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Developing performance support systems for complex tasks: Lessons from a lesson planning system

Martyn Wild
Edith Cowan University

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Systems For Complex Tasks : Lessons
From A Lesson Planning System

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**Developing performance support systems for complex tasks:
Lessons from a lesson planning system**

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Thesis submitted in fulfilment of the requirements for the degree of
Doctor of Philosophy
Edith Cowan University, Faculty of Communication, Health and Science
21 September 1998

USE OF THESIS

The Use of Thesis statement is not included in this version of the thesis.

Declaration

"I certify that this thesis does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any institution in higher education; and that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text."

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7 February 1999.

Abstract

There lacks coherent and persuasive rationales for the further development of computer-based, interactive educational materials, for tertiary settings. Indeed, educational software arising out of what might be coined the 'multimedia era', namely the mid and late 1990s, has been marked by lacklustre products with an emphasis in development and evaluation placed largely on technological issues (such as the use of video, sound and animations). As such, the rapid increase in commercially available (usually CD based) products has generally met a cool reception from academics and educationalists, with both these groups often bemoaning the paucity or non-existence of effective instructional design models in educational multimedia. It is imperative that we provide a range of rationales for the use of 'new media' in teaching and learning, based in clearly delineated constructs that derive their substance from theoretical models and research findings. This research programme was intended to explore one such rationale.

This research originated in the notion of using software technologies as cognitive tools. More specifically, this notion involves a conceptualisation of hypermedia as possessing a set of characteristics and functions that relate closely to certain cognitive processes present in the handling and representation of information and knowledge. Furthermore, the notion also embraces the potential of PSSs as support systems for novices undertaking complex cognitive tasks—a role that is, in part,

suggested by their use in commercial settings but one that is yet to be fully developed in educational ones.

In essence, this research programme comprised the development and investigation of a hypermedia product (the Lesson Planning System) designed to operate as a PSS to support novices in completing a complex cognitive task. The focus of this task was lesson planning; the novices were first year undergraduate students in education.

Findings from this research demonstrated that performance support systems can be designed and applied to complex educational tasks, to the advantage of students' learning and performance in these tasks. It lends strength to the proposal that PSSs provide an exciting, alternative, model of teaching and learning relevant to a range of complex task domains in higher education. Results from this research not only add to literature relating to teacher education but also more specifically, to literature centred in the development of information and interactive technologies in educational settings.

The development of an effective PSS for lesson planning provides a model for similar systems development, and will perhaps serve to stimulate debate on the use of PSSs as a viable and cost-effective means of improving student learning and performance in a tertiary setting.

Contents

CONTENTS	1
LIST OF FIGURES	6
LIST OF TABLES	8
ACKNOWLEDGEMENTS	10
SECTION 1	11
PREFACE	11
Purpose and intent	11
Abstract	12
Introduction	13
Lay out of the thesis	14
SECTION 2	15
LITERATURE REVIEW	15
Introduction	15
Cognitive tools	15
Performance support systems	19
Limitations of PSSs	27

Do PSSs work? The empirical evidence	30
Problems with empirical evidence	38
Are PSSs cost-effective?	44
Considerations in designing the LPS	44
Additional considerations in designing the LPS	47
The context of design for the LPS	49
Design methodology in the LPS	52
Theoretical considerations in the design of the LPS	58
Hypermedia	59
Modelling	61
Cognitive load	63
Learner control	63
Transfer	65
Mapping instructional design and learning in the LPS	66
What is meant by 'learning'?	68
Context and situation	68
Constructivism	71
Interactions as conversation	72
Building learning theory into the LPS	74
Conclusion: Conceptualising a research framework	76
SECTION 3	78
DESIGN AND DEVELOPMENT OF THE LPS	78
Introduction	78
Stage I: Identification of desirable features in the LPS	79
Stage II: Components of the LPS	83
Stage III: Formative evaluation of the LPS	86
Patterns of usage	87
Perceived result of usage	88
Difficulties in usage	88
Project history	90
Implementation issues	95
Conclusion	96

SECTION 4	97
METHODOLOGY	97
Introduction	97
Means and methods	97
Procedure	104
Pilot study	104
Main studies (Part 1 and Part 2)	106
Reliability and validity	109
Conclusion	113
SECTION 5	115
PILOT STUDY: ACCOUNTING FOR THE LPS AS PSS AND COGNITIVE TOOL	115
Introduction	115
Presentation of data	119
Results—novices	119
Discussion	126
Results—experts	127
Discussion	133
Results—lesson plan products	134
Discussion	137
Conclusion	138
SECTION 6	140
INVESTIGATION OF THE EFFECTS OF THE LPS: MAIN STUDY I	140
Introduction	140
Procedure	141
Presentation of data	145
Results—interactions	146
Discussion	153
Interviews	154
Student 1	155
Student 2	160
Student 3	164

Student 4	167
Discussion	171
Results—lesson plan products	173
Conclusion	175
SECTION 7	177
INVESTIGATION OF THE EFFECTS OF THE LPS: MAIN STUDY II	177
Introduction	177
Presentation of data	181
Results—interactions	181
Discussion	182
Looking further into the nature of students' interactions with the LPS	194
Discussion	204
Interviews	206
Student 1	207
Student 2	211
Student 3	213
Student 4	215
Student 5	217
Results—lesson plan products	219
Discussion	222
Conclusion	230
SECTION 8	232
CONCLUSION	232
Introduction	232
Research orientations addressed	232
To identify the critical components of a PSS to support the completion of a complex task (lesson planning)	233
To design and construct the LPS based upon those critical components considered to be relevant to lesson planning	235
To investigate: (i) how novice student-teachers engaged the components in the LPS to produce a lesson plan; (ii) the effectiveness of the LPS as a PSS to support the completion of lesson planning.	237
Significance of findings	239
Implications for future research	240

Limitations	242
Conclusion	242
SECTION 9	243
REFERENCES	243
APPENDIX A	260
INTERVIEW PROCEDURE AND SAMPLE DIALOGUE USING TALK ALOUD PROTOCOLS	260
APPENDIX B	263
STUDENT-TEACHER LESSON PLAN ASSESSMENT SCHEDULE	263
STUDENT-TEACHER OUTCOME STATEMENTS IN RELATION TO LESSON PLANNING SKILLS	265
APPENDIX C	266
CHECKLIST FOR STUDENT USE OF LPS	266
APPENDIX D	268
LETTERS PROVIDED TO STUDENTS INVITING PARTICIPATION	268
APPENDIX E	273
SCREENS SHOWING THE RANGE OF PERFORMANCE AND INSTRUCTIONAL SUPPORT IN THE LPS	273
APPENDIX F	278
REFEREED PAPERS	278

List of figures

<i>Figure 2.1. Relationship between characteristics and extent of design in PSSs (after Sleight, 1993).</i>	25
<i>Figure 2.2. Use of hypermedia structures in a learning environment (after Oliver, 1996)</i>	61
<i>Figure 2.3. A model of the teaching-learning process used to inform the design of the LPS (after Launiland, 1995).</i>	74
<i>Figure 3.1. The provision for performance and instructional support in the LPS</i>	84
<i>Figure 3.2. The range of informational tools provided in the LPS</i>	85
<i>Figure 3.3. The range of instructional sequences or items provided in the LPS</i>	85
<i>Figure 3.4. The provision for 'help' facilities in the LPS</i>	86
<i>Figure 3.5. Main interface of the LPS, showing use of the thumbnail views for feedback and navigation.</i>	93
<i>Figure 3.6. Integration of separate support-tools in the LPS: the Verb Database and the Work Pad.</i>	94
<i>Figure 5.1.1. Novice student N1: Lesson plans 1-4</i>	121
<i>Figure 5.1.2. Novice student N2: Lesson plans 1-4.</i>	121
<i>Figure 5.1.3. Novice student N3: Lesson plans 1-4.</i>	123
<i>Figure 5.1.4. Novice student N4: Lesson plans 1-4</i>	124
<i>Figure 5.1.5. Mean interactions in the LPS for Novice students N1-N4.</i>	125
<i>Figure 5.1.6. Time taken for task completion in the LPS for Novice students N1-N4.</i>	126
<i>Figure 5.2.1. Expert student E1: Lesson plans 1-4.</i>	129
<i>Figure 5.2.2. Expert student E2: Lesson plans 1-4.</i>	129
<i>Figure 5.2.3. Expert student E3: Lesson plans 1-4.</i>	131
<i>Figure 5.2.4. Expert student E4: Lesson plans 1-4.</i>	131
<i>Figure 5.2.5. Mean interactions in the LPS for Expert students E1-E4.</i>	132
<i>Figure 5.2.6. Time taken for task completion in the LPS for Expert students E1-E4.</i>	133
<i>Figure 6.1.1. Student 1 (Study 1): Lesson plans 1-6.</i>	147

Figure 6.1.2. Student 2 (Study 1): Lesson plans 1–6.	148
Figure 6.1.3. Student 3 (Study 1): Lesson plans 1–6.	149
Figure 6.1.4. Student 4 (Study 1): Lesson plans 1–6.	151
Figure 6.1.5. Students 1–4 (Study 1): Lesson plans 1–6.	152
Figure 6.1.6. Time taken for task completion in the LPS for lesson plans 1–6 (Study 1).	152
Figure 6.2. Students 1–4 (Study 1): Grades for lesson plans 1–7 (where 1–6 corresponds to F–A).	175
Figure 7.1.1. Student 1 (Study 2): Lesson plans 1–6.	183
Figure 7.1.2. Student 2 (Study 2): Lesson plans 1–6.	184
Figure 7.1.3. Student 3 (Study 2): Lesson plans 1–3.	186
Figure 7.1.4. Student 4 (Study 2): Lesson plans 1–4.	188
Figure 7.1.5. Student 5 (Study 2): Lesson plans 1–4.	189
Figure 7.1.6. Students 1–5 (Study 2): Lesson plans 1–6.	191
Figure 7.1.7. Time taken for task completion in the LPS for lesson plans 1–6 (Study 2).	192
Figure 7.2.1. Students 1–5 (Study 2): Grades for lesson plans 1–9 (where 1–6 corresponds to F–A).	221

List of tables

Table 2.1. Support structures in PSS design (after Gery, 1995).	23
Table 2.3.1. Instructional and performance components in the LPS	51
Table 2.3.2. Instructional components and knowledge representation in the LPS	52
Table 2.3.3. Tool components and their representation in the LPS	52
Table 2.3.4. Tool components and instructional support in the LPS	52
Table 2.4. Traditional and performance-centred design methodologies (after Gery, 1997).	55
Table 2.5. Elaboration of the instructional design in the LPS.	75
Table 3.1. Verbs provided in the LPS, based on Bloom's (1956) cognitive domain.	82
Table 4.1. Methodology	103
Table 4.2. Instructional and performance components in the LPS	113
Table 5.1.1. Novice student N1: Lesson plans 1—4.	120
Table 5.1.2. Novice student N2: Lesson plans 1—4.	120
Table 5.1.3. Novice student N3: Lesson plans 1—4.	122
Table 5.1.4. Novice student N4: Lesson plans 1—4.	122
Table 5.1.5. Mean use of LPS for Novice students N1—N4	124
Table 5.2.1. Expert student E1: Lesson plans 1—4.	128
Table 5.2.2. Expert student E2: Lesson plans 1—4.	128
Table 5.2.3. Expert student E3: Lesson plans 1—4.	130
Table 5.2.4. Expert student E4: Lesson plans 1—4.	130
Table 5.2.5. Mean use of LPS for Expert students E1—E4	132
Table 5.3. Lesson planning assessment criteria	135
Table 5.4. Student-teacher outcome statements in relation to lesson planning skills	136
Table 5.5.1. Novice students N1—N4: Grades for lesson plans 1—4.	136
Table 5.6.1. Expert student E1: Grades for lesson plans 1—4.	137
Table 6.1.1. Student 1 (Study 1): Lesson plans 1—6.	147

Table 6.1.2. Student 2 (Study 1): Lesson plans 1—6.	148
Table 6.1.3. Student 3 (Study 1): Lesson plans 1—6.	149
Table 6.1.4. Student 4 (Study 1): Lesson plans 1—6.	150
Table 6.1.5. Students 1—4 (Study 1): Lesson plans 1—6.	151
Table 6.2. Articulation of lesson plan assessment: Outcome—Grade—Mark	173
Table 6.3. Students 1—4 (Study 1): Grades for lesson plans 1—7 [shaded areas indicate those lesson plans produced by means of 'pen & paper'].	174
Table 6.4. Students 1—4 (Study 1): Grades for lesson plans 1—7 [where 1—6 corresponds to F—A].	175
Table 7.1.1. Student 1 (Study 2): Lesson plans 1—6.	182
Table 7.1.2. Student 2 (Study 2): Lesson plans 1—6.	183
Table 7.1.3. Student 3 (Study 2): Lesson plans 1—3.	185
Table 7.1.4. Student 4 (Study 2): Lesson plans 1—4.	187
Table 7.1.5. Student 5 (Study 2): Lesson plans 1—4.	188
Table 7.1.6. Students 1—5 (Study 2): Lesson plans 1—6.	190
Table 7.2.1. Students cognitive strategies in their use of the LPS: Student 1: Lesson plans 1—6 [shaded areas indicate totals and sub-totals for LPS component usage].	195
Table 7.2.2. Students cognitive strategies in their use of the LPS: Student 2: Lesson plans 1—6 [shaded areas indicate totals and sub-totals for LPS component usage].	197
Table 7.2.3. Students cognitive strategies in their use of the LPS: Student 3: Lesson plans 1—3 [shaded areas indicate totals and sub-totals for LPS component usage].	199
Table 7.2.4. Students cognitive strategies in their use of the LPS: Student 4: Lesson plans 1—4 [shaded areas indicate totals and sub-totals for LPS component usage].	201
Table 7.2.5. Students cognitive strategies in their use of the LPS: Student 5: Lesson plans 1—4 [shaded areas indicate totals and sub-totals for LPS component usage].	203
Table 7.3. Articulation of lesson plan assessment: Outcome—Grade—Mark	219
Table 7.4.1. Students 1—5 (Study 2): Grades for lesson plans 1—9 [shaded areas indicate those lesson plans produced by means of 'pen & paper'].	220
Table 7.4.2. Students 1—5 (Study 2): Grades for lesson plans 1—9 [where 1—6 corresponds to F—A].	222
Table 7.4.3. Students 1—4/5 (Studies 1—2): Average grades for all lesson plans over Main Studies 1—2.	222

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This is without doubt, the most problematic piece of academic work I have ever conducted. It has less personal significance than anything else I've done in my professional life, but ironically must be the most celebrated...

And its all for you, Mum.

SECTION 1

Preface

Purpose and intent

The purpose of the research was to develop and investigate the use of a Performance Support System (PSS) for novices undertaking a complex cognitive task (lesson planning), within an innovative instructional model for hypermedia development. In particular, the intention was to investigate the value in using performance support as a strategy for engaging learning, by describing how learning might occur in a learner as a result of using a specific PSS. This notion is in keeping with desirable trends in research into instructional technologies (Neuman, 1989; Reeves, 1993b; Reeves, 1995; Reeves, 1996a), where it is considered more appropriate to inquire into the processes of use rather than comparative measures of effect, of various media and technologies.

The idea of electronic performance support is relatively new in the context of teaching and learning, and subsequently there is a need to understand the processes at work in learners' use of these technologies. Developing such an understanding will enable educationalists to refine their design, implementation and management of electronic performance support software for teaching and learning within complex domains.

Abstract

There lacks coherent and persuasive rationales for the further development of computer-based, interactive educational materials, for tertiary settings. Indeed, educational software arising out of what might be coined the 'multimedia era', namely the mid and late 1990s, has been marked by lacklustre products with an emphasis in development and evaluation placed largely on technological issues (such as the use of video, sound and animations). As such, the rapid increase in commercially available (usually CD based) products has generally met a cool reception from academics and educationalists, with both these groups often bemoaning the paucity or non-existence of effective instructional design models in educational multimedia. It is imperative that we provide a range of rationales for the use of 'new media' in teaching and learning, based in clearly delineated constructs that derive their substance from theoretical models and research findings. This research programme was intended to explore one such rationale.

This research originated in the notion of using software technologies as cognitive tools. More specifically, this notion involves a conceptualisation of hypermedia as possessing a set of characteristics and functions that relate closely to certain cognitive processes present in the handling and representation of information and knowledge. Furthermore, the notion also embraces the potential of PSSs as support systems for novices undertaking complex cognitive tasks—a role that is, in part, suggested by their use in commercial settings but one that is yet to be fully developed in educational ones.

In essence, this research programme comprised the development and investigation of a hypermedia product (the Lesson Planning System) designed to operate as a PSS to support novices in completing a complex cognitive task. The focus of this task was lesson planning; the novices were first year undergraduate students in education.

Findings from this research demonstrated that performance support systems can be designed and applied to complex educational tasks, to the advantage of students' learning and performance in these tasks. It lends strength to the proposal that PSSs provide an exciting, alternative, model of teaching and learning relevant to a range of complex task domains in higher education. Results from this research not only add to literature relating to teacher education but also

more specifically, to literature centred in the development of information and interactive technologies in educational settings.

The development of an effective PSS for lesson planning provides a model for similar systems development, and will perhaps serve to stimulate debate on the use of PSSs as a viable and cost-effective means of improving student learning and performance in a tertiary setting.

Introduction

The rationale for this research lay in the paucity of instructional design models or approaches for the development of educational software products, particularly for tertiary education. Furthermore, it was completed in the shadow of seminal comments by Brown (1994), Lebow (1993) and Park and Hannafin (1993), amongst others, which are proving increasingly representative of the field of instructional technology, and which strongly advocate the need for new and better informed (ie. by a greater diversity in research findings) instructional design models.

The nature of the research was to hypothesise the value of using a model of instruction based primarily in the theory of cognitive tools and in the design methodology of (electronic) performance support systems (PSS), but also taking appropriate account of other cognitivist principles in instructional design, such as mental models, situated cognition and authentic learning. There were four orientations to the research programme:

1. To identify the critical components of a PSS to support the completion of a complex task (lesson planning).
2. To design and construct the LPS based upon those critical components considered to be relevant to lesson planning.
3. To investigate how novice student-teachers engage these components in the LPS to produce a lesson plan.
4. To investigate the effectiveness of the LPS as a PSS to support the completion of lesson planning.

The first of these was undertaken to help identify the essential components necessary to the building of a PSS to support the completion of a complex

task—lesson planning. From this point a fully-functional PSS was constructed (a lesson planning performance support system—the LPS) in orientation 2, and its use evaluated and described in research orientations 3 and 4, as both a performance and a learning environment.

Lay out of the thesis

The layout of this thesis reflects the chronology of the research programme. Following this Section, which sets out the broad intention and framework of the research programme, the second Section represents a review of literature in the main areas relevant to this research. The review and critique of literature reports on in particular, the nature and place of cognitive tools as an instructional paradigm; the nature and place of PSSs in both training and education contexts; the design of, and design methodology adopted for the LPS; the considerations made in creating a model of learning in the LPS; and the overarching conceptualisation built to frame the research. The key stages in the design and development of the LPS are addressed in the third Section; and the research methodology used, in the fourth Section. Sections 5–7 describe and analyse the results from three related yet independently conducted, empirical investigations into the use of the LPS by novice and expert student-teachers. The conclusions reached from these studies are brought together and discussed in Section 8, using the research orientations to frame and structure this discussion.

SECTION 2

Literature review

Introduction

This Section addresses a comprehensive range of cognate themes and topics that impact on this research programme; and further, attempts to identify from an inclusive review of various literatures, a theoretical or conceptual basis for both building the Lesson Planning System (LPS), and investigating its effect on the performance and learning of lesson planning as a complex task.

Cognitive tools

Cognitive tools refer to technologies, tangible or intangible, that enhance the cognitive powers of human beings during thinking, problem solving and learning. Written language, mathematical notation, and most recently, the universal computer are examples of cognitive tools. (Jonassen & Reeves, 1996 693)

Jonassen and Reeves (1996) outline a host of computer software, including common software applications and interactive learning environments, that function as cognitive tools—in fact, their approach in this regard is an inclusive one, leading them to classify a very wide selection of educational computing software as cognitive tools. However, this author would prefer to argue that it is

the nature of use that determines whether a software item is a cognitive tool, even where that tool has been specifically designed to operate as an 'intellectual partner' (Wild, 1995). Essentially, then, software becomes a cognitive tool in the context of use, and not necessarily in design nor in some forms of application—for example, a word processor is certainly a cognitive tool, but not when it is used simply to copy-type a nine-year old's narrative, so that it can be neatly printed out (Wild, 1995).

Cognitive tools are best described as computer-based applications that may also function as knowledge representation formalisms and that require learners to think critically when using them to represent content being studied or what they already know about a subject. In an extensive discussion of the value of cognitive tools, Jonassen describes how conventional applications, such as spreadsheets, databases, expert systems, etc., might become intellectual partners and serve to expand and amplify the thinking of learners, engaging students as knowledge constructors rather than information processors (Jonassen, 1995).

Interestingly, the divide that exists for many educationalists, between the North American and the United Kingdom approaches to the use and conceptualisation of educational technologies is particularly apparent here. Indeed, there is a rich and long heritage of cognitive tools in the United Kingdom, that is completely without representation in Jonassen's work. For example, Briggs, Nichol, Dean, and others of the 'Prolog education community' (Nichol, Briggs, & Dean, 1988), have long sought to provide learners with a range of cognitive tools for the representation and exploration of knowledge, and have published their results and ideas widely (Briggs, Nichol, & Brough, 1990; Dean, 1990; Nichol et al., 1988). Furthermore, various research and development teams have similarly been involved with the provision of cognitive tools to engage students in diverse modelling environments, so that they might represent and manipulate knowledge according to various formalisms (Cox & Webb, 1994; Mellar, Bliss, Boohan, Ogborn, & Tompsett, 1994; Webb, 1994). The learning theories underpinning our understanding of the value of such cognitive tools are generally founded in information processing concepts; although the use and value of cognitive tools has, of late, been shown to owe much to mental models theories, particularly to that of Johnson-Laird (Johnson-Laird, 1983; Wild, 1996b).

