.6.1<br>5C.2.6.3: Table 5C.13 | This form of learning is not appropriate for all learners and can lead to attrition. Some learners prefer structured instruction, particularly those who struggle with the associated frustration.<br>For those who persevere, learning is internalised and retained. They learn from solving problems, and frustration is an integral part of problem solving. However, support should be provided during frustration.<br>**RBO:** Clear evidence of constructivist frustration<br><br>**Mkambati 2000**: learners had to produce high-standard documents - beyond that of the usual student product. Some appreciated the experience; others viewed the additional time and effort as hardship. |
| ***Beyond academia: real-world becomes real-life …***<br>The requirement that constructivist tasks have real-world relevance often means simulating a real-world problem.<br>In some cases, real-world projects become real-life products, usable in the workplace.<br><br>***Immediate dual benefits***<br>(related to above, but with a benefit that is external rather than personal to the creator) | Steyn, 2001<br><br>5B.2.2.1 and 5B.2.2.3<br>5B.2.5.3: Table 5B.12 and below<br>5C.2.1.1, 5C.2.1.3, 5C.2.3.3, 5C.2.6.1, 5C.2.6.3: Tables 5C11/12<br><br>5C.2.3.3 and 5C.2.6.3 | Learning events that serve as academic exercises - generating credits for formal studies - but add value by generating artefacts that contribute to real-life solutions, usually to the learner-creators, applying them in their work environments, thus enhancing the quality/scope of that learner's professional performance.<br>**RBO**: Learners were their own 'clients' generating products for use in their own careers.<br><br>**Mkambati 2000**: Sound preparation for real-world consulting.<br><br>The HCMm identified spinoffs where artefacts developed for academic purposes were functional in the market place, in policy-making and as resources in educational environments.<br>**Mkambati 2000**: a provincial authority was the beneficiary. |
| Learners experience ***flow***; forget time; ***tackle more than intended or envisaged***<br><br>Or, conversely, resist additional effort | 5A.2.6.3<br>5B.2.6.3: Table5B.13<br>5C.2.6.3; Table 5C.13 | **All three**: Extent of work was more than initially envisaged.<br>**FRAMES & RBO**: learners voluntarily tackled more than intended due to level of engagement/motivation.<br>**Mkambati**: Circumstances required more than learners had envisaged. |

Table 6.3.1 relates constructivism-in-practice (as evidenced in three case studies) to established constructivist philosophy and tenets, and has gone further in highlighting some **lesser-known constructivist attributes**. In particular, the table draws attention to:

- Strategic exploration by learners and error-recovery;
- The associated concept of disequilibrium as a result of erroneous beliefs;
- Reflection and reconfiguration of knowledge and beliefs; and
- Constructivist frustration - a form of cognitive conflict experienced by learners when explicit instruction is deliberately withheld.

The real-world features of constuctivism are shown to present learners with challenges and obstacles which, if they can be surmounted, will result in personalization and retention of learning, over and above the benefit of relevant, contextual knowledge.

Table 6.3.2 summarises certain findings of this study by listing ways of implementing constructivism. These findings **can serve towards guidelines or recommendations to be used by designers of instructional systems and learning events/environments** - both by professional instructional designers and by educators/practitioners who serve as instructor-designers.

The first part of Table 6.3.2 applies to constructivism in well-structured domains, where technical-rational approaches are used for well-defined, tractable problems with well-formed solutions (3.4.2.5; Schon, 1987). Nevertheless, aspects of constructivism can be effectively applied in such disciplines.

The next part of Table 6.3.2 relates to constructivism in ill-structured domains - the territory of uncertainty and reflection-in-action (3.4.2.5; Schon, 1987), where processes defy pre-definition and precise rules, being approached instead by flexible heuristic guidelines applicable to unique contexts and problems.

The section concludes with Table 6.3.3, which points out limitations on constructivism in well-structured procedural domains, where conditions preclude the full implementation of constructivist models and processes.

| **Table 6.3.2 Ways of implementing constructivism** | | |
|---|---|---|
| ***Well-structured domains*** | **Constructivist approach** | **Implications** |
| ***Instructional features***<br>Closed problems, with a single correct solution for each<br>Little or no scope for personal interpretation<br>Procedural and algorithmic processes for problem-solving | High interactivity<br>Active problem-solving with scaffolding<br>Learner-control<br>Multiple presentation modes (audio, visual, textual, interactive, etc.)<br>Multiple perspectives<br>From problem-solving to theory<br>Non-examples as well as examples<br>Learner-synthesis of examples | Keeps learners engrossed<br>Learners tackle more than they intended<br>Contributes to learner-centricity<br>Supports different learning preferences<br>Inductive learning<br>Conceptual consolidation<br>Conceptual concretization |
| ***Assessment and judgement***<br>Assessment in line with objectives<br>All learners must grasp certain basic knowledge/skills<br>Diagnostic assessment<br>Learning measured as a proportion of what there is to be learned - testing, proficiency assessment, grading, ranking<br>Communication/verbalization | Negotiated goals and personal learning objectives can contribute to self-evaluation / evaluation<br>Absence of a scoring facility<br>Conventional approach can be incorporated<br>Journal-keeping / peer-teaching | Learners less threatened, nor is unwarranted optimism generated |
| ***Ill-structured domains*** | **Constructivist approach** | **Implications** |
| ***Instructional features***<br>Open-ended problems<br>Multiple solutions<br>Lack of boundaries<br>Problem-driven learning<br>Personal interpretation<br>Non-procedural problem-solving and decision-making<br>Social negotiation | Participative learning and high interaction levels<br>Project- and problem-based learning<br>Contextualized problems<br>Multiple perspectives<br>Personal learning goals<br>Exploration of resources, discovery-learning, and experiential learning<br>Collaborative learning<br>Authentic / real-world problems<br>Challenge<br>Scaffolding | Inductive learning<br>Deductive learning<br>Supports learning preferences<br>Value-driven research<br>Personalization of problem and goals<br>Preparation for the real world<br>Solutions used in profession<br>Learner frustration; cognitive conflict; some learners may not realize short-term benefits.<br>Support in complexity |
| ***Assessment and judgement***<br>Learners do not all learn the same thing<br>Subjective assessment of learning<br>Assessment of gain and progress<br>Assessment of collaborative efforts<br>Positive use of errors<br>Aim of learner-equilibrium | Multimodality / portfolio assessment<br>Self-evaluation / peer- evaluation<br>Evaluation against a learner's negotiated goals and personal learning objectives<br>Grading of individual contributions; peer-assessment<br>Strategic exploration<br>Reconfiguration | Emphasis on learning gain and on the process rather than the product<br>Perceived by learners as 'fair'<br>Learning from misconceptions<br>Reflection and recovery |

Table 6.3.2 compares and contrasts ways in which constructivist learning can be implemented in the two kinds of domains. True personal construction of knowledge cannot occur in well-defined problems within well-structured domains, although variants of constructivist models and processes can be used. Table 6.3.3 addresses the limitations by mentioning some features of instruction in well-structured domains that preclude full implementation of constructivist models and processes. Yet moderate constructivist practices can be used as alternatives and supplements - see Table 6.3.2.