There is a sense in which the use of applications software as cognitive tools takes us beyond the intended uses of such software, so that they can be seen to be functional outside of their original design. This is also true of performance support systems (PSSs)—as application software, these can be used by students as cognitive tools to express and extend their thinking in a complex domain. However, unlike most applications software, PSSs are task specific; they also possess a series of functions and resources to simultaneously engage and support the user in both the performance of the task and learning about this task—and in this sense, their use blurs the distinction between task performance and task learning. It is in this view, that PSSs can be conceptualised as offering cognitive apprenticeship to the user. Such a conceptualisation is derived from the notion or theory of situating cognitive activity in authentic contexts, where it is suggested learning and doing, or performing, do not exist independently of the activity in which they occur (Resnick, 1987); and that learning takes place *in situ* (Brown, Collins, & Duguid, 1989; Collins, 1989; Collins, Brown, & Newman, 1987).

The implications of this in relation to the proposed lesson planning system (LPS) is that novice student-teachers can be expected, in the context of use of the LPS, to improve their performance skills in lesson planning and also, to increase their understanding in this domain. Thus, it could be hypothesised the students will not only develop their actual performance in this task but also improve their learning—learning about how to do the task, learning about the task itself and learning about their own cognition in tackling the task.

The intention of the research was to investigate the value in using performance support as a strategy for engaging learning, and to explain the extent to which this strategy is successful. The expectation, although not an assumption, was that in learning to perform a complex task over a number of occasions in which the task is practised, both lower (i.e. identification, recall, descriptive learning) and higher order (i.e. evaluative, critical, analytical, metacognitive learning) learning is likely to occur in the student. Consequently an imperative in this project was to describe how such learning occurs, if at all. This notion is certainly in keeping with desirable trends in research into instructional technologies (Neuman, 1989; Reeves, 1995), where it might be considered more appropriate to inquire into the processes of use rather than comparative measures of effect, of various media and technologies. The idea of electronic performance support is new in the context of teaching and learning, and subsequently there is a need to understand

the processes at work in learners' use of these technologies, particularly in mapping the cognitive change that sees a novice acquiring measures of expertise in a specified domain. Developing such an understanding will enable educationalists to refine their design, implementation and management of electronic performance support software as a cognitive tool.

It is possible to perhaps question the notion that a PSS is necessarily also a cognitive tool. Take for example, a 'performance support cash register', reportedly in use in America (Reeves, 1997) and no doubt elsewhere in the world, as a 'black box' technology to effectively eliminate cognition. There are similar devices appearing to support bank customers in extracting their cash from 'automatic tellers' in Australian banks, and elsewhere. However, such devices are limited to simplistic and procedural tasks, and arguably operate without the intention of leading the user to learn the necessary skills to perform that task without support. Furthermore, it is questionable that these and similar devices are in any real sense, authentic PSSs—indeed, the concept of performance support is well documented and perhaps most usefully reviewed in both Brown (1996) and Leighton (1996), and in these texts, amongst others, (E)PSSs are clearly intended to provide for skill *transfer*, to provide support, guidance and instruction to enable the user to both better understand and better perform the task in question, both now and in the future. Furthermore, it should also be remembered that technology that eliminates cognition at one level also frees 'cognitive space' at another; in fact, this is a principle that underpins cognitive load theory and the implications this theory has for instruction (Chandler, 1995; Chandler & Sweller, 1991). Indeed, perhaps the ultimate 'black-box technology' in this regard, is the computer itself.

For both these reasons then, a PSS is very likely to operate as a cognitive tool, and particularly when it is designed to do so, following definitive guidelines given in Gery (1991; 1995; 1997), Raybould (1990; 1995; 1996), Leighton (1996), Desrosiers and Harmon (1996), Brown (1996), and elsewhere, which, for example, specify the inclusion of on-line advisory support, a range of learning experiences and the means for the user (learner) to articulate problem solving, critical thinking and reflexivity in thinking. Thus, it is argued here that a cash register, even when it assumes considerable sophistication, is not a PSS; and further, that all PSSs, if designed in line with the recommendations of experts in this field, can be applied as cognitive tools in specified domains. That is not to say that a PSS is always a

cognitive tool, but rather, when used in a particular context, a PSS can always *become* a cognitive tool, in the sense of enhancing cognition.

Performance support systems

A Performance Support System is interactive software that is intended to both train and support the novice user in the performance of tasks. Raybould describes a PSS, rather widely, as a:

computer-based system that improves worker productivity by providing on-the-job access to integrated information, advice and learning experiences (Raybould, 1990).

Raybould (1996) has since elaborated on this, making reference to an evolving design methodology, which places emphasis on performers *in* systems rather than users *of* systems:

An EPSS is the electronic Infrastructure that captures stores and distributes individual and corporate knowledge throughout an organisation in order to enable workers to achieve the required level of performance in the fastest possible time and with minimal support from other people. Performance is achieved by designing the computer/ human interface using the principles of Performance-Centered Design (PCD), which focuses on the audiences as performers of work, rather than as users of a system. (Raybould, 1996)

Galagan (1994) in rather less techno-centric terms, describes a PSS as a dynamic dialogue between the performer and the computer through the use of a software interface that represents the appropriate task context. Seen in this sense, the nature and extent of such dialogue, largely initiated by the user or task performer, is likely to provide a measure of the usefulness of the PSS in supporting effective task performance. Indeed, accounting for the nature of this dialogue is one method of evaluating a PSS; and as such, is an approach used in this project, to investigate the use of the LPS.

Sleight (1993) has argued the need to recognise a range of characteristics in seeking to find an adequate working definition of PSSs, to differentiate them from other computerised systems or tools, and has suggested that as a minimal identifier, PSSs need to:

- be computer-based;
- provide access to the discrete, specific information needed to perform a task, at the time the task is to be performed;
- be used on the job, or in simulations or other practice of the job;
- be controlled by the user ;
- reduce the need for prior training in order to accomplish the task. (Sleight, 1993, p. 2)

Gery (1991, p.34) explains that 'the goal of an electronic performance support system is to provide whatever is necessary to generate performance and learning at the moment of need'. An electronic performance support system has 'the means to model, represent, structure, and implement that support electronically—and to make it universally and consistently available on demand at any time, any place and regardless of situation, without unnecessary intermediaries involved in the process' (Gery, 1991, p. 34). Goodyear (1995) emphasises the active part a PSS must take in supporting the process and procedures of task completion.

There exist slightly different perspectives of PSSs, each moulded by small shifts in emphasis. For example, Barker and Banerji (1995) stress the problem-centred focus of PSSs, whilst McGraw (1994) characterises PSSs in terms of their facilities, noting their integration of AI technologies, hypermedia and CBT. PSSs can also be described in terms of the uses made of them—that is, in addition to their role in instructing and supporting novices, they might be used by those more experienced in the focus tasks to increase efficiency and quality of output, for example, by serving as amplifiers of experience and knowledge (Gery, 1991).

Traditionally, however, PSSs have been characterised by their structure and the software resources they provide, and these are usually determined to include: an information base (eg. on-line reference and help facilities and case history databases); interactive and learning experiences; productivity software (often used with templates and forms); and, an advisory system (eg. coaching facility) (Gery, 1995). In some cases, they include intelligent tools, such as an intelligent advisor or expert system (Carr, 1992a; Leighton, 1996)—although this has been represented as a matter for disagreement amongst PSSs developers and theorists. For example, Carr (1992b) has strongly advocated artificial intelligence as a

requirement for PSSs; whilst Gery (1991), has equally strongly disagreed. Sleight (1993, p.4) considers that artificial intelligence will probably become one of the 'defining characteristics' of PSSs, but cannot be regarded as essential at the moment, given the early state of research and development in the fields of both PSSs and artificial intelligence.

Cronjé and Barras-Baker (1997), provide a checklist of features that serve to characterise PSSs:

- an advisory or expert system performing tasks such as structuring problems, analysis, diagnosis, and calculations much in the way 'wizards' function in many Microsoft Office applications;
 - productivity software, such as spreadsheets or word processors;
 - dedicated application software, such as project schedulers, electronic mail, and electronic diaries;
 - help systems which assist with using the software, including the system shell;
 - interactive training sequences which, unlike traditional CBT are granular and task-specific, although they might be strung together to form a longer training module;
 - assessment systems either for self evaluation or employee assessment for certification purposes;
 - monitoring, assessment and feedback systems which observe user performance.
- (Cronjé & Barras-Baker, 1997, p. 3)

Barker and Banerji (1995) emphasise the importance of PSSs possessing appropriate interfaces to both information modules and support tools, suggesting that a PSS interface should be simple and allow users the quickest possible access to required resources. A principal design problem lies in integrating all resources for task completion into an intuitive and cognitively undemanding interface. Gery (1991) suggests that the interface should contain facilities such as back tracking and should allow lateral and back access.

Performance support systems and tools have been developed in medicine (eg. medical diagnosis), sales (eg. real-estate selling), aircraft and space-shuttle maintenance (eg. for the American Air Force and NASA), engineering (eg. computer assisted design) and management (eg. decision support). A brief description of some of the better known initiatives in PSS development and

application, particularly in business and commercial ventures and industries, are now available on the Web¹.

More recently, the concept of performance support has been applied to mainstream and generic software tools, such as Microsoft Office², specifically in the form of 'wizards'—context sensitive, step-by-step task-related, procedural tutors. Furthermore, the nature of supporting functions in current and future designs of PSSs has been re-conceptualised by Gery (1995), to allow for increasingly diverse applications and types of performance support functions of PSSs. In this latter context, we are witnessing the use of different names applied to describe essentially the same concept—for example, 'integrated performance support' (Winslow & Bramer, 1994)—as well as increasing interest in applying intelligent tutoring modules, such as those advocated by McGraw (1994), in the form of intelligent advisors or coaches. Leighton (1996) has conceptualised later development in PSS design, as part of a wider movement to replace people resources in more general systems development.

However, it is not a simplistic or unidimensional task to define what is meant by performance support, since this concept is applied increasingly widely to various software tools and applications, and particularly in training contexts. However, a useful and pragmatic way of dealing with the various approaches to performance support, is given in Raybould's (1997a) conceptualisation of embedded versus external support, suggesting three levels of performance support can be distinguished in PSS design; and reflected in a similar exercise undertaken by Gery (1995):

- Embedded or 'intrinsic' support is tightly integrated into the work-flow and interface of a PSS, so that it is transparent to the user—system and supports appear as one. As Gery suggests, 'this support is so integrated into the interface structure, content and behaviour and the application logic that is impossible to differentiate it from the system itself' (Gery, 1995, p. 33).
- Linked or 'extrinsic' support is loosely integrated into the interface and appears as a separate or secondary interface—examples are advanced forms of Help, Advisors, Wizards, and Cue Cards. 'Extrinsic support is computer mediated and

¹ For example, see: <http://www.epss.com/lb/artonlin/artonlin.htm#CaseStudies>; and: <http://itcchl.coe.uga.edu/EPSS/Sites.html>

² Microsoft Office suite of software, version 6 (Macintosh) and version 7 (Windows 95).

often context sensitive to the task and worker situation but it is either invoked by the performer or is presented to the performer and can be accepted or rejected' (Gery, 1995, p. 33).

- External support includes classroom training, computer-based training courses, documentation, peer support, help desks, and bulletin boards—none of which are directly connected to the PSS interface. (Raybould, 1997a, pp. 4-5). As such, external support may or may not be, computer mediated.

Table 2.1. Support structures in PSS design (after Gery, 1995).

Support Structure	Function	Learning Objectives
Cue Cards —Task guidance —Sequences content by performer choice or underlying logic Explanations or Demonstrations —Presentation sequence —Interactive/non-interactive Wizards, Assistants or Helpers —Presents options or choices —Accepts user-input data —Progresses through task —Previews consequences —Summarises choices or conditions —Produces output or executes task —Transforms data —Changes data, views, screens or states Coach or Guide —Structured interactive 'walk through' of system-related procedural tasks —Takes control of system —Accepts input and releases control of system to user Searchable Reference —Content or knowledge database on concepts, processes, facts —Organised for flexible search, retrieval and navigation Checklist —List of markable items or task completion criteria —Context sensitive Task Process Map —Charts; diagrams —Lists Examples —Database of instances Templates —Pre-structured formats or shells Advice —Hints; Tips —Alternatives Structured Practice Activities —'Let me try' activities Assessments —Timed or judged tests or practice activities	Linear sequential or branched tasks for procedures, diagnosis or troubleshooting Orientation Understanding Skill development Task guidance Task execution Active task guidance through system tasks Information Search Information Retrieval Browsing Quality evaluation Process overview Orientation to process (ie. you are here...) Idea generation Understanding Structured output Presentation of information within a context/condition Low-risk experience Self-directed learning Self assessment	Task completion Learning while doing Learning Task completion Learning by modelling Task completion Learning while doing Replaces human support Information access Learning Task evaluation to be completed by the system or performer Establish and maintain performer orientation Learning Learning Idea Development Consistent and rapid task completion Continuous Learning Problem Solving Skill-building Confidence building Performance evaluation Knowledge evaluation Reflection

Gery (1995) has provided a summary of various support structures and their respective uses, which has been used to guide the development of the support structures in the LPS (see Table 2.1). Indeed, all performance and instructional supports in the LPS are either intrinsic or extrinsic in type, with most falling in the latter category.

Despite Gery's (1995; 1997), Raybould's (1997a) and others' attempts in this context, to provide a working approach to the problem of identifying what is meant by performance support and how the concept relates to the software design, there remains considerable debate to be had when attempting to define the various applications and types of performance support appropriate in PSSs or closely related tools or systems. Some of this debate can be found at the *epss.com!* web site³, with comments ranging widely and centering on, for example, how performance tools differ from 'systems' tools, situations where PSSs can be expected to be most effective, how performance support differs from training and how commercial organisations might take advantage of the concept of performance support.

Sleight (1993) has attempted to make sense of the range of software that sometimes pass for PSSs, by suggesting a classification of PSSs (or what she prefers to term, Electronic Performance Support Systems—EPSSs), based on the relationship between the characteristics of, and the extent of design attributable to, PSSs (Figure 2.1).

In Sleight's (1993) classification, a 'minimal' PSS would have the lowest extent of design, and would exhibit only 'key' characteristics—that is, it would: (i) be computerised; (ii) allow easy access to information when needed; (iii) be available at the worker's work site; (iv) be controlled by the worker; and, (v) reduce the need for prior training (Sleight, 1993). A 'mid-level' PSS would have a higher extent of design, and additional characteristics beyond those suggested as 'key'; whilst an 'optimal' PSS would have the highest extent of design and 'all the characteristics needed to support the task or tasks' (Sleight, 1993, p. 7)—both key and additional characteristics. Thus, in this context, a minimal PSS might be a 'front-end', built onto an existing system but which does not change that system

³ *epss.com!* is actually a 'Webzine' providing information on the use and design of performance support systems, and the development of performance centred design methodologies. This Webzine can be found at: <http://www.epss.com/>

in any functional sense—such as a PSS front-end to a database system, that enabled a user to more quickly and efficiently find the required results from an extensive set of data.

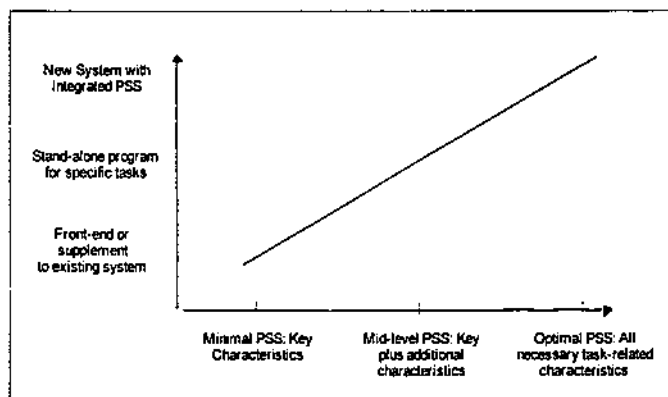


Figure 2.1. Relationship between characteristics and extent of design in PSSs (after Sleight, 1993).

A 'mid-level' PSS would actually change the operational nature of a system, and providing integrated support to user tasks—for example, a mid-level PSS in a database might provide an integral and contextual (rather than extrinsic and supplementary) set of supporting scaffolds to various information-seeking tasks, in the form of non-linear hypertext links to the information in the database. Unlike others in Sleight's (1993) classification, an optimal PSS would not be based on an existing system, but would be designed specifically to embed all key PSS characteristics in a purpose-built task related system. For example, an optimal database PSS would additionally provide access to general and specific software tools, integrated tutorials and context-sensitive expert systems; and data in the database would be presented in multi-mediums to accommodate various learning styles of users.

Akin to Sleight's (1993) rationalisation of PSSs, Banerji has provided a set of 10 basic principles and eight associated design criteria for creating PSSs, predicated on a systematic exploration of a range of tools and techniques for task support (Banerji, 1995, pp. 212, 214). Banerji's approach in his specifications, is to determine the need and context of need for a PSS; to describe the types and basis for use of various technologies, including intelligent agents, an appropriate mix

of media, hypermedia, telecommunications and just-in-time technologies; but also to describe use and user characteristics. It is this latter feature, and particularly his emphasis on the need to accommodate 'individual learning styles', to facilitate group working and to 'create a pool of corporate knowledge' (Banerji, 1995, p. 212), that makes Banerji's approach to the design and development of PSSs an inclusive and informative one.

However, neither the later developments in the design, application and theory of PSSs, as described in Laffey and Musser (1997), Desrosiers and Harmon (1996), and Leighton (1996), Sivertsen (1996) amongst others, nor Sleight's (1993) elegant and useful taxonomy, nor Banerji's (1995) refreshingly concise yet comprehensive set of principles for PSS design, have altered the main and collective purpose of PSSs—which is, quite simply, to facilitate satisfactory or improved performance of a task by someone with limited experience and training in such a task, by providing so-called 'just-in-time' resources (ie. instructional and performance resources). Moreover, PSSs, as well as the supporting functions found in more sophisticated mainstream generic software tools or applications, are more often applied to simple tasks (in the sense of the task being well-defined, well-understood and procedural in nature), rather than complex tasks. In applying PSSs to complex tasks, it is argued that both instruction and performance support functions need to provide for higher-order learning, and particularly for transfer of knowledge. Again, this is fundamentally different to the traditional nature and purpose of PSSs which are concerned with tasks characterised by training in systems' use, whether in a business or software engineering sense (Raybould, 1995). It is worth noting, however, that the uses and types of PSSs are likely to diversify in their future manifestations, where a new generation of PSSs will be defined in terms of how they engender improvements in both performance and learning, in a range of complex domains, such as those that occur at all levels of school and university education. Indeed, we are already seeing of late, examples of such diversification, in the building of Internet-based PSSs for learning (Laffey & Musser, 1997), and in more general calls for the development of PSSs 'as a possible direction for a paradigm shift' in the use of educational technologies (Desrosiers & Harmon, 1996 7).

In this context, Scales (1997) interestingly advocates the use of PSS technology as part of an educational reform agenda, suggesting that developments in PSS technology and the urgent need to reform educational practices should coalesce

in a bid to change not only the way in which educational technologies are conceived and used, but also how they operate in a more general educational system:

Educational reform and the development of EPSS are occurring as the result of the changes in the skills and knowledge needed for the workplace today. Moreover, the implementation of educational reform and EPSS in instructional technology will require following a systematic change process that looks at the entire organisation for change and not just single components. (Scales, 1997, p. 14)

Limitations of PSSs

Ruth Clark (1992) has been one of the few to offer criticisms of PSSs, tailoring her critique to rebuff Gery's (1991) principal assertions, published in one of the defining works in what Burton would call the 'dominant discourse' (Barton, 1994), advocating the development and application of PSSs (Clark, 1992). Others have since pointed to, and repeated, Clark's work when addressing the development of PSSs—for example, see Desrosiers, (1996). It is possible to extrapolate a number of pertinent issues and considerations from Clark's (1992) critique:

- Learning or effective training in a task, is not always best achieved in small chunks or steps, as it tends to be promoted and designed in PSS technology. Clark (1992) reminds us that learners need a framework within which to build their knowledge—and this is even more so in complex knowledge domains. If learning is only provided by reference to non-contextualised knowledge items, and not explicitly tied to an overarching framework, the learner will not develop what Desrosiers' (1996) calls 'the big picture'. Clark also warns that users might be encouraged within the PSS to ignore instructional modules and work primarily to develop greater performance and not develop independent knowledge, thereby bypassing the necessary conditions that must underpin cognitive transfer.

Of course, if this is found to be the case in the LPS, we might well surmise that PSS technology may not suit complex knowledge domains, where learning and knowledge transfer are important criteria for their implementation. However, it is more likely, in fact, that it is the implementation and use of the PSS that determines

whether learning occurs. For example, Clark (1992) warns that in some tasks where PSSs are deployed, it is the environmental factors, or what Tessmer and Richey (1997) have recently described as 'contextual elements', that are key in determining the success or otherwise of learning. It is important to point out here, that recognition of the importance of learning context is not new to education more generally: although there appears to be a resurgence of interest in its impact, of late in relation to instructional design (Anderson, Reder, & Simon, 1997; Richey, 1995; Tessmer & Richey, 1997). Certainly, it should be self-evident that context will largely determine if and how learning occurs in the use of a PSS, such as the LPS, even although it may be difficult to identify specific and causative factors in this phenomenon, where 'context is not the additive influence of discrete entities but rather the simultaneous interaction of a number of mutually influential factors' (Tessmer & Richey, 1997 p. 87).

- In a PSS, users are invariably given considerable control over use of the system, including their use of instructional components. It has, since Reeves' (1993a) article on learner control, been well known that in this area of research into instructional technologies, the poor designs of many studies have mitigated against a clear picture emerging; at best, it seems, the literature demonstrates only mixed results. At worst, we are forced, using Reeves' (1993a) maxims, to reject many of the supposed positive reviews and advocacy in this area. Indeed, turning to a recently published meta-analysis of learner control effects, where 24 studies of learner control in computer assisted instruction were re-assessed, it was found that 'overall comparative effects of learner control are slightly negative but near zero on average' and that, 'learner control, notwithstanding much speculation to the contrary, does not appear to confer special benefits on particular classes of learners under special conditions' (Niemiec, Sikorski, & Walberg, 1997, p. 169). We should assume then, that where users of a PSS are also novices in a task or knowledge domain, which is highly likely in the user-base of most PSSs, they are likely to experience more difficulties in regulating their own control, and learn less, than if they were subject to greater amounts of system or instructional control in the PSS.
- It is thought that in the use of automation to support task performance, as provided for by many of the tools components of PSSs (Geber, 1991; Gery, 1991; Leighton, 1996), users' performances are bound to improve in directed tasks. Clark (1992) is quick to point out however, that this fact remains uncertain, and that there has been little research on how automated tools affect performance.

Furthermore, Clark (1992) suggests that in the use of PSSs, task-related cognitive skills are likely to be lost. For example, if, as in expert systems, procedural and declarative knowledge is encoded in a PSS, we might well find little motivation to transfer such knowledge outside the use of a particular PSS—users might be content to complete a task satisfactorily rather than attempt to understand the nature of the task and their completion of it, more deeply. However, if a PSS is designed to encourage users to reflect on the task and their completion of it, as is designed to occur in the LPS, this may not be so much of an issue.

- Clark (1992) cogently argues that it is hard to justify the cost of developing complex PSSs; and that it might be more cost effective to find alternative solutions to maximising both learning and performance in a task, than to consider developing a PSS. However, this argument is contentious, rests on commercial and pragmatic considerations and is certainly not a new consideration in the field of instructional technologies. Importantly, however, it is not to be a consideration in terms of this research programme.

In this context, a PSS has been developed for use by first year Education students. This PSS is intended to facilitate the development of students' learning and their performance skills in the area of lesson planning. The basic premise underlying the development of the Lesson Planning System (LPS) is that it provides a structured environment within which student and beginning teachers are able to design lesson plans for immediate implementation and also receive instructional support in the design process. By engaging novices in the process of designing materials that impact directly on their teaching, it is intended to provide for deeper processing of a complex task, resulting in a more complete understanding of the domain. This is essentially the role and purpose of all cognitive tools (Jonassen, 1994; Jonassen, 1995; Jonassen & Reeves, 1996; Wild, 1995; Wild, 1996a; Wild & Kirkpatrick, 1996). Moreover, as with PSSs, the LPS can also be conceptualised as providing an environment for cognitive apprenticeship, where the user might engage in learning knowledge and skills that reflect the way in which that learning will be useful in real, professional, life—in other words, where learning is anchored in authentic cognitive activity (Brown et al., 1989; Collins, 1989; Merriam, 1993; Resnick, 1987).

A similar conceptualisation of PSSs (ie. as offering an authentic learning environment as well as operating as a cognitive tool) has recently been employed by Laffey and Musser (1997), to provide a rationale for their development of an Internet-based PSS for 'pre-service teachers, field-mentors and college faculty as they collaborate, engage in practice, document their efforts, share their experiences and assess outcomes' (p. 1). Laffey and Musser (1997) have also developed here, the notion of creating a 'performance and learning space' (p. 2), specifically to support higher order learning in a complex domain, by virtue of performing a task in this domain and with students being provided with tools to both manage and reflect upon their performance.

To date, instructional materials based on interactive technologies, have tended to focus on only the instructional aspect of task performance (Brown, 1991; Jih & Reeves, 1992). It is contended that students' use of the LPS will facilitate the transfer of effective cognitive strategies from the point at which they are learning about the lesson planning task, to the point where they are successfully performing that task, thereby minimising the distinction between 'learning and doing', and improving students' lesson-planning performance. Indeed, there is immediate support to be found for this contention in theories of experiential and authentic learning, where it can be expected that learning about a task is likely to occur in the experience of that task' (Brown et al., 1989; Collins, 1989; Kolb, 1984; Weil & McGill, 1989). Of course, once the LPS is removed from use, questions occur related to students' longer-term retention of learning, and the scope of this project provides not only for understanding of the processes of learning but also an indication of transfer effects.

Do PSSs work? The empirical evidence

There appear to be few studies of the effectiveness of PSSs. Desrosiers (1996) is clear about the reasons for this—PSS development and implementation largely takes place in the world of industry and commerce, and studies regarding how such software improves performance are not considered to be of value in this environment, only the *a priori* knowledge that improvements in performance occur in their use, although not necessarily as a direct result of their use. Indeed, Malcolm and Dickelman (1997) firmly indicate that the effectiveness of a PSS is

⁴ Although, of course, there are a number of qualifications and reservations that operate on this notion—see for example, Merriam (1993).

ultimately a matter of business performance, and this is how effectiveness is finally gauged.

However, Collis and Verwijns (1995) place another perspective on the PSS evaluation studies, arguing that 'with PSSs, ...the great variety of ways and contexts in which a user will turn to the system for support make it very difficult to isolate the system as a causal factor in that user's performance or to compare one system with an alternative' (Collis & Verwijns, 1995, p. 23). Consequently, they suggest the adoption of a usage-oriented evaluation methodology, (based on the rationale that performance gains will not occur if a system is not used, and therefore a necessary, if insufficient, criteria for a successful system is that it will be used in practice), where the product is evaluated not so much in terms of its internal validity, but in relation to user acceptance, thus:

- the extent to which the PSS matches user needs;
- its ease of use; and,
- its capacity to make work easier.

It remains to be seen whether such an approach, which is not primarily based in the measurement of performance gains, will be adopted widely in the commercial world of PSS development, although there is likely to be more interest amongst academic design and development groups, such as that reported by Cronje and Barras-Baker (1997).

Gerber (1994) notes the operation of two PSSs, and the fact that both remain without an assessment of their impact. One is in operation at Apple Computer, and is used to inform sales people about new products. It's called, Apple's Reference Performance and Learning Expert (ARPLE). The second is Northern Telecom's PSS, implemented to support new managers in writing budgets. Both these examples also appear in Desrosiers' (1996) account of present-day applications of PSSs.

Raybould (1990) describes how at Prime Computer, a PSS was developed to help sales agents manage a substantial increase in information; and that simply in the distribution of the software, money would be saved over the distribution of the same amount of information in paper form. Again, however, there is no evaluation given of the impact of this software on performance. Sleight (1993)

also describes this same PSS, built for Prime Computer by Ariel Performance Support Systems, and which she calls an 'Optimal Database EPSS', but again without any evaluation, although with a comprehensive description of features. Sleight (1993) also describes an 'Optimal Help System EPSS', built by Ziff Technologies and Comware, Inc., for Microsoft's 'Word for Windows'—again, with a comprehensive review of features but no evaluation.

The company Steelcase, an office furniture designer and manufacturer with 19,000 employees, is reported by Laffey (1995), to have developed a PSS to support its customer service agents. The PSS provides these agents with the data necessary to answer customers' questions. However, no data on the impact of PSS are provided (1995).

Laffey and Musser (1997) describe their experience in building a PSS based in Internet technologies, at the University of Missouri, Columbia. This on-line PSS is intended to provide pre-service teachers, field-based mentors and college faculty with a supporting environment to develop performance and learning in various aspects of professional teaching practice. In broad terms, Laffey and Musser (1997) do indicate that they have high expectations for their PSS positively affecting students' 'learning by doing ...in the performance environment', although this remains to be proved.

Hoyet Hemphill (1996) has reported on an extensive investigation of a PSS in lesson planning, comparing its effects in an experimental study, to what he terms 'detached training'. Hemphill's work, 'A comparison of a simple electronic performance support system for lesson plan writing to detached training', under the supervision of Dr David Merrill, at Utah State University, in 1996 (1996), is not typical amongst others described here, since its design, intent and use lie outside the commercial world, being concerned with teaching and learning, and in particular, the training of both pre-service and practising teachers in the use of the Talents Unlimited (TU) thinking skills model (Hemphill, 1996 1). In essence, results from his data analysis revealed 'that generally there is no difference on the effect on achievement between the use of an (E)PSS or detached training when assisting students currently involved in TU training' (Hemphill, 1996, p. 116). It was also found in this work, that users of the PSS took more time to complete planning tasks based on the TU model, than those who had undertaken traditional forms of training in the use of the model.

Hemphill's study was concerned with ascertaining the efficacy of a PSS for developing lesson plan writing for Talents Unlimited (TU) lessons, amongst both practicing and student teachers. TU is a teaching model that is apparently used to teach creative thinking skills to both primary and secondary school students (Hemphill, 1996 1-2). The objective in Hemphill's study was:

to compare an EPSS, developed specifically for the assisting of teaching pre-service teachers in writing TU lesson plans, to text-based detached training in writing TU lessons. (Hemphill, 1996, p. 4)

The methodology used was very firmly situated in an experimental paradigm. This is of course not surprising, given Dr Merrill's (Hemphill's supervisor) well-known and publicly lauded antipathy towards non-positivist research (Merrill, Drake, Lacy, & Pratt, 1996). Two separate studies were conducted with each involving two PSS treatment groups and two detached training treatment groups on four dependent measures. Essentially, Hemphill aimed to measure the effects that her PSS had on, (i) the quality of TU lesson plans produced by teachers and student-teachers; and, (ii) the amount of time taken by these groups to complete the lesson plans. She also posed associated research questions, concerning the amount of time spent by the treatment groups on external reference materials, and the attitudes of the PSS groups towards both the PSS, and to writing TU lesson plans (Hemphill, 1996, pp. 4-6).

In the main, negative results were recorded in Hemphill's study, for the PSS tested. Two measures were used to assess the quality of lesson plans produced by the treatment groups (Hemphill, 1996, pp. 63-67). For the first of these two measures, the TU Reactor test, there was no improvement in lesson plan quality recorded for either of the PSS treatment groups. For the second measure, the TU Critique Chart (Hemphill, 1996 64), there were apparently mixed results on some of the test criteria, but again, it was not possible for the researcher to clearly determine that the PSS had any significant impact on the quality of performance of either of the two treatment groups.

Furthermore, the experimental groups in both of Hemphill's studies took longer to produce their lesson plans than the subjects in the non-treatment groups (Hemphill, 1996 108). However, the researcher reasons that this result might have been due to the novelty of the PSS for the teachers and student-teachers using it

(ie. leading them to spend longer 'exploring' the software); and that if the study had been conducted over a longer time frame, it is likely that the performance time recorded for PSS users would have decreased significantly (Hemphill, 1996, p. 109).

In terms of their use of external materials, one of the two treatment groups were recorded as having spent significantly more time using external resource materials (ie. instructional support materials external to the PSS), than those subjects in the non-treatment group. Finally, the attitudinal measures taken appeared to deliver no significant results, although the subjects of one of the treatment groups was recorded as being 'less positive' than the non-treatment group about whether the PSS made it easier or faster to write lesson plans (Hemphill, 1996, p. 111).

Hemphill's study (1996, p.111), whilst superficially concerned with research questions akin to those in this present study, was conducted very differently in terms of the methodology employed. Moreover, Hemphill's work is focused on determining measures of difference in lesson plan writing performance (in terms of time and quality), brought about by use of the PSS; whilst this present study is more concerned to understand how student-teachers use a PSS to write lesson plans, and how cognitive strategies in PSS use can be related to performance measures, of quality and time.

It could be argued that the lack of positive results produced by Hemphill's study overall, says more about the research methodology chosen, than the use of a PSS for lesson plan writing. Whilst PSS technology offers clear and unambiguous possibilities for many teaching and learning applications, including lesson plan writing, the relationship between task performance and task and domain learning, for any such application, is not well understood, according to the literature. We should seek to understand this relationship before embarking on controlled studies to determine the extent of performance improvement, if any, there is in the use of a PSS designed to lift performance in a complex educational task.

Brown (1996) has written a book focusing on the creation of a PSS at Digital Equipment Corporation in 1993. Called the Learning Systems Workbench, the developers' aim was to 'provide on-line tools, information and resources that are

integrated into a core business process and delivered on a laptop personal computer' (Brown, 1996 4). However, despite the identification of the importance of evaluation in the D4M2 design model documented in this book and used to develop the Learning Systems Workbench, no evidence is provided of the effectiveness of the PSS at any level.

Ockerman, et al., (1996) have detailed the development of a Factory Automation Support Technology (FAST), a project which 'uses special hardware and performance support software to improve the performance of users on work tasks by giving users the right information, in the right quantity, at the right time' (Ockerman et al., 1996, p. 545). The special hardware is a wearable, voice-activated computer that allows users to operate the system while keeping their hands free to perform their tasks. The PSS aims to provide helpful, relevant, just-in-time information that users need to perform their tasks, intending to improve the user's performance by providing helpful information when and where the user needs it; and it is based on previously published work that discusses the authors' difficulties in devising a suitable development methodology for this rather unique project (Najjar, Ockerman, Thompson, & Treanor, 1996). However, there are no formal evaluation data available for the operational use of this PSS.

Ockerman, et al., (1996) have also detailed the implementation of the FAST concept for two different poultry industry applications, describing their work with quality control personnel at a poultry plant in Georgia. The first application was a proof-of-concept PSS and wearable computer for quality control inspectors in poultry processing plants. The FAST hardware components enabled quality control inspectors to directly input inspection data into a computer using voice entry while their hands are busy manipulating poultry products:

We are currently working closely with quality control personnel at a poultry plant in Georgia to develop this proof-of-concept performance support system. The second application is an initial educational PSS to aid environmental engineers in conducting water reduction audits. The system allows an employee to walk to various sites inside and outside the poultry facility and perform specific tasks as defined by the PSS, using text, audio, drawings, and video to show the employee how to measure water flow, adjust water valves, and calculate water usage. (Ockerman et al., 1996)

Again, however, no evidence of effectiveness for the applications of the FAST PSS, is offered.

Cronjé and Barras-Baker (1997) have provided a detailed case-study of the development and formative evaluation of a PSS 'to assist middle management in the construction industry with generating contracts in the format of the New Engineering Contract' (Cronjé & Barras-Baker, 1997, p. 1), in the context of post-apartheid South Africa, a developing country. Interestingly, they applied a version of Collis and Verwijs' (1995) evaluation methodology, basing their assessment on three main questions:

- Is the product useful?
 - Does it fit in with the personal work needs of the users?
 - Does the electronic performance support add value to the learning content?
 - Is the product useable?
 - Is the user interface easy to use?
 - Is the product easy to learn?
 - Does the product make the work easier?
 - Does it fit in with the work environment?
 - Does it fit in with working procedures?
 - Do the users have the time needed to use it and does it save time for them?
- (Cronjé & Barras-Baker, 1997, p. 8)

Following a breakdown of results, Cronjé and Barras-Baker (1997) conclude that 'it can be seen that PSS provides a valuable alternative in coping with a society in which all the skills may not be in place to have a specific job done. Although these results cannot be generalised, the evaluation... predicts reasonable to high user acceptance and provides good initial support for PSSs as a solution to the training needs of middle management' (Cronjé & Barras-Baker, 1997, p. 12).

An extensive study by Michael Mauldin (1996), is particularly interesting, although it is not overtly concerned with assessing the effectiveness of PSS technology. Rather it sets out to determine the 'unanticipated effects of an electronic performance support system' (this is in fact the title of the study, written as a PhD thesis) upon a large-scale organisation—in this case, a public hospital; and it produced a number of findings that help to contextualise and inform this author's present study. First, Maudlin's work serves to remind that

whilst all PSSs or Electronic Performance Support Systems, as Maudlin prefers to call them, by definition all bear similar characteristics and design elements, their scale can be very different. Maudlin was concerned with a large scale implementation of a complex, multiple-task oriented software system (Maudlin, 1996, p. 4); whilst the LPS is a relatively simple, single-task oriented system.

Second, it is apparent from Maudlin's study, that to maximise efficacy, a PSS must work within the context of a task and the task environment, rather than require either the task or the task environment to be changed to suit the requirements of use of the PSS (Maudlin, 1996, p. 126). It is perhaps a weakness of this present study that the LPS was used, certainly for data collection, by participating students at a central location, rather than at the 'work-place'—that is, in the classroom or some other environment in which students opted to do their lesson planning over periods of professional practice. Notwithstanding this, however, it could perhaps be argued, that if the nature of the task performance is changed substantially by the use of a PSS, a corresponding change in the task environment and even the task, might be invoked without detriment to enhanced performance in that task. Galagan (1994) highlights this very point in conversation with Gery.

Third, if the users of a PSS do not find all the information required to perform a task within the PSS itself, 'the PSS might not be considered very successful' (Maudlin, 1996, p. 125), requiring users to look outside the PSS for information resources, thereby wasting task performance time. Whilst this finding arose directly from a deficiency of the PSS implemented in Maudlin's study, it was not one that was found in relation to the use of the LPS in this current study. However, it is clear that it is impossible to guarantee that all performance and instructional resources required by all potential users, will be made available in the design of a PSS. Equally, it is apparent that the design methodology of PSSs, including the LPS, must allow for this fact, and should be sensitive to the needs of users, and provide for the PSS to be reviewed and updated, in line with the requirements made of it. But again, this a fundamental feature of systems design methodologies that embrace what Gery (1997) refers to as 'performance centred design'.

³ Table 2.4, (page 53), represents some of Gery's (1997) major considerations in drawing out the differences between traditional and performance-centred design methodologies.

Problems with empirical evidence

In addition to the studies cited above, there are a limited number of other empirical studies reported in the literature that have relevance to this current work. For example, Stoddard (1985), as far back as 1985 reported on a study that investigated context-sensitive help in comparison with menu-driven help systems. Although PSS terminology was not described or used in Stoddard's work, the investigation was concerned with issues of performance support, and the study was initiated at a time that could be identified with the beginnings of interest in the design and evaluation of task-based integrated (performance) systems. The study reported that learners preferred context-sensitive help.

Johnsey, Morrison and Ross (1992) undertook an investigation of the effects of elaboration strategies taught, in turn, by detached and embedded training, in terms of teaching generative learning strategies. In an experimental design, the embedded-training group was found to have performed no better than the detached training group in the learning task, although the former was found to have performed the task more quickly. This study is also briefly described in Hemphill (1996). In addition, Hemphill (1996) describes another study carried out by Hile and Campbell in 1993, where the use of an (E)PSS for training mental health professionals in 'writing treatment protocols' was found to be more effective when compared to 'text based training' (Hemphill, 1996, p. 28).

Of a small number of other empirical studies traced, including those by Dorsey, Goodrum and Schwen (1993), Barker (1995), and Hemphill (1996), only that by Hemphill can be regarded as being worthy of consideration in the context of this present study. The others are either concerned with attitudinal changes in subjects using PSSs (Dorsey et al., 1993), rather than changes in cognitive development (ie. learning), cognitive strategies in use, or performance variables (ie. total task time and/or performance quality); or they can be said to suffer significant problems associated with their methodologies. Indeed, Reeves reminds us that whilst the majority of research investigations carried out in the field of technology are 'empirical in intent and quantitative in method', many of

* This author was unable to obtain a copy of the Hile and Campbell paper, as discussed in Hemphill (1996).

these studies⁷ are badly flawed and deserving of the label 'pseudoscience' (Reeves, 1993a; Reeves, 1995, p. 7). Reeves identifies nine characteristics of pseudoscience such as measurement errors, inadequate sample sizes, inadequate treatment times, shallow literature reviews and meaningless discussion of results (Reeves, 1993a). Others such as Jonassen and Reeves (1996), Tuckman (1990) and Herrington (1997) support Reeves' thesis in this respect, highlighting a dearth of methodologically sound experimental or 'analytic' (Salomon, 1991) studies in the domain of technology.

For example, in the study conducted by Barker (1995), the subjects explored the PSS under investigation for no more than 30 minutes. According to Reeves (1993a), inadequate treatment times, are typical failings in poorly conceived experimental studies. Hemphill's study (1996) provides only inconclusive or ambiguous results, where there were no statistically significant differences found between the treatment groups (ie. between the PSS and 'direct training' groups); where the PSS under investigation was found to have a 'negative impact' on performance (Hemphill, 1996, p. 103); and where the PSS actually prolonged the task completion time (ie. thereby having an additional negative effect) (Hemphill, 1996, p. 108). Furthermore, Hemphill's study is also open to the criticisms raised by Reeves (1993a), being predicated on a quantitative methodology and based in two experimental groups, one consisting of a population of only 12; (Hemphill, 1996, p. iii); where the populations were not representative; and where the sampled populations used were not randomly selected (Hemphill, 1996, p. 112).

Further examples of PSS development and implementation are available, usually announced and described in web references⁸ or via email discussions⁹, but in most of these, important details of data collection, and other methodological issues are not presented and/or have not been undertaken. Also, where an evaluation is provided, it is in the sense described by Malcolm and Dickelman (1997), as a matter of business performance or projected business performance. Some of these examples are described below, and have been taken direct from

⁷ Reeves (1993a) calculates that of over 150 articles published in two leading journals in the field of technology and communications research, 72% published in *Educational Technology Research and Development*, and 61% published in the *Journal of Computer Based Instruction*, exhibit two or more characteristics of pseudoscience and are flawed to the point of being meaningless.

⁸ For example, see: http://www.epss.com/lb/lb_index.htm; and: <http://itech1.coe.uga.edu/EPSS/Sites.html>

⁹ For example, see: *Performance Support and Knowledge Management Forum*. 'A virtual meeting space open to all to discuss topics of interest to performance support and knowledge management practitioners'. Available at: http://www.epss.com/fm/fm_index.htm

web references or email discussions, and in all cases have arisen from a purposeful search for both descriptive information and evaluative data by the author. In some cases, the detail in these examples has arisen from conducting email 'conversations' with representatives of the various business companies listed.