**Table 6.3.3**
**Features of instruction in well-structured procedural domains**

| **Approaches used that are out of line with constructivism** (yet compatible with cognitivism - see Section 6.3.2) | **Constructivist approaches that are inappropriate or complex to implement** | **Implications** |
|---|---|---|
| Conditioning/guidance of learners to perform procedures according to a fixed pattern, in line with single/limited approaches,<br>i.e. prompting learners in formation of specific schemata | Recognition of many possible solution paths and alternative correct approaches.<br><br>Personal construction of knowledge/skill. | Human tutor can recognise correct alternatives, but not a CAI system. To automate this, artificial intelligence (AI) would be required to acknowledge all the alternatives. AI requires complex programming and knowledge-base techniques, which are not cost-effective. |
| Behaviourism in the form of remedial and diagnostic feedback to cut short erroneous paths. | Strategic exploration of errors<br>Personal knowledge construction / interpretation. | Learners with low self confidence prefer system-diagnosis of errors to self-diagnosis. |
| Learners graded and ranked in line with institutional requirements.<br>Scoring facility | Measurement of learning gain | Constructivist learning is simpler to attain than pure constructivist assessment. |

***Concluding remarks***

Tools mediate the nature of human activity (3.4.3.5); and conversely an activity can be understood by comprehending the tool. Similarly, learning events shaped by constructivist design can be understood by grasping the underlying ethos; and conversely, the dynamics of the constructivism can be better understood in the context of use, i.e. the operation and evolution of constructivism and its role in instructional systems design can be better understood by investigating it in learning practice, as has been done in this thesis in three very different learning events.

This study has shown that constructivism can be implemented in rich and varied ways. It can be compatible with objectivism, and may be used to enrich direct instruction, as well as being independently used in problem-driven learning. An important contribution is the demonstration that pragmatic forms can co-exist alongside alternate paradigms in real-life settings.

## 6.3.2 Cognitive learning

Cognitivism, the bridge between objectivism and constructivism, is the key element of the HCMm framework. It relates in some way to almost every other element of the HCMm, since it was a delimitation of the study (Chapter One, Sections 1.2 and 1.6.2) that the learning theories surveyed should belong the cognitive family. As shown in Tables 6.4.1 and 6.4.2, cognitive learning can be supported in different ways, depending on the content being learned and the circumstances of the learning experience. The tables address some of the *nuggets* of cognitive learning which emerged from the case studies in Chapter Five, where the approaches and occurrences within the three learning events serve **as guidelines regarding how cognitive learning can, should and should not be implemented**. Table 6.4.1 shows amplified information about cognitive learning, as revealed in the case studies, while Table 6.4.2 contrasts the way in which concepts can be applied in well-structured and ill-structured domains. Once again the references in the tables to Sections 5A, 5B, and 5C, used to substantiate the findings, merely serve as indications and are not comprehensive, since such substantiations are distributed throughout the text of Chapter Five.

In implementing cognitive learning, designers and educators particularly stress aspects such as relating the new learning to prior knowledge and skills. This study describes a variety of relationships between prior learning and new, depending on the domain and the kind of knowledge/skills to be learned. The problem-solving approach also plays an important role, as does the cognitive-affection connection, which impacts in different ways at different stages - affecting learners' initial attitude to a learning event and their subsequent attitudes when diligence and perseverance are required.

**Table 6.4.1 Information revealed about cognitive learning**

| Concept | Reference (within study / original source) | Occurrence (or negation) revealed in evaluations |
|---|---|---|
| ***Prior learning and background knowledge***<br>Cognition is strongly related to the integration of new knowledge with prior learning. Traditional instructional structures build up knowledge incrementally, alternating teaching and question/practice segments.<br><br>In case-based, problem-based & project-based learning, involving skills in ill-defined domains, explicit teaching is seldom incorporated. Prior learning is assumed to be in place, but links/references can be provided to external resources, either online or hard copies. Moreover, references to theory (explicit or subtle) can be built into the problem. | Section 2.3.2.1<br>Inhelder & Piaget, 1958<br><br>Section 3.4.4.4<br>5A.2.2.3<br><br>5B.1.4: Fig. 5B.1<br>5B.2.3.3<br>5C.2.4.2 | The design of interactive learning and practice environments and that of open-ended learning experiences differ from the design of tutorial instruction.<br>**All three case studies**: No mandatory teaching was incorporated, even for structured knowledge and well-formed problems. Background information was available in various ways.<br><br>**FRAMES**: Information was integrated: visual representations, generation of own examples; use of examples/non-examples to illustrate real-world relationships; definitions built into proof structures.<br>**RBO**: Hyperlinks to multi-media resources on WWW and Internet; viewpoints of peer-learners<br>**Mkambati 2000**: Presentations from peers, viewpoints of experts and stakeholders |
| The kind of ***prior learning that is relevant depends on the purpose of the learning event***, i.e. different kinds of prior knowledge integrate with the required new skills in different ways. New knowledge can relate to prior knowledge by being:<br>▪ In the *same domain* - advanced concepts, building on basic knowledge in same content area;<br>▪ *Different subject matter* - new content/skill must be grasped and related to prior learning in a former content area;<br>▪ *Similar subject matter* - moving from abstract theory to actual practice. | 5B.2.1.3 & Table 5B.2<br>5B.2.2.1<br><br>5C.2.4.1, 5C.2.5.3, 5C.2.5.4<br><br>Text Box 5A | In answering similar questions re prior learning, responses in RBO and Mkambati 2000 followed different patterns. RBO respondents mentioned technical aspects and character aspects; Mkambati responses related to subject-matter expertise. Why the variation? Because there are different ways of integrating new knowledge with prior learning, and learners related to the question by recounting their paramount impressions:<br>**RBO** stretched learners, requiring use of new skills - taking them out of comfort-zones into unfamiliar territory, technically and socially (distance-collaboration).<br>**Mkambati 2000** applied prior theoretical knowledge as basis for practice. Territory, context, and scope were unfamiliar, but academically and socially, learners were comfortable/confident.<br>**FRAMES**: addressed complex composite concepts - following on simpler basic aspects of the same content area. |

| **Table 6.4.1** continued ... **Information revealed about cognitive learning** | | |
|---|---|---|
| For some complexities, learners' ***backgrounds may be inadequate*** | 5C.2.3.3<br>5C.2.5.3: end | **Mkambati 2000**: The community issue - learners in uncharted territory need extra support in making in-depth investigations. In this case, they applied lateral thinking to generate heir own new solutions, but did not feel confident about their proposals. |
| ***Problem-solving structures and support strategies 1***<br>In *well-structured domains*, step-wise presentation of problems avoids the cognitive overload that may be associated with worked examples in textbooks.<br><br>Diagnostic feedback provides remediation. | Section 2.3.2.1; West, Farmer & Wolff, 1991<br>5A.2.1.3, 5A.2.2.3<br><br>5A.2.5.1: Tables 5A8 and 5A9 | **FRAMES**: In all modes, including read-only, problem solutions were given step-by-step.<br>Response-judging and diagnostic feedback are not constructivist ideals, but they enhanced cognition in FRAMES by attempting to explain errors. Several versions are stored to counter common errors, and learners are allowed more than one incorrect attempt before diagnostic feedback is given. This allowed a measure of exploration. |
| ***Problem-solving structures and support strategies 2***<br>Learners typically tackle a problem, concentrating on what is *required* - aiming for conclusions prematurely, paying inadequate attention to using / deriving conclusions from *given information / available resources* | 5A.2.2.3: schemata<br><br>5B.2.3.2 | **FRAMES**: Cognitive learning is supported by templates that prompt learners to consider the theory at an early stage, thus facilitating the application of prior knowledge to the new situation. Visual links inter-relate associated concepts, prompting learners to integration.<br>**RBO**: References provided by instructor and links to external tutorials were under-utilised. |
| ***Objectivist-constructist divide***<br>Cognitivism straddles the divide between constructivism and objectivism, and incorporates aspects of both. | Section 2.8: Figure 2.3<br>5B.2.1.1<br>5B.2.2.1: Figure 5B.5 | **RBO**: Instructional methods and content are constructivist, but the course is presented in an organizational system with admission prerequisites and specified outcomes. |