- **Technology Reforming Exceptional Education (TREE)**
TREE is a joint effort of the Florida Department of Education's Bureau of Instructional Support and Community Services and Florida State University's Center for Performance Technology. The goal of the project is to design, develop, test, implement, and disseminate an PSS for instructional staff of exceptional education students in Florida's public school system. TREE was designed and developed with the participation of Florida school districts and exceptional education professionals throughout Florida, and represents the first significant instance of performance centred designed software in public education.
- **Apollo Travel**
Description: PSS (Millennium 3) designed for Apollo Travel Services, a travel agency based in Chicago. The idea behind Millennium 3 is to put a graphical user interface on Apollo that uses common travel-agency terms to significantly reduce the training required for new agents. Currently, new agents without Apollo experience can take as long as three months for classes and on-the-job training before they are competent to handle customer calls on their own, Edmonds-Shirey, Millennium 3 Project Manager, says. 'With this interface design, we feel confident training time will generally be about three days, and some of that will be familiarising themselves with the agency's policies and practices more than training on Millennium itself'. The Windows 95-based interface has a variety of views on the underlying mainframe data, such as a calendar view or replicas of necessary forms. An agent dealing with a customer will likely spend a lot of time with the itinerary screen, a replica of the printed itinerary travellers get with their tickets. From that point, the agent clicks on the related icon to order a special meal on a flight, ask for a non-smoking hotel room, confirm the customer's choice of rental car, etc. If the agent gets stuck, the interface offers such options as wizards, cue cards, and expert advice screens to help find an answer. The program makes it easier to learn on the job, and it also makes it harder to make mistakes. It automatically catches many common mistakes inexperienced users tend to make and guides them through the correct steps. When an agent starts to schedule an

option that goes against the customer's established travel policies, a dialogue box reminds the agent of the policy and asks him or her, if overriding the policy, to choose from a list of appropriate reasons.

Results: Whilst no results were available, it was reported that evaluation data were being collected; and that analysis was expected to demonstrate the PSS significantly reduced the training required for new agents.

- **American Express**

Description: Development of PSS for new customer service employees.

Results: Before implementation of the PSS, traditional training is reported to have been 12 hours, entry-level productivity recorded as 17 minutes per request, and entry accuracy given as 80% (with 20% error rate). After 11 days of experience, following conventional training, productivity was recorded as 9 minutes per request, with an error rate remaining at 20%. With PSS implementation, training time was reduced to 2 hours, and entry productivity recorded as 4 minutes per request, with an entry accuracy of 98% (2% error rate).

- **Unnamed insurance company**

Description: Use of an integrated PSS, including training and help for customer service employees.

Results: Reduction in training costs of about 60%.

- **Unnamed chemical company**

Description: Use of an PSS to accompany a new system 'roll-out'.

Results: Classroom training reduced; many users learned the application on the job through the PSS. Help desk staff reduced through reduction in help desk calls.

- **GAO**

Description: Use of an PSS to help GAO evaluators produce reports.

Results: Per capita cost of PSS is recorded as \$100, compared with \$900 for traditional training. First year savings recorded as approximately \$250,000; and full life-cycle savings as almost \$2,000,000.

- **Boston Edison**

Description: Use of an EPSS to assist customer service employees.

Results: Recorded as less time away from workplace, and shorter on-the-job training time, with novices performing as experts in comparatively short periods of task-related time. Cost savings given as \$39, 000–\$117, 000, in 1993.

- **IDS Financial Services**

Description: Use of an PSS front end for a legacy system in bank operations; tested on groups of new and experienced employees.

Results: Reported as a reduction task-related errors (ie. 73% for existing employees, 87% for new); reduced time per task (ie. 33% for existing employees, 77% for new); and, reduced training and on-the-job training time (ie. 75% reduction in on-the-job training time).

- **Combat Intelligence System**

Description: The Combat Intelligence System (CIS) is a transportable automated system that supports intelligence staff officers and analysts at US Air Force wings and squadrons. Using the tools and databases in the operational system, the prototype PSS teaches the operators about CIS, the systems with which it interfaces, and the available tools and databases¹⁰.

Results: Not available

- **Armstrong Laboratory**

Description: GAIDA is a case-based, on-line instructional design advisor. The system presents elaborated guidance for the application of Gagne's nine events of instruction to the design of interactive courseware. GAIDA has two modes of operation: Guidance and Lesson. In lesson mode, the user can select from a variety of interactive courseware, using a lesson library or case-base, which offers valid computer-based instruction for a range of learning objectives, and includes various multimedia applications. In guidance mode, the user is provided an explanation of using the nine events of instruction effectively to create meaningful interactive courseware. The explanation is tied to four specific cases currently in the GAIDA case-base allowing the user to jump from guidance mode to lesson mode as required¹¹.

Results: Not available

- **Boeing Commercial Airplane Group**

¹⁰ Reference: <http://mitre.org/capabil/training/tsg/proj/sbyte/sbyte.html>

¹¹ Reference: <http://www.brooks.af.mil/AL/HR/HRT/HRTD/gaida.htm>

Description: An adaptive PSS prototype system for aircraft maintenance, which provides on-the-job access to integrated documentation and training. In this context, extensions to the original system have been made to include multimedia documents; and there has been an evaluation of potential benefits of using performance support in NASA, in the areas of Shuttle maintenance, and astronauts and flight controllers training¹².

Results: Not available

Despite a lack of evidence, there is evidently a growing interest in and commitment to both performance centred design methodologies and products based firmly in PSS technologies. For example, PSS Group is an independent professional organisation that brings together companies and individuals concerned to 'advance the concepts of performance support and performance-centred design, as well as promote the best practices, standards and development tools to advance its implementation' (Lippincot, 1997). This organisation currently lists up to 40 members. Companies that are actively engaged in designing, building and marketing both PSSs and related technologies are wide ranging and include:

- UserTech
- Desktop Support Factory
- TTG Systems Inc.
- RWD Technologies
- RMR Conferences Inc.
- PTS Learning Systems
- Gary Associates
- Consultec
- Beacon Knowledge Group
- Assistware
- Ariel Performance Centered Systems Inc.

Whilst the majority of PSSs described in this Section are centred in the business and commercial worlds, Hemphill (1996), Laffey (1995) and Laffey and Musser (1997) provide some evidence that the interest in the design and implementation of task-based support systems has not been limited to these worlds, especially in

¹² Reference: <http://ic-www.arc.nasa.gov/ja/projects/atm/Pegasus/Pegasus.html>

more recent years. More importantly, they also lend weight to this author's contention that performance support technologies can be designed to support the completion of complex, rather than simple and procedural, tasks; and that this support is likely to lead to gains in both performance and learning measures when applied in instructional environments and intended to provide for educational outcomes. Also, in Laffey and Musser's (1997) work there is an early demonstration of what is likely to become a more common phenomenon—the design and implementation of PSSs in distributed and collaborative systems.

Are PSSs cost-effective?

Almost always, the impetus for the development and use of PSSs in commercial settings is a positive return on investment (ROI). However, ascertaining profitability in PSSs is difficult, since many of their effects may not be directly measurable—for example, they may include enhancements of motivation and confidence, or perhaps increased skills in teamwork or better service provision. Certainly these qualitative effects of PSS use can be valued and this value measured, but the means to do this are not clear cut. There are a number of approaches discussed in this respect, by various authorities in this domain—for example, Phillips (1996a) and Hawkins, Gustafson and Nielson (1997)—some focused on cost/benefit coefficients (ie. arrived at by dividing PSS benefits, by PSS costs); and others on variants on this theme (eg. calculations that omit the initial development cost of the program).

In the case of the LPS there is no need to consider cost effectiveness, although if commercialisation of the software was to be a consideration, ROI might need to be calculated. Interestingly, the application of an appropriate methodology for calculating the ROI of the LPS, may also help refine its use and design, distinguishing between those functions that enhance and those that detract from profitability. For example, providing for functions that prolong use of the LPS without leading to better or quicker learning in task completion, is likely to be a detraction in this regard.

Considerations in designing the LPS

Brown (1996) defines an electronic performance support system as a:

software environment that provides a context within which work is done. Everything needed to do the job—information, software, expert advice and guidance, and learning experiences—is integrated and available, resulting in improved worker productivity and minimal support and intervention by others. (Brown, 1996, p. 6)

There were a number of considerations to make in designing the LPS, so that it might function as a performance support system in the manner described by Brown (1996) and Gery (1991), who both offer probably the most complete and detailed design guidelines for PSSs, as well as that described by others, where a broad consensus can be found in the identification of desirable PSS components (Desrosiers & Harmon, 1996; Gery, 1995; Ladd, 1993; Milheim, 1992; Raybould, 1990; Raybould, 1995). These considerations include:

- electronic support for job task(s);
- support on demand;
- integration of performance and support functions;
- appropriate use of technology.

The first consideration is that it should provide electronic support for the task of lesson planning. In the LPS, such support is provided in the form of explanatory help (for example, how to go about the procedural aspects of planning lessons), descriptions (for example, what experts view as important in lesson planning), and customised templates (for example, of lesson plans) and a number of databases (for example, of verbs to use in writing lesson objectives). In these ways, support in the LPS is both conceptualised and implemented to provide an instructional framework for use in the task of creating a lesson plan, comprising:

- descriptive or declarative information (eg, 'a lesson plan consists of learning objectives, processes and evaluation...');
- explanatory information (eg, 'it is necessary to evaluate a lesson to determine how we might improve later lesson plans, and to measure the level of successful in this one ...'); and,
- procedural information, (eg, 'to create a lesson plan you need to complete four steps—describe your learning objectives, work out the best way of meeting these objectives...').

Secondly, any support provided in a PSS needs to be made accessible at the time of need—a concept often referred to as ‘just-in-time’ support (Brown, 1996; Geber, 1991; Gery, 1991, p. 34), or, as in more traditional software applications, on-line help (Sellen & Nicol, 1990). In the LPS such support is provided as information directly related to the task being undertaken and in a format expected by the student. For example, this might be a sequence of instructions to support the completion of a procedure; or it might take the form of a database of possible objectives for selection and placement into a lesson plan. The range of supporting information available in the LPS is partly tailored according to the on-line help that Sellen and Nicol (1990) suggest should be available in all software applications, to cover questions that are (i) goal-oriented, (ii) descriptive, (iii) procedural, (iv) interpretive, and (v) navigational.

Thirdly, the LPS needs to be integrated in the work environment, so that the task and the PSS are tightly linked. In the LPS, this is achieved by users being able to move freely between both performance and instructional support functions within the LPS operating environment (see Figure 3.1, in Section 3; and Table 2.3.1, below). A more tightly integrated PSS might provide for partial or fully automated error trapping, to detect inconsistencies in any of the data being provided in lesson plan designs. For example, it might be that there are identifiable inconsistencies between (types of) lesson objectives and lesson evaluation strategies, devised in a single lesson plan. Such detection would necessitate the application of software intelligence in the manner described by Self (1990); or perhaps embedded as part of an artificial neural network to model some form of cognitive reflection (Moore, 1997). However, it is currently not feasible, especially for small projects such as the LPS, to design technology applications to facilitate complex cognitive functions such as reflection, directly—this requires the development of sophisticated intelligent tutoring systems.

Indeed, in terms of applying neural networks to PSS technology, Moore (1997) suggests we are still in the early stages of identifying the commercial benefits of the former, and considering how these might be related to PSS design. Of course, this isn’t to deny that other aspects of the artificial intelligence are being applied to PPS, for example in the form of intelligent agents—indeed, Barker, Richards and Banerji (1993; 1994b) have gone some way towards designing a distributed PPS, describing the implementation of intelligent agents based on expert systems

and artificial neural networks, used to locate and share distributed expertise. Furthermore, the same authors also describe the development of supporting technologies to deliver multimedia resources, where the delivery engine has the capacity to incorporate new information, provide a variety of perspectives (or views) onto a knowledge corpus, and learn new perspectives as the requirement arises (Barker, Banerji, & Richards, 1994a). However, the implementation of such intelligence is still some way from easy implementation in PSS tools, such as the LPS.

Finally, the appropriate use of technology is provided for in the LPS, so that its suite of functions may operate on a standard desktop or laptop computer (Apple Macintosh, running operating system 7.1, or greater, with 4 MB of RAM). The technologies in the LPS are presently focused on hypermedia driven informational support and performance tools. It is likely that further enhancements of the LPS might be towards offering greater information currency, where the user may link, on-line, to a wider range of relevant information using distributed information networks available via the Internet. It may also offer multimedia information.

Additional considerations in designing the LPS

In 1995, Ashok Kumar Banerji produced a doctoral thesis concerned with 'Designing electronic performance support systems', completed under the principle supervision of Dr Philip Barker, at the University of Teesside (Banerji, 1995). In this thesis, Banerji used a number of small case-studies to develop a theoretical model predicated on a coherent set of 10 design principles and eight development guidelines for designing and building PSSs. The principles and guidelines that Banerji derives and enthusiastically propagates throughout his work, are not particularly unique or insightful in 1998, except for those few that deal with the actual and potential importance of both individual learning profiles—Banerji (1995, pp. 108, 114) refers to the nature of individuality in learning as incorporating learning styles, learning preferences and learner characteristics—group working and distributed knowledge. Indeed, the principles are largely derived from the literature in this area, and then illustrated by case study projects, rather than vice versa. Banerji's work in this thesis, is of particular interest here for the discussion of the place, value and type of instructional support that should be given to users in PSSs—this discussion is

enshrined in the 'seventh principle of performance support' enunciated by Banerji, that:

Wherever it is feasible, a performance support system should accommodate individual learning styles and thus attempt to maximise its utility for as wide a range of users and task performance situations as possible. (Banerji, 1995, p. 115)

The instructional support considered is premised on the notion that it must be interactive, based in multimedia environments, and be developed according to models of computer-assisted learning (CAL) and computer-based training (CBT), as described by Barker (1989), amongst others. Furthermore, Banerji (1995) goes on to determine, from a study by Barker and King (1993), that there exist ten 'basic perspectives of learning design...which will accommodate the requirements of the needs analysis encountered in most training situations' (1995, pp. 118-119). These are documented as:

- Learning theory mix
- Instructional position mix
- Machine character mix
- Environmental factors
- Mode of use
- Locus of control
- Extent of intervention
- Aesthetic features
- Content
- Role of technology

(Barker, 1994)

Banerji (1995) then goes on to describe a suitable implementation model for these learning design principles, MAPARI, based upon:

- Mimicry
- Apprenticeship
- Practice
- Assessment
- Refinement

- Improvement

(Banerji, 1995)

It is unclear, however, that all PSSs would need to offer the type of instructional support associated with CAL or CBT, since each of these models invariably involves the learner in an instructional setting, where the emphasis is more likely to be on domain understanding rather than task performance. Not all tasks, or all parts of a task, require domain understanding to be completed effectively; and in any case, understanding can, in part, be expected to arise from 'doing' the task itself, supported by a range of non-interactive learning resources. This phenomenon is explained by reference to theories of experiential learning, as described by Kolb (1984) and others (for example, Weil & McGill, 1989). Furthermore, a distinction needs to be made between tasks or sub-tasks that are frequently performed and those that only need to be completed infrequently. The former requires, for task expertise to be satisfied, automaticity in the task, based upon high levels of skill acquisition and domain understanding. However, for the latter, effective task performance can be determined without the need to acquire such automaticity.

The context of design for the LPS

At the core of the LPS is a model of lesson planning required by Edith Cowan University, Western Australia, and wider afield. This model includes essential components of lesson planning such as writing learning objectives, developing learning experiences and planning evaluation (Barry & King, 1993). Each component is supported by activities that instructs the user about the task (eg. provision of information relating to reasons why objectives are necessary, criteria for quality objectives), and which also assist the user in performing the task (eg. provision of a database of verbs to assist in writing quality learning objectives). A set of software tools are available to support each activity. One of these, for example, is a tool designed to engage students' reflective thinking, and aimed at providing them with the ability to evaluate the effectiveness of their completed lesson plan. This tool functions by prompting students to analyse and reflect upon the appropriateness of evaluation processes set in relation to lesson objectives.

It has been suggested that cognitive processes such as reflection can now be provided for in a computer, by applying the use of intelligent advisors or coaches (Winslow & Bramer, 1994). However, despite inroads into the development of these technologies, as described by Self (1990), it apparently remains not possible to design technology applications to facilitate reflection directly. Indeed, where one of the expected outcomes of PSS use is student learning (such as in the LPS), it is probably not desirable to conduct high-level cognitive activity in the computer, in place of this cognitive activity in the learner. Further, present PSS related technologies can mediate and encourage reflection in the student in several ways, such as providing a task-related communication link between learners, providing tools for knowledge and outcome representation during activities (Hedberg, Harper, Brown, & Corderoy, 1994), or simply displaying a record of the learner's activities (Schauble, Raghavan, & Glaser, 1993).

The lesson planning process is viewed in the LPS as an exercise in problem solving. An important factor in solving problems is domain specific comprehension, where Glaser (1984) has suggested one of the features distinguishing a novice from an expert is the incompleteness of the novice's knowledge base, rather than limitations in their processing capabilities; and that the transition from novice to expert performance is largely provided for by the acquisition of a suitable knowledge base (Glaser, 1982). A knowledge base consists of both descriptive and heuristic components—descriptive knowledge is the shared knowledge of experts and practitioners that is usually found in text books, while the heuristic component includes the knowledge of good practice and judgement constructed over years of experience. It is suggested that the description of expert performance should include two related aspects: the information structures and declarative knowledge that are required for performance and the cognitive strategies and procedural knowledge that are required by the task (Kirkpatrick & Wild, 1994). It is in these structures that the instructional and the performance-based knowledge is provided for in the LPS.

Lesson planning is an essential cognitive skill for teachers. Effective lesson planners possess declarative knowledge about themselves as planners, about the task of lesson planning and about ways of going about the task. They also possess domain specific knowledge, such as the criteria for creating instructional objectives, the most appropriate strategies to achieve particular objectives and the range and relevance of evaluation techniques. They know how to plan lessons in

the appropriate way, what is required of them in planning a lesson and they know when and why to perform particular aspects of lesson planning. In addition to this knowledge they have the skills to regulate their own performance, checking and monitoring to ensure they are meeting certain criteria. They also possess the skills and knowledge to allow themselves to correct errors. The LPS is intended to provide a set of scaffolds and structures by which the novice lesson planner can bring to bear these same expert skills in performance in lesson planning that is typical of experienced teachers.

Table 2.3.1 below, describes the functions incorporated in the LPS, as either instructional or performance components. Tables 2.3.2, 2.3.3 and 2.3.4, identify the features of the LPS and describe how each feature is designed to support the descriptive, heuristic and metacognitive knowledge structures that might be expected to be found in human expert lesson planners. It is in terms of use of these components, that the LPS has been designed specifically, to support novice lesson planners in their performance of the lesson planning task, to better their performance, their performance outcomes (i.e. their lesson plans) and also their learning in the task.

Table 2.3.1. Instructional and performance components in the LPS

LPS Components	Cognitive Act	LPS Functions
Instructional Support	Learning	Lesson Structure
		Effective objectives
		Evaluating learning outcomes
		Preparation
		Ways of writing the lesson plan
		Evaluating self
		What is a lesson plan?
		What is a good objective
		Planning methods
		Using the LPS
Performance Support	Task performance	How do I ensure my evaluation will be effective?
		Reflection
		Verb Database
		Example Lesson Plans
		Work Pad
		Example Objectives
		Example Evaluation Processes
		Find Print

Table 2.3.2. Instructional components and knowledge representation in the LPS

LPS Component	Cognitive Act	Knowledge Type		
Instructional Support	Learning	Declarative (D)	Procedural (P)	Metacognitive (M)
		<i>Knowledge about the task</i>	<i>Knowledge about how to perform the task</i>	<i>Perceptions of self as lesson planners, ie. How do I best complete this task?</i>
		Facts Principles Concepts	Procedures	Task processes

Table 2.3.3. Tool components and their representation in the LPS

LPS Component	Cognitive Act	Tool	Knowledge Type
Performance Support	Performing	Reflection	M
		Verb Database	P
		Example Lesson Plans	D
		Work Pad	M, D, P
		Example Objectives	D
		Evaluation Processes	P

Table 2.3.4. Tool components and instructional support in the LPS

Knowledge Type	Instructional Support	Instructional Support
	Think Tool	Help Tool
Declarative (D)	Lesson Structure	What is a lesson plan?
	Effective objectives	What is a good objective?
	Evaluating learning outcomes	
Procedural (P)	Preparation	Using the LPS
	Planning methods	How do I ensure my evaluation will be effective?
Metacognitive (M)	Ways of writing the lesson plan	
	Evaluating self	

Design methodology in the LPS

It is salient to quote Gery's (1995), more recent comments about the lack of design methodologies available for PSSs:

Designers of performance-centered systems are creating new visions of interface design, new performance support structures, and new system functions in direct response to business and user problems and market

competition. Few are guided by a set of integrated and fully articulated design principles. Many innovations are the result of individual or team creativity and iterative design employing rapid prototyping coupled with ongoing useability and performance testing. Articulation and communication of these emerging design structures and principles will be necessary to achieve wide-scale and rapid development of new and powerful software systems that accelerate individual and organisational performance. To date, there is little or no empirical research to explore. While literature citations are available for relevant theoretical underpinnings, the existing definitions and descriptions of performance-centred design are largely a function of individual observations of large amounts of consumer products and personal participation in creative design activities. A chicken and egg observation and formulation process is occurring: I observe and describe products; I then articulate observations and influence product design with clients and software vendors. Essentially, I have synthesised what I am observing in the consumer marketplace because I believe this synthesis of observations portends changes that are necessary and underway in internal systems development. There are, of course, creative designs emerging in large-scale systems development, but the creative results are isolated and generally confined to more one-of-a-kind retail, entertainment, or artistic applications. Innovation is very limited in large-scale software that supports traditional financial, administrative, manufacturing, logistic, and customer service systems. Progress there is incremental and most often focused on improving interface design with new Graphical User Interface (GUI) objects—an admirable but marginal improvement in relation to the overall performance development need. (Gery, 1995, p. 33)

There are no standard or traditional software design methodologies especially suited to designing PSSs, although there are certain features that are recognised to being essential to any one design model or approach taken—for example, a user-centred approach—although many of these features are also suited to the design of other systems (Boyle, 1997; Phillips, 1996b). There are a number of design methodologies available that can serve to guide the development of a PSS, although as Gery (1991; 1995) points out, none provide absolute certainty about the task. However, as indicated earlier, there is guidance available in terms of advice detailing the necessary and desirable components of a PSS (Brown, 1996);

and there is also high-level guidance available, given in the form of questions or principles that designers should consider in their approach to the building of a PSS (Desrosiers & Harmon, 1990; Laffey, 1995; Milheim, 1992). Most recently, Milheim (1997) has provided a review of the issues facing PSS designers, and synthesises a range of statements providing advice and high-level guidance, suggesting both design and development strategies (but not a methodology).

Standard design methodologies available include the 'waterfall model', more typically applied to traditional software engineering (Sommerville, 1989); iterative prototyping, a methodology that has gained considerable popularity of late with a range of commercial software designers, and especially with multimedia designers—a phenomenon that has occurred alongside substantial developments in software modelling and programming tools; and the dynamic systems development method, a typical example and extension of, rapid application development (RAD) (DSDM, 1993). All these design methodologies have features which are attractive and pertinent to the designer of PSSs, and they are all detailed in a range of texts that are geared to hypermedia and multimedia software development (Boyle, 1997; Howell, 1992; Phillips, 1996b; Preece, 1994).

Gery (1997) has recently drawn attention to the major differences between traditional and what has recently become known as 'performance centred design' methodologies, in a bid to ensure that clients and developers in the commercial world come to see the major benefits of the PSS as an alternative design and development methodology to that of traditional software systems:

Advocates must be clear on how these systems are different and what's different about the processes associated with their development to gain sufficient sponsorship to proceed and to create understanding within the IS community about what must be done differently (Gery, 1997, p. 2).

Gery (1997) maintains that most large scale systems development groups have a long and deep data-centric history that has evolved from the heritage of developing transaction systems. Consequently, developers are now to be convinced that they should be creating computer mediated work environments to support tasks, thinking and communications, and that these requirements must be built into both methodology and specifications. Table 2.4, below, represents some of Gery's (1997) major considerations in drawing out the differences between traditional and performance-centred methodologies.

Table 2.4. Traditional and performance-centred design methodologies (after Gery, 1997).

Activity	Traditional Design	Performance-centred Design
Task Analysis	Focus on tasks related to data input, manipulation, retrieval and reporting.	Focus on traditional data tasks plus cognitive, verbal interaction and other tasks currently performed manually.
Contextual Inquiry	Not done—sites rarely visited.	Analysis of entire work context where work is performed, including working conditions, all participants, time requirements, compelling and/or interrupting activities; Conducted via site visits, performer interviews and shadowing performers at work.
Expert resources involved	Management and software sponsors; Expert performers.	Management and software sponsors; Expert performers; Novice performers; Training staff; Documentation staff.
User Interface (UI)	Focused on screens and UI controls; Direct one-to-one relationship between UI and underlying system logic; Must be complete before coding can begin.	Focus on structuring work performance and employing optimal visualisation and metaphor development; Focus on object definition to drive underlying UI and system logic; Design done in parallel to systems development; Task and metaphor changes can occur up to 60% into development; Tweaking of displays can continue until product release.
Support Resources	Viewed as extrinsic (ie. accessible from) or external to the system; Help system structure developed with system; Help and Training developed close to or immediately following project completion.	Design goal: 80% of support intrinsic to the application and provided through the UI; Extrinsic and external support viewed as residual; Support requirements and links defined during UI design.
System Functionality	Defined and frozen prior to development; Additions treated as a 'change' and evaluated based on business impact vs. additional time and development costs.	Baseline determined prior to development; Evolving based on contextual inquiries and detailed work task analysis; Additions treated as 'change' and evaluated based on business and performance development impact vs. additional time and costs.

Although hardly a methodology, Raybould (1997b) paints a more succinct determination of the main differences in the design approach to a PSS or performance tools and the design approach to a traditional information system:

The difference is essentially how the application is designed. A traditional information system application is developed around data screens and may have a help system that helps someone use the application. An EPSS on the other hand is developed around work processes and provides support for how to do the work, not just support for how to use the software. (Raybould, 1997b, p. 1)

Des-Jardins and Davis (1995) list the following pre-requisites for successful design of a PSS:

- commitment to needs assessment and project support;
- cooperation between subject experts and designers;
- the skills of a multi-disciplinary team; and,
- a well-considered plan as to whether the system will be developed from scratch or wrapped around an existing application.

As with Raybould's (1997b 1) generalist views, Des-Jardins and Davis' (1995) requirements hardly count as a methodology, but nonetheless are typical of much of the existing commentary on developing PSS design models. Collis and Verwijs (1995) have refined and extended such 'broad-brush' commentary, to produce a four phase design model, thus:

- Phase 1 involves 'iterative conceptualisation of the product and agreement among the design team, and representatives of potential users, as to what the product should do, be like, and how it will be used'.
- Phase 2 comprises 'iterative clarification of the design through rapid prototyping'.
- Phase 3 sees 'beta-versions of the product, in a from ready for limited field testing and formative evaluation of the product'.
- Phase 4 is the realisable version, complete with documentation and support. (Collis & Verwijs, 1995, p. 24)

Statements of advice, based on relevant and recent experience in PSS development, can be found in a range of publications and more particularly in anecdotal comments, offered in descriptions of actual or potential projects. For

example, Najjar, et al. (1996), have provided some general advice based on their development of 'a simple multimedia EPSS to teach users how to fold a Japanese paper jumping frog' (Najjar et al., 1996, p. 794):

- Use an interdisciplinary design team, including educational technologists, a graphic designer, training experts, and a user interface designer. No one person can have all the skills needed to build high-quality, easy-to-use PSSs.
- Plan for development to take a lot longer than you expect. 'We found that it often took 10 times longer to accomplish a specific development step than we expected'. (Najjar et al., 1996, p. 798)
- Iteration is crucial. 'We also found that we got the most helpful feedback when we asked non-team members to try our system'. (Najjar et al., 1996, p. 798)
- 'Know when to stop, because you can always do more. One of the benefits of using multimedia is that it provides you with a tremendous amount of design flexibility. ...We were constantly tempted to make our system even better, but had to ruthlessly limit ourselves to changes that obviously helped users perform their tasks'. (Najjar et al., 1996, pp. 798-9)

It is unnecessary to further explore the nature of the various design or 'advice' methodologies or the differences between them, except to note that both iterative prototyping and RAD are generally recognised as offering design structures that are particularly suited to small software projects, and where development needs to be strongly influenced by a number of disparate contributors and completed within a short time-frame (Boyle, 1997, p. 187). In particular, it is the progressive structural building and the on-going formative evaluation processes that are especially appropriate to the development of the LPS.

It is for these reasons, and to enable both users (ie. novice lesson planners) and experts to play a central role in the design and development of the LPS, that this project has focused on both iterative prototyping and RAD as preferred design models, although neither have been applied exclusively. Instead, the following principles were used to guide the development of the LPS, but as a framework rather than a strict methodology:

- use of iterative prototyping;
- high degree of active user involvement (although users were not part of the formal design team);

- development is product rather than process oriented.

However, it should also be noted that for many there is a distinct difference between designing performance support systems and designing performance support tools. The difference is largely in the magnitude of the function, where systems refer to 'large-scale applications which automate entire business functions such as sales, production, accounting, maintenance, inventory or customer service' (Malcolm, 1997); and performance tools are indicative of a single task focused application. Of course, it is possible to create a 'cluster' of performance tools as a complete system (Malcolm, 1997). In this sense, the LPS is more clearly a performance tool, rather than a system.

Theoretical considerations in the design of the LPS

There are a number of theoretical considerations that have been made in the design of the LPS. These considerations have been decided upon by addressing the wider literature on new media and instructional technologies and learning, to identify those factors or issues that were likely to be of significance in determining the impact of the LPS on both performance and learning in student-teachers. Of course, it would be possible to isolate a greater range of factors or issues that might have an impact on learning, and in that sense, the ones included here might appear somewhat arbitrary. However, they were identified in the literature as recurring, having recency, and/or being of fundamental significance in the development of instructional software in general or the LPS in particular. The following factors or issues are, in this context, represented here:

- hypermedia
- modelling
- cognitive load
- learner control
- transfer
- context and situation
- constructivism
- interactions as conversation (conversational theories)

Each of these, in the context of the LPS, are considered separately below. This is followed by a discussion addressing the way in which various elements pertaining to these theoretical perspectives have been built into the design of the LPS or otherwise incorporated into its intended or expected context of use.

Hypermedia

There is an assumption made in the design of the LPS, that there is implicit value in the development of information or knowledge in hypermedia structures. That is, much of the cognitive value of hypermedia is directly attributable to the structure governing its application—a semantic or associative network of interlinked information, distributed across a range of media (ie. sound, graphic, animation, video). For example, hypermedia information structures allow for the ‘chunking’ of information, a feature that, in light of information processing theories of working memory, might be seen to support the cognitive processing of knowledge (Biggs & Moore, 1993). There have also been suggestions that in providing for browsing and thematic exploration, hypermedia information facilitates higher order cognitive processes, such as transfer and knowledge application (Jacobson & Spiro, 1995; Oliver, Herrington, & Omari, 1996); whilst at a more conceptual level, there has always been a case made for hypertext mirroring the ways in which much of human thinking occurs—by association rather than linearly or procedurally (Burton, Moore, & Holmes, 1995; Bush, 1945; Minsky, 1975).

However, we need to remember hypermedia or hypertext, as a technology, is only a delivery medium for information or knowledge (Clark & Craig, 1992; Clark, 1983; Clark, 1985; Clark, 1994). Hypertext does not possess a single or normative information structure—hypertext documents are created to conform or fit to a structure, imposed by their authors. At one extreme this structure might be highly ordered, supported by a constrained and sequential set of links; whilst at another extreme, the hypertext may be non-sequential and supported only by referential links. In many cases, a coherent hypertext document, such as a World Wide Web site, might comprise a mix of these structures. It is, then, the nature and application of these structures that determines the effectiveness of engagement with knowledge carried in hypermedia or hypertext. Furthermore, to maximise engagement, the knowledge needs to conform to a structure that best fits or suits both the type of knowledge being conveyed, and the objectives

set by the author for the types of interactions a user should have with it. As Jonassen points out:

Few designers of hypertext believe that hypertext knowledge bases should be unstructured and totally non-sequential so that users would have no guidance about the information they access. Even Nelson (1981) concedes that totally non-sequential hypertext can be disorderly and could lead to "idiosyncratic and exceptional forms of connections". Non-sequential hypertext also results in navigation problems (getting lost in hyperspace), as well as integration and synthesis problems. (Jonassen, 1990, p. 35)

This is the context, then, in which any hypermedia or hypertext information structure needs to be designed. Concern has to be taken to represent the various knowledge types in appropriate structures and to build into these structures sufficient scope for the desired learner-material interactions (Wild, 1997a; Wild, 1997b).

Oliver (1996) characterises the application of hypermedia structures to learning environments as a continuum, where at one extreme the hypermedia structure of interlinked information is a linear one, with information nodes connected in a specified and hierarchical fashion; whilst at the other extreme, information nodes are associated through a referential structure (Oliver & Omari, 1996, p. 50). Thus, if we superimposed issues of learner control over Oliver's continuum of hypermedia structures, at the former level learners would have only minimal control—that is, they would be led through sequences of highly structured information. However, at the latter level, learners would be free to choose their access of information, limited only by the number of referential links engineered between information nodes. Indeed, Oliver and others have extended the association further, by aligning this continuum of hypermedia structures with one describing levels of knowledge acquisition or cognitive activity (Jonassen, Mayes, & McAleese, 1993; Oliver, 1996). So, for example, where learners are intended to acquire low-level knowledge (ie. factual statements, rules, procedures) or engage in low-level cognitive activity (rehearsing, identifying, matching), this is best achieved in a linear, highly organised, hypermedia structure; and where learners are intended to acquire higher-level knowledge (ie. abstraction, transferability, understanding) or engage in higher-order cognitive activity (ie. reflecting, predicting, imagining), this is best achieved in an unstructured or referential hypermedia framework.

Thus, the most notable if not the most distinguishing feature of interactive multimedia software in terms of its educational significance, is this facility to provide for non-hierarchical representations. Interestingly, it was those working with knowledge representation tools who, looking for a theoretical framework in approaches to learning, initially suggested that computer based semantic representation of knowledge perhaps best mirrored the behaviour of certain higher order cognitive activities (Nichol, 1988; Nichol et al., 1988)—a suggestion that finds a basis in Minsky's theory of cognitive frame representation (Minsky, 1975); and, more recently, in mental models theories (Gentner & Stevens, 1983; Glaser, 1984; Johnson-Laird, 1983; Johnson-Laird, 1993; Wild, 1996b). Of course, even if one accepts this premise, it does not automatically follow that using hypermedia structures for knowledge representation will result in better cognitive representations on the part of learners.

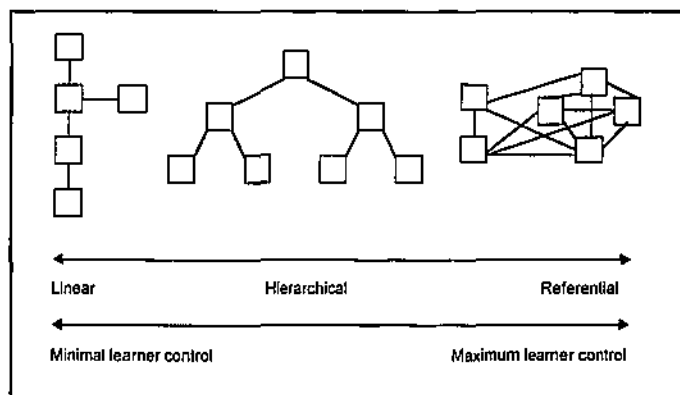


Figure 2.2. Use of hypermedia structures in a learning environment (after Oliver, 1996)

Modelling

The LPS was designed as a cognitive tool and is intended to encourage problem solving through modelling, that is, the building and exploring of qualitative models. In this sense, users of the LPS are encouraged to create models of lesson plans and to explore, test and refine those models. Modelling is an essential component of cognitive activity, of thinking, and for Craik (1943), the originator of the concept of mental models, thinking is concerned with the organisation and

functioning of mental processes and representations (Johnson-Laird, 1993). It follows that cognitive tools must necessarily provide for modelling activity. That is, they must provide the means by which learners can construct, manipulate and evaluate representations of knowledge. The modelling environment needs to be accurate and structural but not necessarily complete, enabling learners to move from their own mental representations of lesson planning to the conceptual model of that process required by an expert. In this process, novices will be able to construct a deeper understanding of a complex domain.

It is generally agreed that although a modelling environment should not be complete it is important that it remains functional; that is, it must provide the learner with some expert knowledge and it must facilitate learner predictions (L.M.M.G., 1988; Mellar et al., 1994; Wild, 1996b). It is the incompleteness of the model that provides the opportunity for construction, reflection and change. In this sense, the LPS provides an environment for learners to externalise their own understanding of the lesson planning process, to identify inaccuracies or insufficiencies in their thinking and to reflect on their cognitive models without expressing a commitment to any one in particular.

Indeed, it is known that mental reasoning (propositional, relational and quantified reasoning) involves the construction and evaluation of a number of possible models to suit particular interpretations of premises to an event, before making a final inference or conclusion (Johnson-Laird, 1983; Johnson-Laird & Byrne, 1991). Since the limitation to inferential processing is the capacity of working memory, the greater the number of models needed for an inference, the harder that inference will be (Sweller & Chandler, 1994). Furthermore, learners will sometimes fail to construct all possible models to for a given event—if they arrive at an conclusion that fits their available beliefs, they will tend not to search for others, with the consequence of overlooking the correct conclusion (Johnson-Laird, 1993; Johnson-Laird & Byrne, 1991). Also, in this context, learners may construct mental models based on seemingly analogous experiences which may compound the construction of misconceived models (Jih & Reeves, 1992). Thus, by providing cognitive tools in the computer, it is possible to provide the necessary means for learners (in this case, student teachers) to externalise their thinking and consequently create strong and accurate models that otherwise might prove elusive.

Cognitive load

The greater the availability and accessibility of information within a given computer environment, the more likely users will flounder as a result of excessive cognitive load or *cognitive overload* and consequently fail to learn. According to Jih and Reeves (1992), learners using a hypermedia system must cope with and integrate three types of cognitive load: the content of the information, the structure of the program and the response strategies available. How learners cope with such a load depends largely on the human-computer interface. For example, cognitive load can be reduced by: (i) reducing the number of options at any one point in the program; (ii) by encouraging users to externalise their thinking, by use, for example, of text annotations and place-marking; (iii) by 'hiding' program options not likely to be needed by most users; (iv) by providing strong visual cues to aid navigation; and, (v) by reducing the number of hypermedia links between information nodes (Oren, 1990).

The means by which users deal with the cognitive load imposed by the LPS is expected to be largely a function of their conception of the lesson planning task as well as that of the software interface. Certainly software features such as on-line help (ie. help, for example, in planning the task) and dynamic structure maps (ie. maps to show a user's position in the hypermedia environment at any one point), are included in the design of the LPS to encourage learners to build strong conceptualisations, or mental models (Jih & Reeves, 1992).

Learner control

Learner control is essentially a reference to that dimension in computer use that describes the level of control exercised by the learner when interacting with a given software item. However, in a research context the term is used to encompass a varied range of concepts, such as student selection of goals and content, time allocations for mastery, sequencing and pacing of instructional materials and units, and student choice of practice items, reviewing and feedback (Niemiec et al., 1997 157, p. 158).

Despite the fact that learner control has been one of the most heavily researched dimensions of computer based education in recent years (Niemiec et al., 1997; Steinberg, 1989), Reeves (1993a) has pointed out that many of the research studies are flawed both in their theoretical and methodological bases. Further, the

comparative effects of learner control produced over a range of such studies appear inconsistent; and also that, in a meta-analysis these effects 'are slightly negative but near zero on average' (Niemiec et al., 1997, p. 169). However, it seems to be popularly and speculatively assumed that the greater the control exercised by the learner (as opposed to that exercised by the software) within a given software environment, the greater or better the level of learning will be. This assumption is undoubtedly a product of cognitivist learning perspectives, and is closely related to the following, fundamental, premises: (i) learners are active processors of information; and, (ii) knowledge is more likely to be successfully constructed when learners have control over the learning process (Rowe, 1993). Indeed, despite equivocal or negative evidence, many reviews of learner control appear to believe, either as a matter of expectation or special insight, that many students benefit from some form of learner control, albeit with the provision that 'the degree or form of learner control must be matched to student maturity, experience and learning preferences' (Niemiec et al., 1997, p. 166)—for example, Oliver (1994) draws attention to research that suggests that unskilled learners fare especially badly in terms of performance outcomes when the degree of learner control is high and external control (eg. control by the program) is low.

Thus, what evidence we do have about learner control is at best contradictory and at worst slightly negative (Niemiec et al., 1997; Reeves, 1993a; Steinberg, 1989). However, some categories of instructional or educational programs are, by their very design, premised on providing a substantial degree of learner control in use. These would include, in particular, learning systems 'designed not so much to instruct as to provide contexts wherein understanding and insight can be uniquely cultivated' (Hannafin & Land, 1997, p. 169). The growth in development of, and advocacy for, such learning systems has been largely the result of a perceived as well as a measured deficiency in more traditional instruction-centred (as opposed to learner- or student-centred) methods of instructional or pedagogical design. More pointedly, direct instructional methodologies, particularly in the design of interactive educational software, have been heavily criticised for failing to provide deep or higher-order learning in students—and especially skills of situated problem-solving and critical thinking (Brown et al., 1989; Hannafin & Land, 1997).

Learning systems designed to promote deep learning include micro-worlds (eg. Logo), 'expressive' modelling simulations (Mellar et al., 1994), resource-rich investigative domains (Reigeluth, 1989), such as databases, and cognitive tool based environments (Jonassen, 1992). In these systems, the motivation is to provide for student-centred learning experiences, and in particular, encourage skills of information retrieval, self-directed inquiry, prediction, reflection and overall, individual meaning-making.

It is in this context that the LPS, designed as a cognitive tool, is intended to provide for learner control over a range of learning processes, including, the instructional materials or tools accessed, time allocated to the task(s), sequencing and pacing of instructional materials and content, and task reviewing. This level of learner control is vested in the LPS as a manifestation of the notion of learning as a dynamic process of reflection-in-action, where the act of completing a task (in this case, planning a lesson) is used to extend thinking in this task, and reflection is governed by the results of action (Schon, 1987). The research program to investigate the effectiveness of the LPS, in part, considered whether the high degree of learner control invested in the software system effects both learning and performance outcomes. Clark (1992), for example, suggests it is likely that a novice user of a PSS will not be able to make appropriate decisions concerning essential knowledge and skills, levels of required practice and sequencing requirements; and that this will lead to inefficiencies in user-performance.

Transfer

Transfer in the context it is used here, can be regarded and described as a maintenance of learned performance in like situations—which, in terms of this research, is lesson planning conducted over different media but within similar tasks (Tessmer & Richey, 1997, p. 99). The development of the LPS supposes that students, by using the LPS will come to understand the processes involved in lesson planning, and be able to develop performance skills in the planning of lessons both through their use of the LPS and also by conventional means (eg. pen and paper).

Transfer has been described as a continuum between far and near transfer, where near transfer is determined by a closeness or similarity between training or learning and application of that learning through task-related behaviours.

Conversely, far transfer is seen to involve considerable dissimilarity between training and application and where strength in transfer requires the generalisation of learning to contexts other than those presented or used in instruction and learning (Royer, 1979). A significant finding in transfer of learning research is that where there are common factors in the content or procedures in carrying out two tasks, or between learning and application—that is, near transfer—successful transfer is more likely (Child, 1981). However, others have suggested that transfer is largely determined by the context of transfer, rather than similarities between elements of the task(s) and learning or training. For example, Tessmer and Richey (1997) have determined that what they call the 'transfer environment' or 'transfer context' (Tessmer & Richey, 1997: 99), requires three elements be intact for successful transfer to occur:

- opportunities to apply the learning in the transfer context;
- motivation by the learner to apply the learning; and,
- cognitive and social supports to perform the task.

The transfer context here, encompasses student s' development of lesson plans following their use of the LPS, and is focused on their using conventional media. The elements of the transfer context, described above, are largely a function of the methodology employed in this research programme, and these have been designed to maximise the possibilities for transfer to occur. For example, students are given authentic opportunities over an extended period, to promote retention and skill habituation in their development of lesson plans, with and without the support of the LPS (Quinones, Sego, Ford, & Smith, 1995). The research programme and particularly data collection procedures, provide students with an 'opportunity structure' to practice and deliver a large number and range of lesson plans by use of the LPS, and within a pen-paper medium. Furthermore, the opportunities for transfer designed in this research programme, are largely free of 'transfer impediments' or 'transfer interference' (Tessmer & Richey, 1997, p. 101), and although there will exist some pressures on students to produce lesson plans for implementation in real classrooms, this is seen here as a motivational factor rather than a pressure or impediment.