| **Table 6.4.1** continued ... **Information revealed about cognitive learning** | | |
|---|---|---|
| ***Cognitive-affective connection 1***<br>Motivation<br>Maintenance of attention<br><br>Twin statements by researcher:<br>- Learners' values and emotions influence their ***initial ability to acquire knowledge,***<br>- Learners' motivation influence their ***ongoing attitude and attention.*** | Section 2.3.4.1;<br>Tennyson and Nielson, 1998;<br><br>5A.2.6.3<br>5B.2.1.3: after Tab 5B.4<br><br>5C.2.1.3<br><br>5C.2.1.3: Table 5C.5 | The case studies demonstrated the researcher's twin statements.<br>1. When learners become rapidly engrossed, they learn better. Where the initial skills-gap is wide, particularly between academic concepts and real-world demands, anxiety is an issue. Adult learners feel threatened and find it stressful to bridge learning gaps. Attrition can be high.<br>**FRAMES**: Learners were engrossed.<br>**RBO**: Attrition prior to the evaluation and one learner afterwards; problem exacerbated by distance collaboration.<br>**Mkambati**: Absorbed in the problem and the natural environment, Learners were stimulated to tackle the issues.<br>2. The second aspect was illustrated by the difference between the diligence levels of motivated and less motivated learners. Elements of the ARCS model should be applied where appropriate - in ill-structured domains, primarily the A and R of ARCS.<br>**Mkambati**: Some lost enthusiasm during write-up. |
| ***Cognitive-affective connection 2***<br>Stress and insecurity | Section 2.3.4.1, Tennyson and Nielson, 1998<br>5B.2.1.3: Table 5B.4<br><br>5C.2.5.3 | **RBO**: Insufficient feedback - learners wanted assurance they were on the right track; overload; skills-gap.<br><br>**Mkambati 2000**: Learner-stress was caused by uncertainty regarding what was required - breadth, depth, detail, etc. |
| ***Self-regulation and metacognition*** | Sections 2.3.2.1, 2.3.4.3<br>5B.2.1.6: self-regulation<br>5C.2.2.3: Table 5C.6<br><br>5C.2.1.3 | **RBO** Some learners did not practice effective self-regulation; they missed deadlines. Some requested self-paced courses. Self-pacing is complex to implement within constraints of formal education. Poor self-regulation complicated collaborative work.<br>**Mkambati 2000** Metacognitive adjustment in response to errors |
| ***Differentiation, integration, and construction*** as the three primary cognitive abilities to support effective learning processes: | Section 2.3.4.1, Tennyson and Nielson, 1998<br>5A.2.2.3,<br>5C.3.2 | **FRAMES**: theory and practical skills were integrated.<br>**Mkambati 2000**: theoretical concepts integrated with practice; Learners manipulated data and constructed new material. |

Table 6.4.2 compares and contrasts ways in which cognitive learning should be implemented in the two kinds of domains.

| **Table 6.4.2 Ways of implementing cognitive learning** | | |
|---|---|---|
| ***Well-structured domains*** | **Cognitive approach** | **Implications** |
| ***Instructional aspects***<br>Basic components are foundational knowledge for advanced content.<br>Prior learning and new knowledge to be integrated<br>Procedural / algorithmic knowledge | - Basic foundational knowledge should pre-exist, and be available, along with illustrations, on a just-in-time basis, rather than extensive direct teaching prior to any application | Fast access, as required<br>Scaffolds problem-solving<br>Integrates theory-current problem<br><br>Alternative perspectives |
| | - Visual aids and representations<br>- Structures/methods to relate theory and practice<br>- Step-by-step procedures<br>- Cognitive-affective connection, use ARCS model | Interactive supportive in problem-solving<br><br>Avoids cognitive overload<br><br>Supports metacognition |
| Self regulation of learning | - Structures to support higher-order thinking skills | |
| ***Entry, assessment and judgement***<br>Entry requirements<br>Objective assessment<br>All learners should grasp certain basic knowledge/skills | - Response-judging<br>- Diagnostic feedback<br>- Predefined objectives | Pinpoints errors and explains common errors to halt erroneous paths |
| ***Ill-structured domains*** | **Cognitive approach** | **Implications** |
| ***Instructional aspects***<br>Foundational knowledge serves as background<br>Learner-anxiety in unfamiliar territory; learning gaps and attrition | - Foundational knowledge on a need-to-know basis<br>- Cognitive-affective connection, use A and R of ARCS model<br>- Scaffolding | Prior learning assumed to be in place; but supported if required<br>Real-world training<br><br>Learner-control |
| Self regulation of learning | - Self-paced (where feasible and appropriate), else planning & self-monitoring to meet deadlines | |
| Heuristic knowledge | - Independent use of HOTS<br><br>- Build new skills on prior learning<br>- Supportive feedback | <br><br>Bridge the theory-to-practice gap |
| ***Entry, assessment and judgement***<br>Frequently entry requirements<br>Subjective assessment<br>Not all learners learn the same thing | | |

***Concluding remarks***

This analysis of cognitive learning sets out characteristics of the various types of domains and different ways of implementing cognitive learning within them.

In particular, cognitive-affective aspects should be addressed, so as to generate positive attitudes to learning. The theory-practice gap should be bridged, producing learners who are equipped for the real world. In line with its aim (Sections 1.3, 1.4.2), the goal of this study is to explore cognitively-based learning and instructional design theory, so as to support designers and educators and educators in facilitating effective learning, retention and transfer. Implementation of the cognitive approaches outlined in this section would contribute to this.

### 6.3.3 Creativity and motivation

The next element of the HCMm considered is the factor of creativity and motivation. The inquiry into creative instructional design and motivational aspects of learning uncovered a variety of issues in the three learning events investigated. The findings are shown in Tables 6.5.1 and 6.5.2. The former table suggests ways in which creativity, innovation and learner-motivation can be implemented, and addresses some of their 'nuggets' in supporting effective learning. Table 6.5.2 once again draws a contrast between well-defined, procedural domains and their less structured counterparts, suggesting how creativity can be encouraged and motivation supported in each.

References to Chapter Five serve merely as an indication, and are not comprehensive, since substantiations of the findings are distributed throughout Sections 5A, 5B, and 5C.

Two of the learning events show the value of a metaphor as an analogy to which learners can relate. Novelty also has worth in engaging its audience and holding attention, but any form of innovation must occur over and above underlying motivational factors that should instil in the target group a positive attitude and determination to succeed. Furthermore, novelty and innovation should not detract from content-learning.

A synergistic by-product is achieved when academic tasks contribute to personal self-development and career-worth, as took place in the two postgraduate learning events. A noteworthy observation in this study is the creativity engendered by creativity. Lack of boundaries stimulated learners and inspired them to generate innovative products and to reach high personal standards.