Again, students will have both cognitive and social supports in the transfer context—supervisors to these students are all enthusiastic about the students using the LPS to both learn and perform lesson planning tasks, and alongside the

researcher, have agree to provide a 'sympathetic ear' and support to students working in the pre-transfer climate (ie. whilst using the LPS), and the transfer context itself (ie. whilst students are using pen-paper means to write lesson plans). Specifically, cognitive supports, first provided within the LPS, were subsequently made available to students in the transfer context, by access to peers, supervisors and by use of other resources (such as textbooks, exemplar lesson plans, etc.,). Situation cues to for students to use certain skills or knowledge, are built into the LPS; in the transfer context, these were available from supervisors and the researcher. Motivation in the transfer context, is generated by the authentic nature provided to the lesson planning tasks—the transfer context involves the students creating lesson plans for implementation in real-world classrooms, during a period of professional practice in schools. Moreover, all lesson plans will be subject to scrutiny by supervisors, as part of the supervising process for all students in the professional practice programme at Edith Cowan University.

To facilitate transfer of learning, or as in this case, transfer of learned performance, the metaphor that guides the design of the human-computer interface is provided by traditional lesson planning: the LPS environment (ie. the pre-transfer context) in which students plan their lessons makes use of identical terms and elements to those encountered in the pen-paper process (Barry & King, 1993). It was expected that students undertook the performance aspects of the lesson planning task using similar methods, whether they were working with the LPS or pen-paper media. Furthermore the amount and type of human-computer interaction expected by use of the LPS (for both the performance and supporting functions of the LPS) was intended to approximate to that between learner, lecturer and other supports (eg. information sources) in a traditional context.

The design of this research programme was intended to provide some indication of the level of transfer in learned performance, from computer-based task completion using the LPS, to paper based task completion without recourse to the LPS. In particular, data were collected to investigate patterns of student use in the various functions of the LPS, which might help determine how transference is effected in learned performance in the same task over different media.

Mapping instructional design and learning in the LPS

The LPS is a product that seeks to implement a certain approach to instructional design, based fundamentally on the concepts and theoretical constructs related to cognitive tools in learning, and performance support systems in performing complex tasks. However, clearly the instructional design in the LPS involves more than these concepts and constructs alone—the design features a number of theories of learning (notably situated cognition and information processing theories) in its development.

Invariably, we need to look towards educational theories, or more accurately, theories centred on learning, to engage and underpin approaches to instructional design, whatever the context or focus of the instruction (Wild & Quinn, 1998). To what extent, however, should a given instructional approach reflect a holistic and integral view or theory of student learning? Is it appropriate, for example, to approach the design process eclectically, using a mixed bag of theories or frameworks to rationalise a particular instructional design? Whatever the answers to these questions, there are a number of theoretical frameworks that deserve particular attention in this context; indeed, each of these frameworks have been considered in the model used to inform the design of the LPS.

What is meant by 'learning'?

In the context of this research, learning it is suggested, should be seen in terms of cognitive change. That is not to suggest that other learning of an affective or psychomotor sort is not of importance, or that interactive multimedia does not provide for such learning—but rather, in tertiary contexts at least, cognitive development in learners is perhaps the central aim of most instruction.

Context and situation

Situated learning as a theoretical construct came to prominence with the publication of several articles in the later 1980s (Brown et al., 1989; Collins, 1989; Collins et al., 1987; Collins, Brown, & Newman, 1989), the first of these originating as technical reports from the Centre for the Study of Reading at the University of Illinois. As Herrington and Oliver (1997b) have since observed, the theory seemed to quickly capture educators' imaginations 'with its foundations in the apprenticeship system and its emphasis on the importance of learning

within the context of real world applications' (Herrington & Oliver, 1997b, p. 127). The theory has since been applied widely.

The article published in the *Educational Researcher* by Brown, Collins and Duguid in 1989, provides an effective articulation of the theory of situated learning, being predicated on several research studies (Brown et al., 1989). This, above all others, has been the article most readily identified as representing the popular birth of the theory. Essentially, this article demonstrates that the learning of knowledge cannot be separated from the situations in which it is used, with the implication that knowledge can be regarded as a tool:

We should abandon once and for all any notion that a concept is some sort of abstract, self-contained substance. Instead, it may be more useful to consider conceptual knowledge as in some ways similar to a set of tools. (Brown et al., 1989, p. 5)

Brown, et al., further argue that knowledge can only be learnt successfully in authentic activities, or in other words, the genuine application of knowledge; and that the power of situating learning is in contextualising it, where a learner's experience in an authentic activity is the unifying context for coming to know a problem exists, identifying a solution to that problem by the application of knowledge, and applying the solution.

Others have served to consolidate the work of Brown, Collins and Duguid (1989). Lave (1988) argues that learning as it normally occurs outside of formal settings, is a function of the activity, context and culture in which it occurs (ie. it is situated). This contrasts with traditional classroom learning activities which usually comprise a series of abstracted knowledge statements and are delivered out of context. Furthermore, Lave and Wenger (1990) maintain that for learning to be maximised, social interaction must be a critical component of situated learning environments, where learners are encouraged to enter a 'community of practice' embodying the practices and culture pertinent to a particular domain and which are essential to performing successfully and expertly within that domain. As novices move from the periphery of this community to its centre, they become more active and engaged within the culture and hence assume the role of expert. This process is what Lave and Wenger (1990) call 'legitimate peripheral participation'.

Brown, Collins and Duguid (1989), Collins (1989), and Collins, Brown and Newman (1987) emphasise the notion of cognitive apprenticeship, a concept which recognises the role of students in acquiring, developing and using cognitive tools in authentic domain activity, and premised on key elements extrapolated from more traditional trade apprenticeship models. Consequently, it is suggested, teaching methods should be designed to give students the opportunity to observe, engage in, and invent or discover expert strategies in context, so that they might best learn both cognitive and metacognitive skills (Berryman, 1997; Collins et al., 1987). Suchman (1988) has also explored the theoretical frameworks of situated learning and cognitive apprenticeship in the context of artificial intelligence.

Situated learning, as a general theory of knowledge acquisition, has for some time now been advocated and applied in the context of technology-based learning activities that focus on problem-solving skills, particularly for school education (Cognition and Technology Group at Vanderbilt, 1990; Cognition and Technology Group at Vanderbilt, 1992; Cognition and Technology Group at Vanderbilt, 1993; Harper, Hedberg, & Brown, 1993). More recently, there has developed a growing advocacy for similar applications to be made to the development and use of instructional technologies by students at university level (Herrington & Oliver, 1995; Herrington & Oliver, 1997a; Herrington, 1997; Young, 1993); and, similarly, for students working in formal training situations (Chandler, 1997).

Thus, it is now often argued that context and situation are all important in providing for learning at all levels, and should influence in particular, the design of instructional multimedia (Herrington & Oliver, 1995; Herrington, 1997). It is not clear, however, that the concept of situated learning allows for the levels of abstraction required for understanding in many domains of knowledge, particularly those studied by university students. For example, Merriam (1993) describes how locating or situating activity in experience is by itself not sufficient to result in meaningful learning—that is, learning that is transferable or generalisable. Similarly, Laurillard (1993) argues cogently that learning in situated contexts does not, by itself, allow for a learner to make abstractions from the particular context and therefore be able to generalise or even be able to apply what is learnt to new situations or contexts. This has, in particular, an important implication for learning what Laurillard classifies as ‘academic knowledge’—she

considers academic knowledge to be different to everyday knowledge, drawing a distinction between learning 'percepts' in everyday life and learning 'precepts' in education, implying that learning precepts necessitate students building understanding in a deeper (abstract) sense, a level of understanding which cannot be provided for simply by situating the learning experience (Laurillard, 1993).

Constructivism

There exist a range of theories concerned with the way in which students learn which together inform what is usually meant by 'constructivism'; some theories emanate from a cognitivist tradition, others from a social psychological, interactionist or experiential perspective (and the list could go on). However, in much of the current and recurring debate about the role of educational and learning theory in instructional technologies (especially multimedia and hypermedia), there seems to be a readiness to polarise one theory of learning (behaviourism) with a meta-theory (constructivism), and, further, to present the former as grossly deficient and the latter as singularly credible in explaining student learning.

The difficulty here is that such a polarisation is entirely philosophical, and as such represents fundamentally different views on what is meant by knowing, the role of education and the nature of learning. The polarisation, outside of a philosophical debate, is certainly not helpful in determining effective instructional design. For example, even although the main components of behaviourism (or at least the behavioural theory of Skinner) were largely discredited as general truths in the 1970s, the principles of contiguity, repetition, reinforcement through feedback and motivation are still recognised as important in processes of learning (Entwistle, 1987). Indeed, there are various dimensions in different theories of learning, and not all fit along an imaginary continuum connecting two supposed extremes—this is where Reeves' work (1992; 1994; 1996b) on the evaluation of instructional technologies is possibly misleading, since it is predicated on the existence of such a simplistic continuum. If we need a metaphor to represent learning or educational theories as a whole, a series of corresponding and opposing objects, each with its own attributes, some common, some unique, is ultimately a more accurate and useful metaphor than a simple, linear path connecting two poles or extremes.

Perhaps the overriding point is that, in designing and evaluating interactions in hypermedia structures, we must be prepared to refer to explanations of student learning to describe the most appropriate way of addressing a particular learning situation. Also, that all theories or explanations of learning, be they psychometric, humanistic or behaviouristic, are each credible in helping to understand certain kinds of learning; but that each theory is also partial in that it refers to a limited range of learning situations and that it is often based on a limited set of data.

Interactions as conversation

From the phenomenographical research of Marton, (1984; 1988), Saljo (1984) and Thomas and Harri-Augustein (1985), it is useful to consider the notion of the ultimacy of individuality in learning, that learning is different for individual learners; and that learning involves a negotiation of meaning (in the form of conversation), within and between learners, which leads to understanding. To describe what is successful in learning, in this context, is to describe successful interactions between learner, context and instruction. Thus, it is not possible to distil from such interactions a set of prescriptive conditions of learning since the interactions that might be described will be rooted in a particular context and therefore are likely to be context specific and non-generalisable (Tessmer & Richey, 1997).

One way of embracing the findings of phenomenography and using these to provide for a new model of instructional design, is to conceptualise the computer as tool to engage the learner in interactions—principally with their own meanings or understandings, as well as those of others, in order to build a more complete, richer, understanding. This notion is not especially new, and it has a theoretical base in mental models theory. Johnson-Laird (1983) explains mental models thus:

Understanding certainly depends on knowledge and belief. If you know what causes a phenomenon, what results from it, how to influence, control, initiate, or prevent it, how it relates to other states of affairs or how it resembles them, how to predict its onset and course, what its internal or underlying 'structure' is, then to some extent you understand it. The psychological core of understanding, I shall assume, consists in your having a 'working model' of the phenomenon in your mind. If you understand

inflation, a mathematical proof, the way a computer works, DNA or a divorce, then you have a mental representation that serves as a model of an entity in much the same way as, say, a clock functions as a model of the earth's rotation. (Johnson-Laird, 1983)

By providing an interactive, hypermedia environment in the LPS, which is able to accommodate learners' representations or models of lesson planning and allow for predictions, explanations and evaluations, then we are providing the means by which learners can represent, explicitly, their own understandings in this complex domain, interact with others' (teacher's or students') representations and come to understand a range of conceptual meanings in relation to their own. The LPS, in the shape of a cognitive tool, allows the learner to externalise their thinking, to enrich it, manipulate it and change it, all by interacting with one or more conceptual models on the computer, in the form of a dialogue (where that dialogue is real and conducted with others, or where it occurs in the learner's head).

Thus, instead of designing instruction in the form of predetermined instructional goals, each matched with an artificially constructed learning event (Gagne, 1977), it is possible to enable the learners themselves to design by expressing their representations or models of understanding, and by doing so, engage in meaningful cognitive interactions. Jonassen and Reeves (1996) describe this process thus:

Instead of specialists such as instructional designers using technology to constrain students' learning processes through proscribed communications and interactions, the technologies are taken away from the specialists and given to the learners to use as media for representing and expressing what they know. (Jonassen & Reeves, 1996)

Jonassen and Reeves (1996), appear to limit their view of what constitutes a cognitive tool on the computer whilst the view taken here is perhaps more inclusive and centres on the use an item of software is put to, rather than on its characteristics (eg. see an earlier discussion on this subject). Thus, for software that is designed to act as a cognitive tool, it is important, in terms of mental models theory, to allow for the building of computer models, which are beneficial to the processes necessary in constructing accurate, appropriate and enhanced mental models (Wild, 1996b).

Building learning theory into the LPS

Clearly, the role of learning theories in designing for instruction and learning in the LPS, is a multifarious one. There is not a single theoretical approach to the design task that can be seen to be satisfactory; indeed, since all theories of learning are partial in their explanation of student learning, they must be used collectively to help inform the design task. Equally clearly, however, the choice of theories used to inform the design need to lie within a cohesive and coherent overarching framework, one that accounts for and describes the learning experience, rather than prescribes it. So, in this sense, the LPS attempts to put into place, within its design, a discursive model of teaching and learning, (Figure 2.3), (Laurillard, 1995, 100; Marton et al., 1984; Marton & Ramsden, 1988). The elaboration of this model and its implementation in the LPS, is described in Table 2.5.

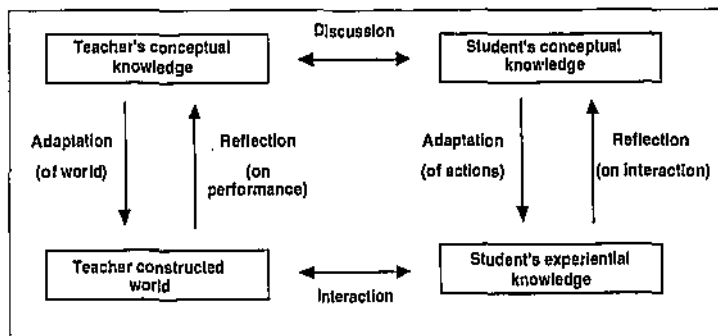


Figure 2.3. A model of the teaching-learning process used to inform the design of the LPS (after Laurillard, 1995).

Inherent to this model, is the notion of dialogue or conversation. Obviously, in the use of the LPS, it cannot be assumed that there will be real dialogue, between two or more learners (although this might occur); yet there does exist the possibility for developing dialogue *within* a learner. Thus, in the sense of creating a conversational framework, particularly as it is interpreted and applied by Laurillard (1993; 1995), Pask (1976), Ramsden (1992), as well as by Vygotsky (1962), where dialogue is seen as a mediation between the known and the

unknown or between the learner and the object of learning, the LPS does provide a workable model. Indeed, in this context Laurillard specifically determines that:

...dialogue may never take place explicitly between teacher and student. It could be a purely internal dialogue, with the student playing both roles.

(Laurillard, 1995, p. 104)

Table 2.5. Elaboration of the instructional design in the LPS.

	System (teaching-learning) components		
	Reflection	Adaptation	Interaction
Principles	Learning environment facilitates reflection on descriptions and actions.	The relationship between the expert's and student's conceptions must be the basis of continuing dialogue.	Students should explore and express experts' and their own descriptions and actions in the domain. ¹³
Strategic implementation in LPS	Provide scaffolds in the form of tools and information resources, to encourage meaningful reflection.	Prompt students to adapt their actions in line with task requirements and expert models.	(i) Provide expert models of domain knowledge; (ii) Provide the means for students to articulate their own knowledge.
Example practical implementation in LPS	Provision of a set of reflective statements in the 'Reflection Tool' that need to be actively considered (by 'licking' a check-box) when completing each lesson plan.	Provision of resource support (eg. verb database) and instruction (eg. segment advising on what constitutes a good lesson plan), that allows students to create all parts of a lesson plan with guidance.	(i) Provision of example lesson plans as Word templates, to be explored as a model of lesson planning; (ii) Provision of means of creating and exploring original lesson plans in a Word document.

¹³ There is no opportunity in the LPS for the provision of real feedback (which is, of course, an attribute of true interaction). However, the process of dialogue that is intended to occur in the student's head at this level of usage, might be seen to operate as feedback.

Thus, dialogue in the LPS was designed within a conversational framework of teaching and learning, and provided for the cognitive strategies of adaptation and reflection, occurring in the student at the level of description (ie. in the student's head—for example, critically reviewing an aspect of a lesson plan) and action (in the student's actions—for example, adapting a lesson plan upon critical review).

In this light, the LPS is designed to possess certain pedagogical characteristics by virtue of the provision of both tools and information resources (to support performance and instruction), to encourage and/or determine learners to conduct dialogue (within themselves) by a process of:

- reflection—critical review of conceptions and actions;
- adaptation—taking and adapting actions;
- interaction—with descriptions of the domain world.

Conclusion: Conceptualising a research framework

The aim of this research was to, (i) design and implement an innovative instructional model for hypermedia development; and, (ii) investigate the nature and effectiveness of this model.

The LPS invokes an instructional design model that is centrally founded in cognitivism but also acknowledges the need to look beyond information processing theories concerned centrally with memory, to provide an inclusive, eclectic and multi-dimensional approach to the design process. Indeed there are a number of theoretical levels at which this approach can be elaborated; these have been described above. However, it was not intended in this research program, to test any one of these theories, but rather at a more general level, to develop a holistic rationale for the development and application of performance support tools for learning in complex knowledge domains.

The framework in Figure 2.3, and elaborated in Table 2.5, above, closely aligns the development of a principled teaching strategy to the instructional design within the LPS, as a PSS. The teaching strategy is derived, in part, from Laurillard (1993; 1995). It is empirically based, having foundations in diverse research findings:

Its empirical base derives from discovery rather than hypothesis-testing; it uses qualitative rather than quantitative data; and it produces descriptions rather than explanations. (Laurillard, 1993, p. 82)

Moreover, it contrasts markedly with conventional instructional psychologies, such as those developed by Glaser (1987), Gagne (1977) and Merrill (1991), amongst others. The basic design principle, is to think in terms of what the learner must do (performance) and how the teaching should support the them (instruction)—and to describe this within a system (Laurillard, 1995, p. 186).

Arguably, this system finds an entirely appropriate expression in the theory of cognitive tools and in performance centred design methodologies. The LPS is an embodiment of this expression, and is intended to provide for improvements in performance in novice students in lesson planing. The nature of use of the LPS, intended to operate both as a cognitive tool and a PSS, provided the focus for this study.

SECTION 3

Design and development of the LPS

Introduction

This Section provides an account of the design and development of the LPS, together with an account of the history of the software development project.

There were three distinct stages in the design and development of the LPS:

1. Identification of desirable features in the LPS.
2. Iterative design and development of these features as components in a coherent software model.
3. Formative evaluation of the LPS to determine the behaviour of the features.

Whilst the LPS cannot be determined by all objective measures to be the optimum tool for novice lesson planners, it was designed, developed and evaluated within available guidelines for building PSSs, and in accordance with an operational understanding of cognitive tools. Also, in line with the design and development methodology employed to build the LPS, the software underwent a number of revisions as a result of iterative, formative and 'impact' feedback. The principal stages in this process are documented below.

Stage I: Identification of desirable features in the LPS

This was achieved by two approaches: the first involved using relevant literatures to help predict the cognitive processes that are necessary to the completion of a complex task, such as lesson planning, and then outlining the nature of the software tools and information resources that might best support these processes.

The second approach utilised focus group interviews of both novices and experts in lesson planning to determine the most efficient ways and means of creating lesson plans, together with identification of the shortcomings in lesson plans presently constructed by first-year (novice) undergraduates at Edith Cowan University. Part of this approach was akin to that followed in a similar exercise to elicit expert information in instructional design project management, by Klimczak and Wedman (1997). Three experts in lesson planning (ie. lecturers who are currently teaching lesson planning to Edith Cowan University undergraduates), were individually interviewed to identify the elements deemed important in the process of creating lesson plans, with special emphasis given to those elements which undergraduates, as novice lesson planners, often had difficulties with. Each focus group interview was held for approximately one hour; and data were collected in the form of a transcription of an audio tape recording of each interview. The interviews followed no fixed pattern, were open and provided a framework within which the experts could express what they thought to be significant elements in the lesson planning process (Patton, 1990, p. 24). Following individual focus group interviews, a composite listing of desirable features in the LPS was extrapolated from the transcripts of each interview and closely based on the lesson planning process elements given. This list was then given back to the three experts as the focus of a round-table discussion, lasting approximately 45 minutes, with the aim of addressing any omissions or misinterpretations and validating the features as described. Following this discussion, a final list of features was drawn up.

Alongside this process, three students who had not previously completed any lesson planning of any type were independently observed undertaking the writing of a series of lesson plans (eg. approximately three lesson plans per student) over two sessions, each session lasting approximately 30 minutes for each student. The resulting lesson plans were then used as a focus for a group

discussion between all three students and observer. In this focus group, the students were asked to discuss and develop a composite listing of those parts of the process in their lesson planning which had been problematic in any way, or which might be profitably supported by tools or information—advice was given, when requested by a student, as to the possible function and nature of operation of these tools when implemented in software.

This approach, informed by novice and expert lesson planners, has collectively resulted in the identification of a set of procedures by which effective lesson plans might be created by novices in this domain, together with the information resources necessary to support their creation. The two sets of data (i.e. focus group interviews of experts and novices, and literature review) have been used to determine the features or components of the LPS necessary or best suited to the task of lesson planning by novice students in this domain. In fact, the data revealed a preferred model of the lesson planning process that has since been represented in the LPS. This model can be seen as a process that focuses on five questions. These questions are given below, together with statements which explain their meaning and, in some cases, their original context in either the experts' interviews or novice's focus group discussion.

1. *What background facts need to be considered in planning this learning experience?*
The student teacher needs to determine the context to the topic or theme to be taught, as well as the abilities, needs, interests, skills and understandings that students will bring to this lesson.
2. *What should the students learn as a result of this learning experience?*
The student teacher should identify a wider goal (i.e. expressed perhaps as an intent or aspiration) as well as specific objectives for the lesson. Objectives are best stated as what learners should be able to do, or do better, as a result of having worked through this lesson (Rowntree, 1990, p. 44).