| Table 6.5.1 Information revealed about creativity and motivation | | |
|---|---|---|
| **Concept** | **Reference (within study and/or original source)** | **Occurrence (or negation) revealed in evaluations** |
| ***Metaphors and analogies*** | Section 3.3.2.3:2<br>West Farmer & Wolff 1991<br>(Branscomb, 1996)<br>Text Box 5A<br>5A.2.1.3, 5A.2.5.3, 5A.2.6.1<br><br>Text Box 5B, 5B.2.6.1 | **FRAMES**: The *virtual table top* and *andragogic activity box* of FRAMES are innovative metaphors. Learners' comments suggest a virtual coach - 'the person behind the computer' who 'has shown you how to do it' and 'It proves where you are wrong, and says "No guys, this is the way to do it" '.<br>**RBO**: RBO learners identified themselves with the analogy and virtual surroundings of their *classroom-on-the-web*. Some played the roles of virtual pupils, referring to 'teacher' and 'bunking'. |
| ***Innovation and novelty***<br>Academic environments need not be sober and sombre. | Section 2.5.3.1<br>5B.2.6.3,<br>5B.1.4: Figure 5B.3<br>5B.4 | Humour as a communicative medium is a contemporary societal approach.<br>**RBO** is characterized by creative tasks and by humour. Its relaxed approach initially disguises its serious nature, and its depth and breadth. Designers should, however, be aware that not all learners identify with humour - the RBO 'frivolity' displeased one learner who claimed that it distracted from the real purpose of studies. |
| ***Creativity engenders creativity*** | Section 2.5.3.1<br>5B.2.2.3, 5C.2.1.3 | **RBO and Mkambati:** Creative and innovative instructional approach fostered creative solutions and experimentation by learners. |
| ***Allow learners to make errors*** | Section 3.4.2.2: 5<br>5B.2.2.1<br>5C.2.1.3 | Educators are often hesitant to allow learners licence to make mistakes. Allowing learners to make errors is thus a creative strategy. A significant feature of all three case studies was that learners found it a positive experience to deviate and self-correct. |
| ***Content as a motivator***<br>instead of artificial means<br>(Some learners appear to believe that learning and enjoyment are inherently mutually exclusive!) | Section 3.7, Duchastel, 1998<br>5A.2.6.3<br>5B.2.2.3, 5C.2.1.3 | **FRAMES:** Learners enjoyed what they were doing: 'Loved it' / 'I even forgot I was learning'<br>**RBO and Mkambati:** Content & requirements were stimulating and challenging: 'I LOVE the educator-as-learner experience' (RBO), 'Captivated by scenery' (Mkambati).<br>The achievement in completing demanding tasks was therapeutic and intrinsically rewarding. |

| **Table 6.5.1** continued ... **Information revealed about creativity and motivation** | | |
|---|---|---|
| ***Motivation***<br>Affective & motivational aspects affect learning in different ways: | | |
| First, *creative features,* which can be considered as *external affective aspects,* and relate strongly to the outset of the learning event | Section 2.5.3.2 | First, the external affective aspects:<br>**FRAMES and RBO**: Novelty in content and presentation motivated and engaged learners.<br>**Mbambati project**: The natural environment was a strong motivating force. |
| Second, the *cognitive-affective connection*, or the *internal affective aspect,* which occurs as learning proceeds. It is enhanced if the event optimises on personal skills/strengths, thus *empowering* the learner. | Section 2.3.4.1<br><br>5B.2.6.3: Table 5B.13<br>5C.2.1.3: Table 5C.3<br>5C.2.2.3, 5C.2.3.4<br><br>5A.2.6.3 | Cognitive-affective connection - the internal affective aspect. This relates to issues which encourage/ hinder the acquisition of knowledge and skills, and which come into play during the course of a leaning event.<br>**RBO and Mkambati**: Innovative aspects motivated learners to apply themselves.<br><br>If learners reach a state of *flow,* an ideal has been achieved.<br>**FRAMES:** 'I could do it all day' / 'I never think about time'<br><br>Learners approach studies with mixed emotions - anxiety and stress are common. Adult learners tackling continuing education and life-long learning may feel threatened and inadequate, technology being a particular threat. Others approach learning with confidence, enthusiasm and assertiveness. Designers of instruction must address these conflicting needs. Options should be provided and varying degrees of support, so as not to bore the competent or arrogant individual, nor to intimidate learners who lack self confidence. |
| It is an added benefit if resources developed by adult learners are e used for *personal business and professional development* or to simplify work-related activities. | 5B.2.5.3: Table 5B.12 and comments<br>5C.2.3.3 | **RBO and Mkambati:** The synergy presented by personal professional development has both extrinsic and intrinsic benefits |

| **Table 6.5.1** continued ... **Information revealed about creativity and motivation** | | |
|---|---|---|
| ***Value systems***<br>Learning is work, and learners' value systems and attitudes are vital | Section 3.5.3;<br>Wager, 1998<br><br>5C.2.1.3: Table 5C.2<br>5C.2.3.3<br>5B.2.2.3: Table 5B.6 and comments<br>5B.2.5.3: Table 5B.12 and comments | Where a learning event is intellectually and affectively challenging, a creative and innovative approach can motivate learners to produce beyond their own expectations. Working under novel and stimulating circumstances, learners in all three cases were surprised by their creativity and progress in demanding situations. In the open-ended situations, they appreciated freedom to use their expertise in paths of their own choice.<br><br>**Mkambtai and RBO:** Value-driven learners are intrinsically and extrinsically motivated by the chance to 'do something real'. Where feasible, particularly with adult learners, persons with a vision and a mission should be able to use their studies to pursue ideals. Nevertheless, not all learning experiences are appropriate vehicles to do something real.<br>Yet all should, by some means, promote hard work and effort. |
| ***Innovation engages learners, but must be used with care*** | Section 2.5.3.2 | These characteristics hold learner's attention but must not obstruct the instructional message. |
| ***Some learners require more than intrinsic motivation.***<br>For competitive and results-driven individuals, motivated by achievement, the reward of placing high in a class is intrinsic as well as extrinsic motivation. An egalitarian system that avoids grades or that does not publish results may demotivate such achievement-oriented learners who require explicit recognition | Section 2.5.3.2<br><br>5B.2.2.3, 5B.2.5.3<br>5C.2.1.3: Table 5C.2 | <br><br>**RBO:** Learners' artefacts were acknowledged and used in the workplace.<br>**Mkambati:** For a certain learner, the goals were high marks and recognition. |

Table 6.5.2 compares creativity and motivation in well-defined, procedural domains and their less structured counterparts, showing certain similarities as well as differences in approach. The approaches listed can serve towards guidelines for designers and educators.

**Table 6.5.2 Ways of implementing creativity**

| ***Well-structured domains*** | **Implications** |
|---|---|
| ***Metaphor*** | Using the familiar as a bridge to the unfamiliar |
| ***ARCS model*** to: gain attention, ensure relevance, instil confidence, and lead to learner-satisfaction | Learning can be an enjoyable experience!<br>Learners fully engaged in a task surprise themselves by the extent of work they accomplish. |
| ***Innovation*** | |
| All resources provided in single environment | Cognitive support |
| Incorporate elements of informality, fun and relaxation. | Reduces learner-stress and anxiety |
| Even in a closed domain, learners can be required to generate an open-ended artefact. | Scope for learner-creativity |
| Presentation of material on alternate media for perusal by learners | Asynchronous, own-place instruction/learning |
| ***Motivation*** | |
| Practical utilitarian value | Difficult work facilitated |
| Varied degrees of available support: offering challenge to the achiever and undergirding the less confident | Individual affective need are met<br>Learners gain confidence as performance improves |
| Intrinsic motivation by supporting achievement | Extrinsic motivation is intrinsic motivation to the high-achiever |
| Affective-cognitive connection | Encourages persistence |
| ***Less structured domains*** | **Implications** |
| ***Metaphor***<br>Use context of adult learner's own profession | Unfamiliar presented in a context of familiarity<br>Real-world solutions used by learners in own real-life environment |
| ***Innovation*** | |
| Scope for humour, fun and frivolity in traditionally sober academic environments/resources. | Stress reduction - learning can be enjoyable and even be perceived as fun. |
| Project-based tasks for learners | Learners may display astonishing creativity themselves. |
| Expose mature learners to professional consultant-type situations | Market-oriented training |
| Presentation of material on alternate media | Asynchronous, own-place instruction/learning |
| Permit erroneous ventures | Self-exploration and recovery |
| ***Motivation*** | |
| By real-world problem solving | Real-world worth for value-driven learners |
| Varied degrees of support | Individual affective need are met |
| Vision-driven activities | Intrinsic motivation |

A further form of innovation occurs when the fundamental approach or medium is transformed, such as the current tendency towards distributed learning environments. Certain organizations are dedicated distance-educators, but in other cases a new genre of creativity is applied - namely 'distance-learning' models by choice - with WWW resources or material on intranets in laboratories being used to supplement class-teaching, but sometimes to replace it - as in RBO (Case Study 5B).