The experts' interviews revealed a range of possible objective types, from general through to specific, but favoured the need for beginning or novice student teachers to describe objectives written in terms of observable learner behaviours or learner performance, under specified conditions and within stated parameters. For example: 'Working in a group of three, describe three different ways you can get to school'—this objective specifies conditions (i.e. working in a group of three), the

expected behaviour (ie. describe different ways you can get to school) and parameters of that behaviour (ie. *three* different ways).

The experts' interviews also revealed a discrepancy between statements of learning objectives as descriptions of observable learner behaviours or performance, and learning objectives given as descriptions of outcomes, or 'outcome statements', where in the latter case, emphasis is placed on outputs or outcomes attained by students, rather than on inputs to be applied by teachers. However, the experts' interviews determined that outcome statements could still be taken to be descriptions of learning, often expressed as observable behaviours, but on a predetermined continuum of development, often originating in national or state curriculum or policy statements (Marsh, 1995).

Objectives can be of three different domains—cognitive, affective, or psychomotor—and within each of these domains be at a specified hierarchical level of performance (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956; Harrow, 1972; Krathwohl, Bloom, & Masior, 1964). For example, in the cognitive domain there are six levels of performance, from knowledge (lower order) to evaluation (higher order), (Bloom et al., 1956). These six levels can be used to organise corresponding levels of verbs that might be used to invoke appropriate descriptions of specific behavioural objectives (for example, see Table 3.1), as with those provided for use in the LPS.

It is clear from the novice's focus group discussion that it is not always possible nor desirable to express learning objectives in behavioural terms—for example, when planning for a learning experience that is entirely creative, or one that is expressive or exploratory and should not have delimiting or restrictive operators on the scope of the experience. However, in the final analysis, it would seem that a prime characteristic of expertise in lesson planning, is knowing when to apply learning objectives that are behavioural and when to use non-observable or less precisely stated objectives.

Table 3.1. Verbs provided in the LPS, based on Bloom's (1956) cognitive domain.

Knowledge

define	describe	list	state	identify
recall	name	show	write	match
tell	locate	relate	acquire	outline
label	underline	select	recite	measure

Comprehension

explain	interpret	compare	contrast	read
illustrate	infer	estimate	give example	specify
distinguish	summarise	represent	indicate	

Application

use	calculate	construct	apply	solve
mark	demonstrate	perform	predict	find
change	make	compute	order	manipulate

Analysis

analyse	classify	categorise	detect	hypothesise
differentiate	breakdown	compare	contrast	separate
diagram	discriminate	relate	sub-divide	select

Synthesis

create	develop	propose	plan	design
combine	compose	produce	relate	conclude
categorise	compile	devise	explain	organise

Evaluation

choose	decide	evaluate	compare	justify
discuss	judge	debate	consider	assess
criticise	support	determine	contrast	defend

3. *What knowledge, concepts or skills have to be covered in the learning experience?*

This refers to the sequencing of instruction, in terms of the underlying structure of the content material of the lesson. There are three clear guidelines to the development of answers to this question:

- (i) start planning with students' prior knowledge or previous learning;
- (ii) work from the concrete to the abstract in structuring the content to be learned, particularly for younger children;
- (iii) break the content into discrete yet related 'chunks' or smaller parts, to allow more easily for processing and particularly for mastery learning (Biggs & Moore, 1993; Miller, 1956; Simon, 1974).

4. *What experiences will help students learn in this domain or subject?*

Here the student teacher is intended to consider the strategies (ie. the organisation of the learning experiences) that are to be devised to meet the learning objectives. This strategies would be chosen to suit the learners' ages, abilities, interests, skills and needs.

5. *How can I best know what the students learn as a result of this learning experience?*

Evaluation might occur before instruction (ie. as a diagnostic tool), during learning (ie. as formative evaluation) or after learning (ie. as summative evaluation). Each type of, or approach to, evaluation can be catered for by the use of various techniques—some of these are described below:

- (i) Diagnostic evaluation: use of a standardised test (pre-test); use of student observation over a specified period of time.
- (ii) Formative evaluation: questioning students about their understanding; commenting on students' work whilst they are completing the lesson; student demonstration of their understanding; students conducting self-assessment.
- (iii) Summative evaluation: marking completed student work; use of a standardised test (post-test); student interviews; profiling students.

Stage II: Components of the LPS

As in any standard design for a performance support system, there are two major types of components to the LPS: the first are support or performance tools (also classifiable as task-support tools); the second, instructional sequences or items. In addition, there is a 'help' facility, which can be classified as an instructional aid (see Figures 3.1–3.4, for a view of the interfaces that provide access to these elements). The primary difference between performance-support and instructional-support components in the LPS, is one of operation. For example, performance-support functions provide dynamic access to information, templates and generic tools (ie. the Work pad), to allow users to implement information directly or indirectly into their lesson plans. Alongside and in addition to these dynamic tools, is the provision for a standard series of other tools (such as 'save' and 'print') that allow for the manipulation, in various ways, of the students' work. Conversely, the instructional information is not primarily intended for students to embed into their work, but rather to inform both their performance and understanding of lesson planning.

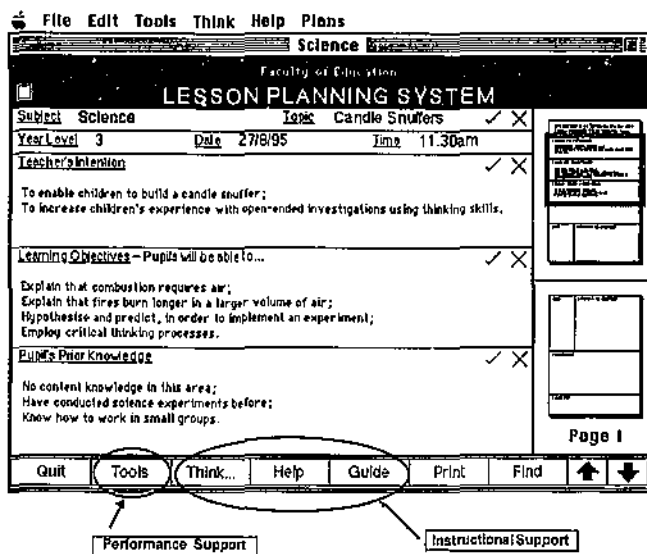


Figure 3.1. The provision for performance and instructional support in the LPS

The components provided in the LPS, together with their relationship to desirable knowledge types and their corresponding means of representation, are described in Tables 2.3.1–2.3.4, in Section 2. The components represented in the LPS also correspond in particular, to those knowledge types suggested by Brown (1996) and Gery (1991) as being desirable in PSS knowledge base development.

Figure 3.1 illustrates how access is provided to the performance-support and instructional-support components in the LPS. Figure 3.2 further demonstrates the nature of access to the informational components, including the Work pad, Verh database and various Examples' frameworks, all of which allow users to implement information directly or indirectly into their lesson plans.

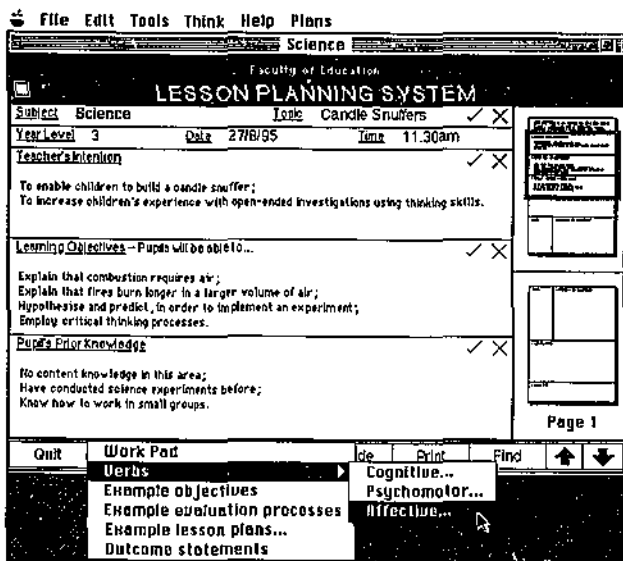


Figure 3.2. The range of informational tools provided in the LPS

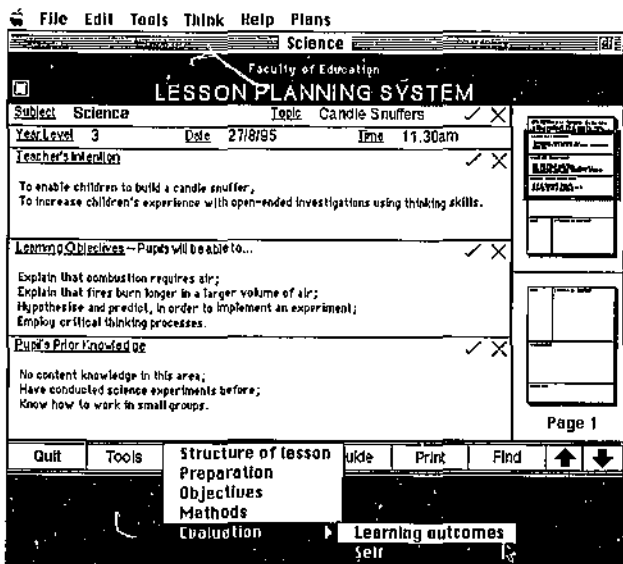


Figure 3.3. The range of instructional sequences or items provided in the LPS

Figure 3.3 shows the range of instructional sequences or items available in the LPS, including those for lesson preparation, lesson structure, teaching methods and lesson evaluation. Figure 3.4 illustrates the provision for 'help' facilities in the LPS, including basic such as 'what is a lesson plan', 'What is a good objective', and 'How to ensure lesson evaluation is effective'.

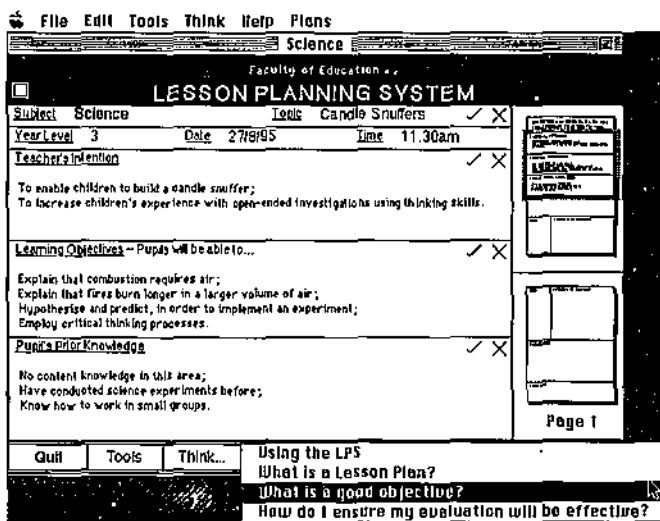


Figure 3.4. The provision for 'help' facilities in the LPS

Stage III. Formative evaluation of the LPS

An initial, formative, evaluation of the operation of the LPS, in terms of its original design specification was completed. The LPS was used by four novice student teachers whilst in their first year of study enrolled full-time in an Education degree, over a period of four weeks prior to fulfilling a course requirement of two weeks teaching practice at local primary schools. Use of the PSS was provided to these students both in and outside the university campus. These students were interviewed individually (for approximately 30 minutes) using a semi-structured set of questions, immediately following this four week period, to establish broad patterns in students':

- (i) patterns of usage;
- (ii) perceived result of usage;
- (iii) difficulties in usage.

Patterns of usage

All students revealed an increasing reliance in their usage of the LPS, on the support tools, particularly the Verb Database, example lesson plans and the lesson planning template, together with print and save functions that are inherent to the software. Correspondingly, a decreasing amount of time over the four week trial period was spent in the instructional components of the LPS. Reasons given for this pattern of usage were of two categories: the first set of reasons suggested that students quickly absorbed what was required of them by the system, to be able to perform the task competently; or, that students seemed to quickly understand the concepts in the domain of lesson planning, so they did not consider it necessary to return to the instructional components. Interestingly, one student suggested that his understanding of the use of the system was mistaken, and that he had originally set out, before all else, 'to look for the test' in the software, being convinced that there would be a test somewhere in the system!

By asking students to expand on these responses, it appeared that at least three out of the four students became aware, over no more than 3–4 occasions of use of the LPS, that they did not need to know much about lesson planning to perform the task, only 'how to go about using the software'. This suggests that students perceived themselves able to complete the task competently, without having to learn about aspects of the task—in other words, they used the LPS to learn how to perform the task (procedural knowledge) without spending effort in learning about aspects of the task (declarative knowledge). This also infers that these students quickly applied metacognitive strategies to regulate their usage of the LPS, concentrating on using those system functions that enabled them to competently perform that task of generating a lesson plan, without undue recourse to pushing the boundaries of their knowledge to understand about aspects of the task. For example, two students described that they were able to generate a large number (ie. 8 and 14, respectively) of lesson plans more quickly, by 'always starting writing out a new lesson plan with the previous lesson plan', and only altering those aspects of each lesson plan that distinguished it from others they had previously planned. Indeed, whilst this approach to the use of

the system was undoubtedly efficient, it carried with it the danger of reproducing a series of lesson plans, perhaps in one session, with a minimum of appropriate consideration given to all aspects of each—a danger that one student was aware of:

After about the third lesson, I realised that I hadn't really thought about how I was going to evaluate what I was teaching... how each lesson should be evaluated perhaps differently. So I went back and made sure I used different techniques for the lessons.'

In the same vein, all students revealed that after 3–4 occasions of use, they deliberately by-passed system prompts (that are provided in the Reflection tool, and similar prompts automatically brought into play if the system detects the closure of a lesson plan without the student having accessed the Reflection tool) to force them to reflect on their lesson plans—for example, to consider the appropriateness of their evaluation strategies and how well these strategies match lesson objectives. This suggests that students either quickly internalise these kinds of metacognitive processes, or are unwilling to be 'forced' by the software system to practise such processes.

Perceived result of usage

All students in this evaluation suggested that they now knew more about lesson planning than before (they used the LPS), despite having been introduced to lesson planning in a lecture as part of their course of study immediately prior to their role in this study. They also all suggested that this was a direct result of having used the LPS (Note: two students in this group had missed the lecture given on lesson planning by their course-unit coordinator; and one other student suggested that she 'hadn't really followed what was being said about lesson planning in this lecture'). Also, three out of the four students suggested that they were now competent lesson planners and would be able to plan a variety of different types of lessons competently with or without the use of the LPS. The remaining student said that she would still prefer to have the use of LPS to plan her lessons, 'just in case I need to look at the proper choice of verbs to use' (using the Verb Database).

Difficulties in usage

It was imperative to all students, that they could both save and print their lesson plans. Indeed, whilst these functions are provided for in the LPS, all students

here suggested that it was frustrating that they could not print their lesson plans at the point of need (ie. in or near the classroom in which the lessons were to be taught; or at the point of completion of the lesson plans, when perhaps there was not a printer available). Of course, this is a difficulty in the computer system availability rather than a difficulty with the LPS itself, although the students clearly indicated in this concern, that they did not perceive there to be a difference between the two systems—this was a problem that might prevent them from using the LPS as a ‘tool of convenience’ in real-world or authentic situations.

Mention was also made by two students, of the system’s tight focus on a predetermined lesson plan format. Students suggested that once they knew how to create competent lesson plans in the LPS, they were interested to consider how they might use other lesson plan templates or formats to provide for different types of lessons. In this context, students are probably referring to the requirement in the LPS to plan lessons to a behavioural model, where for example, it is a requirement for lesson objectives to be written as observable behaviours in students. This structure was suggested as being appropriate for novice and inexperienced lesson planners, by the panel of experts used to advise on the components and features of the LPS. Furthermore, instructional resources in the LPS do describe to students that the LPS provides only one model for planning lessons, and that other models do exist. However, the student teachers’ concerns in this case imply a mismatch between some students’ requirements of the system, and the provision in experts’ predictions of these requirements. Indeed, this mismatch might also be an example of a situation already revealed in novice-expert studies, where experts, in some cases, are seemingly unable to appreciate or predict the knowledge structures or knowledge requirements of novices, having long since been removed themselves from a similar situation (Chi, Glaser, & Farr, 1988).

From this analysis, then, it was decided to update the LPS, so that it provided, in particular, for greater access to more diverse information about lesson planning, particularly different models of lesson planning; and to provide for greater availability of use. To implement both these provisions, it now seems appropriate to provide an on-line version of the LPS. An on-line version of the LPS, with dynamic links provided to more, and more diverse, information on lesson planning, should increase accessibility at more vantage points, for use in and

outside school classrooms. However, for the purpose of this research, the update to the LPS based upon this initial evaluation, was provided for use on the ‘static’ or disc version of the LPS. Specific changes to the LPS, based on this formative evaluation, included:

- refinements and additions to information made available, particularly that which informs student teachers of the available range of lesson planning approaches;
- sound provided for ‘copy’ and ‘paste’ actions in the notepad, to better indicate an action had occurred to the user;
- a greater range of lesson plans were added to the LPS, as exemplars of peer-generated lessons planned in all major subject areas that student teachers might be expected to teach in, in both primary and secondary schools. However, a similar, comprehensive representation of children’s ages in these lesson plans was not provided for—not only was this a difficult task to fulfil (ie. to find examples of extant lesson plans for all subjects and all ages), the instructional designer thought that having too much choice in lesson plan templates might hinder originality and encourage students to work only from lesson plan templates, and mitigate against developing alternative cognitive strategies for performing the lesson planning task.

Project history

Whilst the development of the LPS has been described, little has been said thus far concerning the context and background to this development. It is appropriate to describe in brief, the major steps in the history of the project.

The project to create a PSS for lesson planning was first conceived by this author in discussion with Dr Denise Kirkpatrick, then of Edith Cowan University, and more recently of the University of Technology, Sydney, after listening to a visiting academic, Professor Tom Reeves from the University of Georgia, describe the broad nature and background to what he termed, ‘Electronic Performance Support Systems’—EPSSs. It later became apparent that Professor Reeves had, shortly following his lecture, begun to lay the conceptual foundation for developing an ambitious PSS, intended to support teachers’ activities across many different yet related professional tasks. Despite the superficial attraction of this larger notion, the logistics of even beginning to catalogue the nature of these professional tasks was difficult to comprehend, without thinking about the criteria and technical specification for developing an integrated PSS to support

teachers in a diversity of professional activities. Instead, we, Dr Kirkpatrick and the author, quickly identified the task of lesson planning as one that was:

- reasonably well bounded and defined;
- of sufficient complexity, in the sense that it demanded a range of skills and knowledge to be completed well;
- performed poorly by novice student-teachers at Edith Cowan University, who had particular and well-documented difficulties;
- grounded in performance, so that student-teachers had to undertake or perform the task whilst still learning it;
- fundamental to the education of teachers.

The author then proceeded to work with Dr Kirkpatrick to develop an initial mind-map of the LPS, confirming very early on in the project, that our initial conception of the 'lesson planning problem' was best tackled by specifying the design and development of a PSS, using user-centred, rather than top-down systems methodology. Even at this early stage, it was clear from Dr Kirkpatrick's assessment of students' difficulties in the lesson planning task¹⁴, that traditional ways of teaching lesson planning at university were deficient. In particular, it appeared that students experienced difficulties with lesson planning both as a performance task and the manner in which it was taught. For example, the approach to teaching lesson planning assumed that all students were deficient in the same ways and to the same extent, in an identifiable skill and knowledge base; and that students were all aware of the significance of lesson planning to professional skills in teaching. However, in reality, students experienced significant difficulties in learning lesson planning skills out of context; and many made a clear distinction between planning and teaching a lesson, often failing to appreciate the importance of the former to the outcomes of the latter. Furthermore, it was evident that students' preferences for learning about lesson planning were varied—some wanted a 'formula' for good lessons; others questioned the premises on which lesson planning was taught (eg. 'why was making a detailed lesson plan important?'); and others still, had procedural misunderstandings about the task which were not covered by the operational

¹⁴ Dr Kirkpatrick recorded a range of individual student responses to requests she had made, over a six month period, for students to identify difficulties they experienced in preparing for professional (teaching) practices. A significant number of these responses concerned lesson planning. Whilst the collection of this information was anecdotal and not part of a systematic enquiry, it was undertaken specifically to provide a rationale for the development of the LPS.

model for completing the task presented to them. It was on the basis of this anecdotal evidence that the three stages of development of the LPS, described earlier in this Section, were embarked upon.

The operational steps in the development of the LPS started with initial designs for a PSS in lesson planning that described broad features of the PSS, devised using a mind-map technique. This was followed by a more detailed specification of one 'unit' or function of the PSS, on paper, to further determine the operational behaviour of the LPS as well as to explore the feasibility of the project¹⁵. This level of specification was completed in the form of a storyboard, where all screens in one unit or function of the LPS were specified in terms of their components and their behaviours. An extended storyboard was then created for other planned functions in the LPS. After positive testing of two prototype programs, the storyboard was 'signed-off' and used to provide the programmer and graphic designer with full specifications of the LPS.

Some early designs for possible interface screens were created, with the principle consideration for the main LPS interface arising out of a central need to engage both performance and learning. In this context, the guiding design principle for the interface to the main components of the program, was one of 'form suggests function': the form of the interface should suggest to the user what it does and how it operates (Stoney & Wild, 1997; Stoney & Wild, 1998). This principle has particular relevance to a user-centred design methodology, and is a variation on the notion of 'form follows function', a common attribute of screen design heuristics (Jones, 1989).

As such, the act of writing lesson plans was made central to the main interface, with a word processing and text layout environment created within a recognisable lesson plan writing framework. All other functions and user-system interactions were designed within this framework. Navigation within the task of writing a lesson plan is via two 'thumbnails', each representing two sections of the lesson plan. In this way, users can easily keep in view their whole lesson

¹⁵ Project feasibility was largely determined by consideration of development and distribution costs, together with general software specifications and perceived suitability of the product. However, an extensive feasibility study was not appropriate to this project, given its limited scope and research-focused intent, but was rather used to establish some 'development boundaries' and 'broad possibilities' (Phillips, 1996b, p. 42).

plan, and also move around its sections or parts by 'mouse clicking' on a part of the miniature representations.