***Concluding remarks***

Creative instructional systems / learning events are those which motivate learners, and help them to enjoy learning. Creativity goes beyond the 'gold star' syndrome and achieves its ultimate **when content and/or context are the motivators**. Although creative individuals can demonstrate their creative faculties under any conditions, a creative environment nurtures further creativity. Finally, the affective-cognitive connection encourages positive attitudes and contributes to effective learning.

## 6.3.4 Collaborative learning

Table 6.6.1 sets out information about collaborative and co-operative learning efforts revealed by the three case studies. It incorporates positive aspects as well as complexities. Tables 6.6.2 and 6.6.3 respectively show some of the ways in which collaborative and co-operative learning can be implemented, and describe problems that can occur. There are references to previous discussion of a concept or its occurrence in a learning event, but these are merely indicators and not comprehensive, since substantiations of the findings are distributed throughout Sections 5A, 5B, and 5C.

The co-operative efforts of pairs at a computer in the FRAMES procedural domain enhanced learning and also made it a more enjoyable, social experience. The constructivist projects, RBO and Mkambati 2000, capitalized on teamwork to optimize strengths and support deficiencies.

The inquiry disclosed that collaborative work has its complexities. Interpersonal issues, delays, unequal contributions, grading are all some of the problems encountered. However, despite the obstacles, collaboration has intrinsic benefits - it entails life skills as well as subject-matter expertise, and is sound preparation for the real world and employment. Learners may complain that collaborative work is unfairly distributed, yet the hard truth is that collaboration is preparation for real-life and the working-day world, and these are not fair!

The inherent complexity of collaboration is exacerbated by further factors. The time period and the number of participants play a role. Another dimension that serves as an obstacle is distance. Distance collaboration, formerly almost infeasible, is currently offering new opportunities, yet brings its own unique set of problems.

| Table 6.6.1 Information revealed about collaborative and co-operative work | | |
|---|---|---|
| **Concept** | **Reference (within study and/or original)** | **Occurrence (or negation) revealed in evaluations** |
| ***Where collaborative learning is suitable:***<br>Collaborative problem solving is not usually suitable for algorithmic tasks where highly developed procedures pre-exist (Nelson, 1999).<br><br>It serves well for heuristic tasks involving complex knowledge/skills. Where projects are open-ended, true collaborative learning, i.e. teamwork, can occur. | Sections 2.5.1 and 3.5.1 Nelson, 1999<br><br>5A.2.4.1: Table 5A.7<br>5A.2.4.3<br><br>5B.2.4.1:1<br><br>5C.2.2.3 | This investigation suggests, to the contrary, that joint work can be done in certain structured domains. Co-operative problem solving, i.e. two at a computer - sharing expertise as they work through a fixed procedure - can be effective.<br><br>**FRAMES**: Co-operative learning: Where learners lack self-confidence in defined procedures, discussion and joint decision-making with peers was efficient and effective. A learner mentioned role-reversal - after overcoming initial fear-block, he found himself the more competent performer.<br><br>**RBO and Mkambati 2000**: The learning in these cases is a constructivist variant of collaborative learning. Contact-collaboration is preferable, yet distance-collaboration can be implemented, facilitated by the Internet. It is complex, yet it is collaboration which, formerly, would have been yet more unwieldy or even infeasible. The RBO *Opera* and the *Planning Guidelines* submitted to Mkambati authorities capitalized on synergistic integration of skills, multi-disciplinary expertise and practical competencies, e.g. technological know-how, writing skills, leadership ability, subject expertise, as well as social negotiation and interpersonal relationships. |
| ***Distribution of workload is an issue.***<br>Collaborative work is controversial. Some students take lead roles; others are frustrated by the requirements of fellow-learners.<br><br>***Rules and roles should be clearly defined***, as proposed in Activity Theory. | 5B.2.4.3 and Table 5B.7<br>5C.2.2.3 and Table 5C.6<br><br>Section 3.4.3.5<br>Jonassen & Rohrer-Murphy, 1999 | **RBO and Mkambati:** The more committed or motivated students take lead roles, doing more than a fair share to ensure quality. Others, possibly those of whom it was said 'not all students participated equally', may be weaker students or else pragmatic, being prepared only to devote a certain amount of time and effort. Dynamics of work distribution are complex, particularly in distance collaboration, and exacerbated when participants do not know one another.<br><br>There were no rules regarding accountability to the group. |

| **Table 6.6.1** continued ... **Information revealed about collaborative and co-operative work** | | |
|---|---|---|
| ***Distance-collaboration is more complex*** than face-to-face collaborative learning. | 5B.2.4.1:1<br>5B.2.4.3<br>5B.2.4.4 | Without tight control, distance-collaboration can be inefficient.<br>**RBO**: There were real and varied obstacles to groupwork, but the problems were overcome.<br>Why distance-collaboration at all? Distance learning is traditionally an isolated experience. But technology-enabled distance-tuition has enhanced and expanded the experience - the Internet and WWW can provide rapid transmission of distance-learning material, available to a vast target. So distance learning has improved, why supplement it with distance-collaboration?<br>First, it's an experience of real-world teamwork and personal interaction - virtual collaboration is better than no collaboration. Second, group work presents an opportunity to capitalize on strengths and minimize inadequacies. When team members have complementary knowledge and abilities the joint products are better than any individual could produce alone. |
| Where grading occurs, ***team marks are a source of contention.***<br>Learners claim:<br>- Team grading is unfair<br>- Participants do not all put in equal effort<br><br>Designers of collaborative events should consider peer-evaluation and/or self-evaluation. | 5C.2.4.3<br>5C.2.2.4 | **Mkambati:** The evaluation indicated dissatisfaction with aspects of grading:<br><br>Individual grading, based on each learner's personal efforts - with peer-evaluation and self-evaluation contributing towards the final mark, would help to solve the first problem in the left-hand column. Implicitly, the second would be less of an issue, since the more committed or achievement-oriented learners would be less driven to make diligent efforts on the group project to ensure their own mark. It could, therefore, reduce the quality of final products and be detrimental to the overall team effort! A compromise - recognising both joint and individual efforts in awarding a grade - appears to be best. |
| ***Co-operative work may expedite a process***.<br><br>***Collaborative efforts are less efficient*** (though synergistic due to skills-mix). | 5A.2.4.3<br><br>5B.2.4.3<br>5C.2.2.3 | **FRAMES**: When two minds were applied to co-operative problem solving, efficiency increased. The activities mainly involved closed problems with fixed solutions, and joint perspectives enriched the process.<br><br>**RBO and Mkambati:** Certain team members delayed proceedings |

| Table 6.6.1 continued ... Information revealed about collaborative and co-operative work | | |
|---|---|---|
| *Collaborative efforts function in different ways* ***according to the time scale of the venture***<br><br>*The issue is* ***exacerbated in distance-collaboration*** | 5B.2.4.3<br><br><br>5B.2.4.3<br>5C.2.2.3 | Short-term co-operation and collaboration are simpler than efforts over extensive periods.<br>**FRAMES:** Short duration co-operative computer sessions worked well.<br>**RBO and Mkambati:** Extensive and complex longer-term projects were demanding, as<br>- Inter-personal variables and group dynamics came into play,<br>- Attention-holding and diligence levels vary between individuals, which impacts on progress and flow of the project - some have initial enthusiasm but bore quickly or are easily distracted,<br>- Time management for the group is a function of individual time management. 'Crisis managers' retard group progress.<br>- The inherent complexity and ardour of long-term projects cause frustration. |
| ***Group size can retard / expedite progress*** | 5C.2.2.3 | **RBO**: Group size of eight was not optimal for distance-teamwork. Strategy, roles, and accountability should be pre-determined, and would be simpler with a smaller team. |
| ***Attitudes to collaborative learning*** depend on the individual | 5B.2.4.3: Table 5B.7<br>5C.2.2.3: Table 5C.6<br>5C.2.2.3 | **RBO and Mkambati**: There were both positive and negative impressions of interaction and collaborative learning.<br>**Mkambati:** An achievement-oriented learner felt that joint accountability 'got in the way of ownership'. |
| ***Collaboration is excellent preparation for real-world applications in the workplace*** | | Tables 6.3.1 and 6.5.1 addressed the value of 'real-world' experience in terms of the content of the learning.<br>Similarly, the exposure to the rich synergism of collaborative work - as well as its complexities and drawbacks - is excellent preparation for the teamwork milieu of the working world. |

Table 6.6.2 shows how co-operative and collaborative learning are used in the two kinds of domains - well-structured and ill-structured. In the latter a distinction is also drawn between contact- and distance-collaboration. More than the other elements of the HCMm, collaborative learning is characterised by complexities, and Table 6.6.3 briefly lists some of these problems.

**Table 6.6.2 Ways of implementing collaborative learning**
(mainly in the context of computer-based or web-based learning)

| Type of domain | Implications |
|---|---|
| ***Well-structured, procedural domains, contact- or distance-learning***<br>Co-operative problem-solving, two-at-a-computer or work station<br>(In the distance learning context, learners in same locality often form study groups) | Sharing of knowledge and skills increases competence and confidence.<br>Discovery-learning occurs. |
| ***Open-ended domains, contact-learning***<br>Teamwork, collaborative problem-solving, joint projects<br>Role allocation & role shifts<br>Capitalization on strengths and support in weaknesses<br>An efficient method of handling heuristic tasks based on complex knowledge systems | Sharpens interpersonal skills.<br>Teaches relationships, power-sharing and power-struggles in a social context.<br>Preparation for real-life team work.<br>The combining of different knowledge in different ways, as well as discovery-learning. |
| ***Open-ended domains, distance-collaboration***<br>As above, using electronic communication<br>Lacks factors of urgency and human dynamics that that go with face-to-face contact; ways and means must be sought to compensate for this. | Supports joint development of products.<br>Processes are more time-consuming, particularly where participants do not know each other or one another's expertise. |

**Table 6.6.3 Problems incurred in collaborative learning**

| ***General issues*** | **Implications** |
|---|---|
| - Some carry more responsibility / do more work than others<br>- Assessment of teamwork is contentious | Preparation for real-life!<br>Learners request inclusion of peer-assessment and self-assessment |
| ***In distance-learning*** | **Implications** |
| Distance-collaboration issues:<br>- Less control than in contact-collaboration<br>- Team members can reduce output or drop level of communication, thus delaying progress<br>- Not all team-mates carry equal share of work | Frustration and irritation<br>(Bonus is that distance-collaboration can occur at all) |

Team collaboration is inefficient for discovery-learning in procedural tasks or closed problems where a defined process that can be taught directly. Small group co-operative work can be useful here, as partners support one another in problem-solving. Collaborative learning is highly appropriate for open-ended heuristic tasks involving complex knowledge and skills that can be integrated in a variety of ways to solve a problem or complete a task.

## 6.3.5 Components

The practice of instruction/learning, as investigated in Chapter Five, also provides information about the theory of componential instruction. In all disciplines, learners must internalize certain basic knowledge and skill components. Some learning events are explicitly designed to impart this kind of knowledge, and in certain domains it is best to do this by explicit, even decontextualized, transmission using, for example, direct instruction via component-based tutorials (none of the learning events of Chapter Five are of this sort). Yet other instructional products (e.g. FRAMES) emphasize the practice of skills, but provide the necessary components as options, available when required. Other learning events, by contrast, assume components to be in place as a foundation on which further knowledge is constructed. In such cases, further contextualized learning by discovery and personal knowledge interpretation play a role, as occurred in RBO and Mkambati 2000.

The way in which components are taught and/or learned varies according to the domain. Tables 6.7.1 and 6.7.2 address the findings regarding the use of components in instruction and learning, and show some of the ways that instructional components can be learned and reviewed.

**Table 6.7.1**
**Information revealed about components within instruction and learning**

| Concept | Reference | Occurrence (or negation) revealed in evaluations |
|---|---|---|
| ***Component display theory***<br>Based on the performance-content grid, to ensure that instruction covers the single and composite skills in a variety of ways.<br>Learners make own decisions about the content and the strategy. | Sections 2.3.3.3, 3.3.3.1 and 3.6.1<br>Merrill, 1983, 1987<br>5A.2.5.3: Table 5A.9<br><br>5A.2.1.1: Tab 5A.2<br>Fig 5A.3<br>5A.2.1.3 | **FRAMES**: Practice of skills and structured procedures is offered in a learner-controlled component-based fashion, as a supplementary learning aid.<br>Theoretical information is provided as knowledge components; practical exercises are available as activity components. |
| Advanced, ***open-ended problem-solving*** is beyond the level of basic components. They should be present as a foundation. | 5B.2.3.1, 5B.2.3.2, 5B.2.3.3<br><br>5C.2.4.1, 5C.2.4.2 | **RBO**: Has links to external resources that include basic information - tutorials, websites, hard copy material, etc.<br>**Mkambati**: Students came to the fieldwork with existing building-blocks of own discipline and ecotourism. |
| ***Deductive and inductive use of components*** | 5A.2.2.3<br>5A.2.3.3 | Some learners go from theory to practice; others in reverse.<br>**FRAMES**: Theory built in to examples<br>Practice-to-theory opportunities |
| The teaching of basic methods is a general occurrence in instruction. Whether or not, and how to incorporate them ***depends on the context*** | Sections 2.6.2 and 3.6.1 | Procedural and well-defined domains require explicit teaching of the basics.<br>Ill-structured problems require foundation to be in place |

<table>
<tr><th colspan="2">Table 6.7.2 Ways of implementing the learning of basic components/skills<br>(mainly in the context of computer-based and web-based learning)</th></tr>
<tr><th>In well-structured, procedural domains</th><th>Implications</th></tr>
<tr><td>Domain components tutored or directly accessible<br>Basic knowledge and skills, chunked into units<br>Theory available within material/resource as an option. (Traditional CAI offers alternate teaching and question segments, but more contemporary approaches use a just-in-time basis.)<br>There are also more complex composite components, such as principles/procedures of Merrill's CDT.</td><td>Fast internal access to basic information supports learners</td></tr>
<tr><td>Procedural / algorithmic knowledge, examples subdivided into steps, available within learning material / resource on just-in-time basis, initially</td><td>Avoids cognitive overload</td></tr>
<tr><td>Visual templates to support integration of theory and current problem or structued steps to scaffold the problem-solving procedure</td><td>Supports integration of components and principles into complex procedures</td></tr>
<tr><td>Interactive practice environments can be designed to offer far more than the conventional computer-based, program-controlled drill</td><td>Composite components are as important as unitary components</td></tr>
<tr><th>In open-ended domains /<br>learning environments</th><th>Implications</th></tr>
<tr><td>Basic component/methods available externally<br>Provide access to basic knowledge resources:<br>- If learning environment is online, provide direct electronic links<br>- If learning environment is offline, provide lists of resources</td><td>Does not detract from the purpose of the event as advanced open-ended problem-solving, but provides external scaffolding as and when required.</td></tr>
<tr><td>Contextualized learning - in some situations<br><br>In other situations - decontextualized skills</td><td>Elements not isolated in order to teach them, but learned within problem-solving<br>Conversely, generalizable skills learned outside of contextualized problems</td></tr>
</table>

### *Concluding remarks*

Components of learning, a cognitivist-behaviourist mix, are viewed by some as incompatible with constructivism, yet there is a complementarity between them. Components are used within direct instruction to transfer basic (or composite) units of content from the educator to the learners, while constructivism promotes self-construction and self-interpretation of information by learners themselves. Most domains incorporate different kinds of knowledge, some of which are best taught by components - unitary and/or composite components - and other forms that are better self-constructed.

### 6.3.6 Customization of learning, learner-centricity, and learner-control

Learning can be customized in many different ways, going way beyond the basic original concept of customizing by branched learning systems, also known as adaptive systems. Tables 6.8.1 and 6.8.2 address some of the nuggets of customized learning revealed in this study, particularly from the studies of three different learning events in Chapter Five.

Table 6.8.1 sets out information about customized learning as discovered in the three case study evaluations, explaining the difference between conventional learner-control and learner-centricity in the more contemporary sense. Learner-centred learning environments/events support learners in taking responsibility for their own learning. The table also describes how collaborative learning can customize an activity to individuals by providing opportunities for them to exercise their speciality/ies on a team situation. References to the literature and to Chapter Five serve to illustrate points, but are by no means a comprehensive cover of the rich findings of this study.

To set a background, branching, the original method of customizing learning, is briefly described in Table 6.8.2. Willis (1998) expresses reservations about traditional instructional design, which focuses attention *on strategies rather than on underlying principles*. This approach was a cornerstone of early customization, presenting options between alternative methods, and used particularly along with direct instruction. Branching between options was initially system-controlled as shown in Table 6.8.2, an approach incompatible with contemporary practice, since it can hinder design of the newer approaches to instruction and learning. In the rest of the table some of the newer cognitively-based forms of customization are shown, starting with learner-controlled branching and moving on to alternate, interrelated learning methods such as project-based and problem-based learning, case-based reasoning, and customization within collaboration. These truly learner-centric methods are used in domains that may well be compatible with direct instruction, yet where explicit teaching is complex to design. Auto-customization may entail learners making learning experience more powerful by taking them in different directions, i.e. having differing purposes as well as different ways of realizing them. Table 6.8.2 lists different ways of customizing learning, distinguishing once again between well- and ill-structured domains.

| Table 6.8.1 Information revealed about customization of learning | | |
|---|---|---|
| **Concept** | **Reference (within this study and/or original source)** | **Occurrence (or negation) revealed in evaluations** |
| ***Conventional learner-control*** in a procedural domain (Learner-control is not necessarily learner-centric) | Section 2.5.2<br><br>5A.2.5.1: Table 5A8<br>5A.2.5.3: Table 5A.9 | Certain fixed material must be communicated to learners, making it less easy to implement learner-centricity. A way of doing so is to provide the required content, but without imposing fixed paths - a pick-and-mix situation.<br>**FRAMES:** Learners customized the material by controlling the components / activities they did, selecting content, sequence, quantity, mode, and extent of help to meet their individual needs or stage of study. |
| ***Auto-customization, true learner-centricity*** For different learners, there can be diverse ends as well as diverse means of achieving them | Reigeluth, 1999; Section 3.6.3<br>5B2.5.2, 5B.2.5.4<br><br>5C.2.5.3: '*Integration …* ' | There are two cases - tasks can relate to specified topics but have open-ended content; other tasks have open-ended specifications. In both, learners take responsibility for their own learning<br>**RBO**: Auto-customization occurred as individuals steered the exam project in a direction of their choice.<br>**Mkambati 2000**: Individuals used the tasks to do research in the directions of their specializations, but in ecotourist context. |
| ***Customization by content,*** as learners' backgrounds and interests are matched, and learning preferences realized. | Kearsley, 1998<br>5B2.5.3: Table 5B.9/10<br>5C.2.3.3: Table 5C.7, 5C.2.3.4 | **RBO and Mkambati**: Students were able to personalize the learning experience and match their own interests. |
| ***Customization within team-based, co-operative & collaborative work,*** as learners finds roles in a group (Also preparation for the business and professional world) | Reigeluth, 1999<br>5B.2.4.1: 1 and 2<br>5C.2.2.1, 5C.2.2.4 | **RBO and Mkambati**: Teamwork that optimized on each member's specialized expertise - teams can do what individuals may be unable to do, due to personal lack of particular skills/abilities. Diversity brought varied knowledge and talents to bear, and is a foretaste of the business and professional working environment. |
| ***Individually mediated understanding*** Learning experiences individualized | Hannafin *et al*, 1994<br>Section 3.4.4.3<br>5A.2.3.4<br>5B.2.5.1 and 5C.2.6.3 | All three case studies: This thesis shows how understanding was individually mediated in three learning events, as self-directed learners took active responsibility for knowledge construction |

| Table 6.8.2 Ways of customizing learning | |
|---|---|
| **Original way of implementing customized learning** | |
| ***In well-structured, procedural domains, contact-or distance-learning*** | **Implications** |
| ***Branching***<br>System-controlled customization<br>- Learner answers entry-questions<br>- Based on responses, is placed by system on an appropriate path | Effective, if done as by a human tutor, as is the case in intelligent computer-aided instruction (beyond scope of this study) |
| **Cognitively-based ways of implementing Customized learning** | |
| ***In well-structured, procedural domains, contact- or distance-learning*** | **Implications** |
| ***Branching***<br>Learner-controlled customization<br>- Learner chooses out of optional pre-set paths<br>- Learner chooses own components/activities on a pick-and-mix basis (no pre-set paths or quantities) | Rigid, but appropriate for sequential domains<br>True learner-control; learner-centricity as they select own sequence, quantity, even content. |
| ***Multiple presentation / modes***<br>Same material, learner chooses from mode options and/or medium options<br>***Incorporated subversion***<br>Learner uses learning event in an original, unintended manner | Consolidation of learning<br>Supports effective personalised learning, since different learners learn best from different media and modes |
| ***In open-ended domains, contact- or distance-learning*** | **Implications** |
| ***Auto-customization / customization by content***<br>Use of a learning event in a way that is personally optimal; supporting diverse ends as well as diverse means:<br>- Learners choose own approach within set content.<br>- Learners determine own content and direction within a broad domain, or develop own product.<br>- Learners choose own specialization/role within a collaborative team environment, i.e. use own complementary skills/expertise. | Usually learner-generated content, rather than basic taught-content |
| ***Individually mediated understanding -*** learner/s direct the learning, deciding what, how and when learning occurs, evaluating and explaining from experience in a problem-based/case-based context. | Instructor must guide and support, yet without controlling. |
| ***Incorporated subversion*** - learner uses learning event in an original, unintended manner. | Design should avoid rigidity, leaving space for creativity. |
| ***Customization by collaboration/team-learning*** | Capitalizing on unique individual abilities in context of teamwork. |

***Concluding remarks***

Contemporary thinking on customized learning goes beyond individualization of instruction by means of branching. Alternative means of customization aim to engross learners and **match their interests** by challenging them in innovative attention-holding ways.

Customized learning is closely affiliated to learner-centricity, but the two are not synonymous. An instructional system can be customized by system-control, or even by learner-control, yet may not be truly learner-centric, i.e. not designed with the specific interests of the learners at heart. Conventional means of customization can be superficial (Reigeluth, 1996b), and the designers of instructional systems or learning events would do well to incorporate features that permit individual learners to match their particular needs and interests. It is more complex to implement this in basic instruction than it is in open, less-structured domains, where the newer concepts such as auto-customization, positive subversion, and customization by collaboration are appropriate.

With respect to educational technology, Kearsley (1998) points out the need, over and above teaching learners to use computers as tools for word-processing, spreadsheets, etc., to emphasize the cognitive abilities required to write, analyze, and formulate. Using computers as tools should entail problem solving, decision-making, manipulation, integration, and interaction with those tools. Learners who successfully attain these skills - with or without computers - and are able to **cognitively process, manipulate, and communicate information independently** are truly customizing their learning.

## 6.4 Inter-relationships and integration within the Hexa-C Metamodel

It has become clear in the course of this study that learning and instructional-design theories from the cognitive family are **dynamically interrelated with each other** as well as with the **characteristics** (in the HCMm) of contemporary instructional/learning practice. Each of the six sections in this chapter on a particular element of the Hexa-C Metamodel (Sections 6.3.1 to 6.3.6) presents a table on information regarding that particular element, as revealed in the case studies of Sections 5A, 5B, and 5C. It is notable that the references in these tables frequently point to material relating to an element other than the specific one under the spotlight, thus indicating their inter-dependency.

Two trianglular-format tables follow which set out relationships between each pair of elements in the HCMm framework. Table 6.9.1 shows positive factors, where theories/characteristics interact synergistically. Table 6.9.2 indicates a few situations where one element may rebound in a negative manner on another. Within the tables, each element is placed on both axes.

To investigate the **relationship between a particular pair**, the reader should locate each element on a different axis, then access their cell of convergence. To overview **all the relationships of a specific element**, access that element on the vertical axis and move right until the row ends, then move vertically upwards.

*Cognitivism* is the key element, interacting strongly with all the others to support or enhance them. *Constructivism* is a further major role player. As mentioned in Section 6.3.6, traditional ID focuses attention on strategies rather than on underlying principles. Constructivism, conversely, is more focused on principles than on strategies, and so concerned about changing thinking on instruction and learning that it can fall short in promoting practical ways of implementing the principles (Willis, 1998). Where true constructivism is achieved in a context that synergistically incorporates other elements of the HCMm, however, learning is achieved, the kind of learning that is transferable to other domains and that holds real-world outcomes. Regarding the relationship between customization and constructivism, Lebow (1993) suggests that the latter provides a much-needed theoretical basis for understanding learner-control strategies and guiding future inquiry. The crux of *customization and learner-centricity* is learners' freedom to choose their own focus and approach within a broadly defined context and content, a capability towards which all the other elements contribute. *Collaborative learning* is a characteristic that integrates harmoniously with the other elements, being a contemporary approach that effectively supplements conventional instruction as an integral part of open-learning and problem-based environments. According to Wager (1998), many cultural factors work against learning - such as cultural factors and learner norms. If time spent in collaborative work can also meet social and emotional needs, it should improve cognitive behaviour. *Creative, motivational instruction* is paramount in order to reach learners on an affective level, which is closely related to their ability to process information cognitively. The use of *components*, both unitary and composite components, is important at early stages of cognition particularly where some direct instruction is needed. Componential instruction and constructivism, though the antithesis of each other, are compatible in that each is optimal in a certain type of domain, and some domains optimize on both by employing them as supplementary forms of learning.

**Table 6.9.1 Positive relationships between elements of the Hexa-C Metamodel framework**

| | Cognitivism | Collaboration | Components | Constructivism | Creativity and motivation | Customi-zation |
|---|---|---|---|---|---|---|
| Customization | *Prior-new learning:* Customize to relate to learner's background, expertise, &inadequacies. The way integration occurs depends on the types of knowledge to be inter-related. | Customize collaboration to *optimise on each learner's abilities* and minimize weaknesses. | When learners can *individually select* the knowledge and skill components, that they need, learning is more relevant. | Constructivism provides a theoretical basis for understanding learner-control/customization; Learners can choose own focus and approach within broadly defined context and content | Support auto-customization to encourage learner-creativity; Creatively match personal interests and needs to maintain learner-centricity | |
| Creativity and motivation | *Cognitive-affective:* Creative instruction helps learners to produce beyond expectations. Well-chosen metaphors simplify learning | The focus question of CLEs, OELEs, problem-based, and case-based learning should be creatively selected | Unitary components are usually de-contextualized, but composite ones can be presented in creative settings | *Not edutainment:* Learners from an entertainment-oriented society get bored easily. Use humour and novelty, but do not distract | | |
| Constructivism | *Schemata construction:* Is facilitated by active participation *Cognitive anxiety*: Is part of constructivist frustration – adequate support must be provided. | *Social negotiation:* Helps construction of knowledge. Collaboration is an inherent feature of constructivism. | Components fall outside the ambit of constructivism, yet there is a complementarity and compatibility. | | | |
| Components | *Optional modes*: When components are available in optional modes, they support cognitive learning | *Peer-interaction:* Learner-learner communication and articulation of knowledge can consolidate learning | | | | |
| Collaboration | Meet social needs in the learning process to reduce resistance, support learner-norms, enhance cognition. | | | | | |
| Cognitivism | | | | | | |

**Table 6.9.2 Negative relationships between elements of the Hexa-C Metamodel framework**

| | Cognitivism | Collaboration | Components | Constructivism | Creativity and motivation | Customi-Zation |
|---|---|---|---|---|---|---|
| Customization | | Collaborative work can work against personal styles/needs | | | | |
| Creativity and motivation | | Tight regimentation of team projects can reduce uncertainty, but may impede learner-creativity. | | Over-creativity and less familiar metaphors can overwhelm learners | | |
| Constructivism | | Being face-to-face & doing non-task activities, can strengthen bonds, therefore collaboration between remote partners is complex;<br>Lack of boundaries in constructivism can impede collaborative efforts. | Components of knowledge and skills tend to be the antithesis of holistic knowledge construction, yet are supplementary to it. | | | |
| Components | Do not serve well in ill-structured domains | | | | | |
| Collaboration | Focused learners and achievers find that collaboration can slow down learning processes | | | | | |
| Cognitivism | | | | | | |

## 6.5 Conclusion

As stated in Chapter One, Section 1.4.2, the composite goal of this research, closely related to the three research questions in Section 1.2, is:

> To explore the current thinking in cognitively-based learning theory, instructional design theory, and effective practice, so as to develop a compact synthesis that can be used:
> 1. As a framework or tool to assist in the development of instructional systems, learning products, environments, and events;
> 2. For evaluating existing products, environments, and events from the viewpoint of learning theory; and
> 3. For determining further information about the dynamics of theories and characteristics embodied in the framework.

The **Hexa-C Metamodel**, which resulted from the first part of the goal, is not a rigid model with which learning products/events are expected to comply, nor is it a checklist of elements used to test conformance. It is clear, however, from the evaluations conducted in achieving the second subgoal, that **learning events and environments of which the characteristics correspond with most or all of the elements of the HCMm are effective in supporting learning**. In search of the third subgoal, each of the six C-elements was studied in-depth to determine what its use as a tool disclosed about it - in and of itself, as well as its role in the toolset. Information was tabulated about its use in practice and to suggest ways in which it could be applied in different kinds of domains. Where particular complexities were discovered, they were listed. The findings provided information about the HCMm as a composite, bonded framework, indicating a strong synergism between its elements. This study has contributed to the body of knowledge on the dynamics between theory and practice of current instructional systems design, by showing some of the most salient features of the literature, and indicating how they function in practice. Information has also been revealed regarding application of certain less-known aspects.

A further significant point is the convergence of the HCMm and learning-focused theory, an aspect introduced in Table 4.9 in Section 4.6. In Section 5.2, the conclusion to Chapter Five, the issue is pursued, where it is mentioned that each event: FRAMES, RBO, and Mkambati 2000, conforms to the seven guidelines for the new learning-focused paradigm as defined by Reigeluth (1996a; Reigeluth & Squire, 1998; and Sections 2.6 and 3.6 of this thesis).

Following the evaluations of Chapter Five, where the HCMm framework was used as a set of tools to investigate three learning events, Chapter Six, conversely, has inquired into the evaluations to determine what the case studies reveal about the elements of the tool and their inter-relationships.