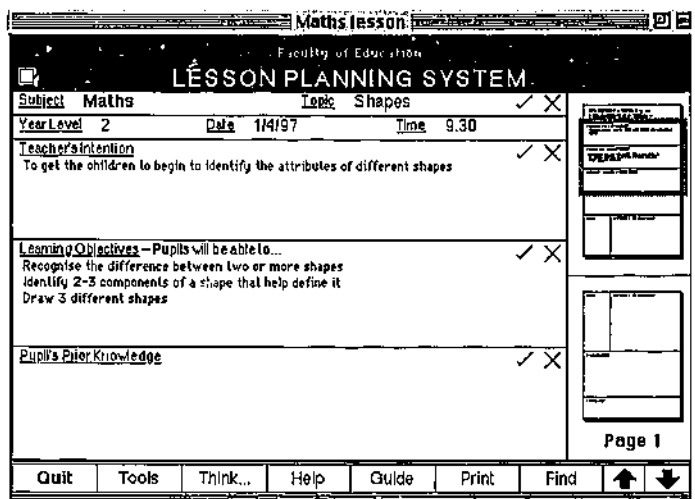


Figure 3.5. Main interface of the LPS, showing use of the thumbnail views for feedback and navigation.

Furthermore, these navigable elements also provide feedback on the progress of completing the lesson plan, by accurately representing the amount, if not the detail, of text and graphics already entered on the lesson plan. Each of the two thumbnail views were created to embody in form and function, one page of the standard two-page (A4 sized) lesson planning template used to write lesson plans by students using pen and paper. Use of the thumbnails can be seen in Figure 3.5, above. Other specific functions, such as the Work pad and Verb database tools, and instructional components, such as informational support on 'lesson structure' and 'effective objectives', were provided within separate windows (see Figure 3.6, below).

At an early stage, it was decided to apply for internal funding from Edith Cowan University, of approximately \$5,000, to fund the development of the LPS, as a research venture, with the intent of investigating the viability of the LPS as a teaching and learning tool. An application to the Faculty of Education, Edith Cowan University, was successful and as a result, a small project team was created. The tasks of project management, instructional and interactions design

and providing expert content were shared by Dr Kirkpatrick and this author, whilst programming and graphic design expertise was outsourced and funded on a contract basis.

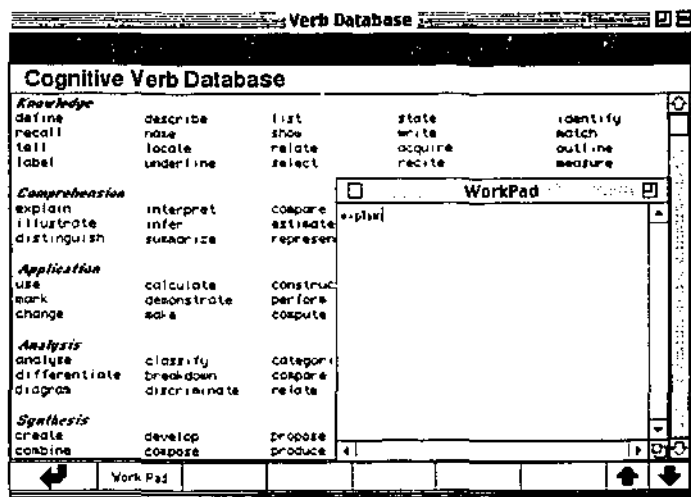


Figure 3.6. Integration of separate support-tools in the LPS: the Verb Database and the Work Pad.

Programming was completed in HyperCard, for the Apple Macintosh, for various reasons: (i) this programming environment allowed program size to be kept to a minimum, allowing standard single disc based distribution; (ii) single platform development (Apple Macintosh) allowed for ease of software maintenance; (iii) the specifications of the LPS did not require extensive multimedia programming; (iv) HyperCard was limited to black and white screens, and therefore suitable for use on the range of delivery computers already identified for the project—Apple Macintosh SE, SE/30 and LC II and LC III computers; and (v), HyperCard as a high-level programming language, is eminently suitable to the production of prototypes, the preferred software development methodology. It should also be said, that the choice of HyperCard was also influenced by the availability of a programmer skilled in its use—a pragmatic consideration facing many multimedia and hypermedia software projects (Phillips, 1996b, p. 45).

The development project occurred approximately over 12 months. Over this time, two distinct prototypes were developed and modified, with one of these forming the basis for the development of the final beta-version of the LPS. As a research tool, the LPS was not intended for wider distribution but rather as a model for the development of PSSs in lesson planning and other complex task domains.

Implementation issues

Implementation issues are not considered in this present work, since the research programme is concerned with investigating the effects of the LPS upon performance and learning in a semi-controlled situation, where the user population is small. However, strategies for implementation will be of concern if and when plans are made for the wider use of the LPS, for a much larger user population. In this context, Sultan's (1997) recent work offers some interesting insights.

Adel Sultan produced her doctoral thesis, entitled, 'Guidelines for the implementation of an electronic performance support system', in May, 1997, under the supervision of Dr Gary McConeghy, at Northern Illinois University (Sultan, 1997). Sultan's work serves as a reminder that implementation issues for the large scale adoption of any PSS, including the LPS, are substantial and need to be given consideration at all appropriate points in the design, development and post-development phases of the software system. Indeed, many of Sultan's findings confirm that without an adequate implementation model, the LPS, even if accepted as significantly enhancing the performances and learning experiences of student teachers in lesson planning, will not be effectively established as a valuable tool amongst student teachers at Edith Cowan University. In fact, there are specific aspects of the design and development models used to produce the LPS (see Section 3, further on) that can be criticised using the implementation guidelines found to be of value by Sultan (1997, pp. 159-181), that would severely inhibit the successful adoption of the LPS. However, we should remember, that Sultan's research was invariably centred on large-scale 'profit organisations' (1997, p. 185), and was concerned to produce recommendations with the intention of boosting profits by raising productivity in complex tasks. The LPS cannot be seen in this same frame; moreover, it was produced as a research tool, rather than a commercial product.

Conclusion

This Section has provided an account of the process of development of the LPS and in particular, how its features were identified, how these features were then iteratively designed and developed within a coherent software model; and finally how the LPS was formatively evaluated to determine the behaviour of the component parts in the context of use in 'real-world' lesson planning tasks.

Furthermore, an account of the history of the project has also been given, partly to draw attention to the fact that funding available to develop the LPS was minimal, and that as a software development project, the LPS can only be considered at its present stage of development, as 'beta' software. The account of the history of the project also acknowledges the pivotal role of Professor Tom Reeves from the University of Georgia, in inspiring the original conceptual foundation for the LPS.

Finally, issues related to the wider implementation of the LPS have been considered, and whilst these are not of immediate concern in terms of this research project, strategies for implementing the LPS will need to be worked through if it is ever to be used across a larger population.

SECTION 4

Methodology**Introduction**

This Section provides an account of the research methods applied in this project, and the procedures used in the various parts of the research programme in relation to three empirical investigations. The latter are described in Sections 5, 6 and 7.

Means and methods

It was primarily important to account for how unskilled lesson planners made use of the features of the LPS to learn and to perform effectively in this domain. This demanded that for a substantial part of the study, subjects needed to be studied in realistic and natural settings, where they might be expected to develop skills and learning in lesson planning. The questions asked in this research programme were largely 'non-comparative, non-causative and non-directional' (Robinson, 1995, p. 330); and the answers sought, were of the type which described how performance and learning might occur within the context of use of a new and purposeful technology—the LPS. For these reasons, research methods belonging to the interpretive paradigm were considered to be of greater relevance than those of the normative paradigm. Indeed, Guba and Lincoln (1982), and Miles and Huberman (1984), amongst others (Driscoll, 1995;

Robinson, 1995), are clear in their determinations, that qualitative research methods are most suitable for describing phenomena from a learner's or subject's perspective, and where questions of *why* and *how* are predominantly important. Qualitative methods offer the better opportunities to produce work that can function as 'a source of well-grounded, rich descriptions and explanations of processes occurring in local contexts' (Miles & Huberman, 1984, p. 15).

In particular, emphasis in this study was placed upon understanding the actions of individuals working with a new technology, with a view to constructing theoretical perspectives of the value of the LPS and PSSs more generally, based upon an interpretation of how individuals students worked with the software environment to affect performance and learning. Of course, the conceptual framework for this work included an awareness if not an intention, that use of the LPS was very likely to affect performance and learning—that is, the LPS had been constructed on a conceptual basis that gave a strong indication that some effects in these two areas would occur. However, there could be no certainty about this and before consideration could be given to attempts to measure or test predictions of such effects on a general population, it was imperative to gain a rich and detailed picture of their nature and occurrence. This could only be achieved in the development of research methods based in the interpretive paradigm (Patton, 1990; Robinson, 1995; Salomon, 1991). However, there is every reason why at a later date, given the positive results from this current research programme, a methodology based more centrally in a positivist paradigm could be applied to generate more predictive accounts on a general population, of the value of such tools as the LPS and other PSSs.

There was also a historical as well as a pragmatic premise for choosing to work with qualitative methods in this research programme. For some years, researchers working with instructional technologies have been aware of the folly of undertaking media comparison studies (Clark, 1983; Clark, 1985; Clark, 1994) and instead have increasingly focused on contextual studies of technologies employing research designs that help build understanding of the complexities of effects rather than question the existence or relative size of those effects. This new focus arguably came about largely as a result of Clark's (1983) famous 'mere vehicles' dictum, where it was contended that media do not influence learning; and although not convincing for everybody (Kozma, 1994; Tripp, 1996), research into instructional technologies has since changed somewhat, if not radically, to

encompass the mantle of qualitative methodologies, marked by questions such as 'why' and 'how' rather than 'if'.

Even before Clark's (1983) time, researchers in the field of instructional technologies questioned the apparent dominance of experimental research designs in much of the literature, and argued strongly for redressing the balance and to expand and enrich scholarship in this field (Becker, 1977; Heinrich, 1984). Indeed, almost 10 years ago, Neumann (1989) was able to determine that research into interactive and instructional software had emerged from its adolescence and was now ready to wrap itself in methodologies other than those of an experimental paradigm, to produce 'context-bound information' required to understand the naturalistic application of interactive media (Neuman, 1989, p. 40). Some would no doubt argue about the degree to which this new tradition has established a grip on the research literature in this field (Reeves, 1993a), yet a range of studies continue to emerge that lie either wholly or partly within this new tradition. Driscoll (1995) and Robinson (1995) have, quite recently, made convincing cases for the continuing influence of the qualitative paradigm in researching instructional technologies; and studies such as that by Land and Hannifin (1997), demonstrate the nature and place of qualitative methods in such research. However, it is probably Salomon's work that is most persuasive in its bid to transcend the so-called 'paradigm wars' in the fields of both instructional technology research and educational research more generally, arguing that each of the major research paradigms has a place in furthering our understandings (Salomon, 1991). Others have since echoed this sentiment, suggesting that with the 'acceptance of a duality of perspectives would come great growth and some much-needed refocussing of directions' (Robinson, 1995, p.332).

This research programme was guided by Denzin and Lincoln's (1994) view of the qualitative approach, where it is stated:

Qualitative research is multi-method in focus, involving an interpretive, naturalistic approach to its subject matter. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them. (Denzin & Lincoln, 1994, p. 2)

Patton (1990, p. 41) elaborates on this theme, surmising that 'the point of using qualitative methods is to understand naturally occurring phenomena in their naturally occurring states'.

In this light, data in this research programme were collected to allow for a full description of how students engaged the LPS to perform the task of lesson planning effectively. There were four orientations to the research:

- 1 to identify the critical components of a PSS to support the completion of a complex task (lesson planning);
- 2 to design and construct the LPS based upon those critical components considered to be relevant to lesson planning;
- 3 to investigate how novice student-teachers engage these components in the LPS to produce a lesson plan; and,
- 4 to investigate the effectiveness of the LPS as a PSS to support the completion of lesson planning.

The orientations described in 3 and 4 are those that sought to describe how students engaged the LPS; orientations 1 and 2 were concerned with accounting for the design of the LPS. These orientations and the way in which they determined the methodology of this research, is described fully in Table 4.1.

The research programme invoked phenomenology to inform and rationalise the nature of this inquiry into the LPS, as an overarching methodological model. Phenomenology is well suited to questions that focus on the structure and essence of human experience, particularly experience of a new programme or approach to doing something (Patton, 1990); in this case, for example, it was considered centrally important to unravel how students engaged the LPS, and to ascertain what they considered to be salient about their experience. As Patton suggests:

A phenomenological perspective can mean either or both: a focus on what people experience and how they interpret the world (in which case one can use interviews without actually experiencing the phenomenon oneself); or, a methodological mandate to actually experience the phenomenon being investigated (in which case participant observation would be necessary). (Patton, 1990, p. 70)

The experiences of individual students who used the LPS over time, were analysed and described, so that it was possible to identify what was common about the experience, in terms of the cognitive strategies used in engaging the system, their management of the lesson planning task more generally, and the processes in their learning. The results of the study are largely descriptive in nature—to describe and account for use. This is in line with Eichelberger's (1989) view of phenomenological studies when he states:

Some researchers are misled to think that they are using a phenomenological perspective when they study four teachers and describe their four unique views. A phenomenologist assumes a commonality in those human experiences and must use rigorously the method of bracketing to search for those commonalities. Results obtained from a phenomenological study can then be related to and integrated with those of other phenomenologists studying the same experience or phenomenon. (Eichelberger, 1989, p. 6)

The first level of this research project, namely the identification of the critical components of a PSS to support the completion of the lesson planning task; and the design and construction of the LPS based upon these critical components, is accounted for in Section 3 of this thesis, dealing with the stages and decisions in the design and development of the LPS. The second research level, corresponding to research orientations 3A and 3B was the central part of this whole project. At this level it was important to find out how students used the LPS as a performance support system; and also how they managed the task of lesson planning using this system. For orientation 3A, data were collected by video recording students' uses of the various functions and features in the LPS, with an intention of identifying their cognitive strategies or patterns in use, by considering such questions as:

- which functions were used in the LPS?
- what was the frequency of use of various function types (instruction cf. performance)? and,
- what action or sub-task was the student performing in their use of each of the functions in the LPS?

For orientation 3B, data were collected by interview. Interviews were conducted one-to-one, and comprised a series of open questions which sought to identify how students perceived they completed the lesson planning task; but more

importantly, probed why students performed and managed the task in the manner they described. Also, interviews were only held once for each student, and at the completion of the two-week use period. Therefore, students were asked to reflect on the lesson planning tasks as a whole, addressing the notion of change—did students think they changed their cognitive strategies (how they used the LPS) over the period of use; and, did students change their management of the lesson planning task over the same period?

Initially, it was considered preferable to document students' thinking in greater detail, by obtaining data by interview, for each lesson planned—that is, using the video tape of each lesson planned with the LPS to stimulate students' recall of their thinking at the time of their use of the LPS. This type of stimulated-recall interview would be completed shortly after each students' use of the LPS, to plan a lesson. However, it was intended to collect data by interview to provide insights into students' *changing* cognitive strategies, and change was more likely to be efficiently documented by requiring students to reflect more broadly upon the process of that change (ie. their use of the LPS over the specified two-week period), rather than to reflect upon each lesson-planning moment individually. Furthermore, it was projected, after testing and refining the interview questions at an earlier date, that too much unnecessary data would be generated if interviews were held following each student's use of the LPS over all six lesson plans; that this amount of data gathering would be difficult to manage; and finally, that students could be guided to describe and explain the changes in their cognitive strategies they might have experienced over multiple uses of the LPS, by only using the last (most recent) video tape of their lesson planning using the LPS, to help stimulate both recall of and reflection on, previous sessions with the LPS.

For orientation 4, it was necessary to capture temporal data in students' use of the LPS—how long did it take for students to plan a lesson using the LPS; and also, to provide a descriptive measure of the quality of each lesson plan produced—with judgements being made by expert lesson planners (ie. lecturers or teachers). In both instances, the data were analysed to consider if there was a positive development in students' progressive use of the LPS—did the students plan lessons in progressively shorter amounts of time; and did the lesson plans produced, show progressive developments in quality?

Table 4.1. Methodology

Level	First	Second	Third
Research orientation	<p>1 Identify the critical components of a PSS to support the completion of the lesson planning task.</p> <p>2 Design and construct the LPS based upon those critical components considered to be relevant to lesson planning.</p>	<p>3A Investigate the cognitive strategies^{1a} of novice student-teachers in their use of the LPS.</p> <p>3B Investigate students' management of the LPS to perform the task of lesson planning</p>	<p>4 Investigate the effectiveness of the LPS as a PSS to support the completion of a complex task.</p>
Rationale	<p>To provide appropriate support tools and instruction, to facilitate the completion of lesson planning, for novice student teachers</p>	<p>A To describe students' cognitive patterns of use of the LPS—to ascertain how they did the task</p> <p>B To describe students' management of the lesson planning task using the LPS—to ascertain why they acted in a certain way.</p>	<p>A To provide measures of how effective the LPS is in supporting lesson planning task.</p> <p>B To provide a measure of the effectiveness of student learning in their use of the LPS.</p>
Data required	<p>A Data from expert and novice lesson planners, to determine appropriate components in the LPS.</p> <p>B Data on operational use of LPS.</p>	<p>A Descriptions of students' relative use of the performance and instructional components in the LPS</p> <p>B Descriptions of how students managed the task of lesson planning using the LPS.</p>	<p>A Measures of performance in terms of: (i) time taken to produce a lesson plan; (ii) quality of lesson plan.</p> <p>B Measures of learning in terms of transfer of learning across media.</p>
Method of obtaining data	<p>A Audio recording of experts' and novices' focus groups discussing lesson planning task;</p> <p>B Interview data from novice student teachers following their use of the LPS</p>	<p>A Observational (video) data of student use of the LPS—how did students complete the task?</p> <p>B Post-task interview data—why did students manage the task as demonstrated in A?</p>	<p>A (i) Timing of task performance; (ii) Evaluation of product (lesson plans).</p> <p>B (i) Evaluation and comparison of lesson plans, produced across media—by use of the LPS and by 'pen & paper'.</p>

^{1a} A cognitive strategy refers to pattern of use, and can be determined by identifying the nature of students' cognitive engagement with the various components, instructional and performance, of the LPS.

In addition, in this final research orientation, it was necessary to account for the degree to which learning occurs in students as a result of using the LPS. This was achieved by relating how students transfer their learning and performance skills across media, from generating lesson plans using the LPS, to producing lesson plans by 'pen & paper' means, without recourse to the LPS. Media comparisons of this type were conducted on an individual student level; and only descriptive statistics, displayed in graphical format, were used to offer some indication of the strength of the levels of transfer for each student. The intention was not to develop normative generalisations to obtain a more precise measurement of this level of transfer. Indeed, where transfer was indicated in the data collected, it might be advisable to develop at a later date, an experimental or quasi-experimental study to provide a predictive measure of such learning transfer across media, and for a general population.

Taking account of the data generated here as a whole, it has been possible to draw conclusions about the operational value of the LPS as both a PSS and cognitive tool. It should be pointed out that caution was exercised in the interpretation of findings, and they have not been attributed to more general accounts of, or perspectives on, how PSSs and cognitive tools work to develop both performance and learning. Rather, these theories have been used to help explain the findings from this study.

Procedure

Pilot study

There were important preconceptions underpinning this research programme, and it was necessary that these were first tested in a pilot study. Indeed, the design intention that the LPS would operate as both cognitive tool and PSS prejudged a number of issues which may not have been subsequently supported by the data; and it may have become evident that the LPS operated neither as an effective cognitive tool nor PSS for novice teacher education students. It was therefore important to establish the veracity of the intended design.

Central to the investigation of the LPS, and indeed, to its development and implementation, was the notion that its use would result in individual students creating better quality lesson plans, and more efficiently (ie. more quickly, using appropriate cognitive strategies), than they do by pen & paper means. In this

context, there was a need to obtain data early on in this programme, at a pilot stage, that indicated that the LPS not only operated as a PSS but that it could, more specifically, improve or support improvements in students' lesson planning performance skills over time.

In this context, data were collected and analysed at a pilot stage, to provide a foundation for proceeding further with this programme. A quasi-experiment was conducted, after an approach followed by Barker and Banerji (1995), to map the use of the LPS in terms of context of use, types of user and system resources made available. Two groups each of four participants (ie. $n=8$) were identified (a novice [N] and an expert [E] group), both groups created from first year and third/fourth year students, respectively, currently studying Education full or part-time, as part of either a three-year or four-year degree program¹⁷. After a period when all students were tutored in the use of the LPS, to the point at which they felt comfortable with their skill in the use of the technologies (ie. computer and software use), they were asked to use the LPS to plan at least four lessons, over a period of two weeks. All students were recorded by use of video camera, in their completion of four lesson plans using the LPS; and taping occurred, for all students, over the first two and last two days of the two week period. This was to maximise the chances of collecting a range of data for each student, that might reasonably be expected to demonstrate a development in lesson planning skills, with the expectation that in performance, these skills, for each student, would become more refined by the last two days of the study.

The researcher, as operator of the video camera, was present at all video taping sessions for all students. In this context, the researcher also operated as a participant observer (Hopkins, 1985), helping students if and when they requested it, both with operational use of the LPS and the computer, as well as with requests for support which addressed issues of lesson plan construction. However, all interventions by the researcher were only completed as a response to a student request for support; and, whilst in some cases taping occurred of two students simultaneously, only one student was addressed at any one time. The

¹⁷ The use of the term 'novice' and 'expert', to describe two types of student lesson planners is somewhat problematic (ie. no student is likely to be regarded as an expert in a task in which they have only three to four years experience). It would probably be more accurate to describe these students, respectively, as inexperienced and more-experienced, in lesson planning. The criteria adopted in this thesis for using the terms expert and novice, are explained in Footnote 23, page 117.

video cameras set-up for this study, were positioned to obtain a view of the computer screen and a partial view of the computer keyboard, for each student. In two cases of data collection, two students were observed and recorded simultaneously using two cameras. This was done as a pragmatic response to difficulties in timetabling individual and separate data-collection sessions.

The video tape footage for each student and each session using the LPS, was then subject to transcription, coding and analysis by the researcher. This process was completed by:

- monitoring and recording student use of various components of the LPS during the completion of a lesson plan, differentiating between use of performance and instructional components;
- determining the total time taken to complete each lesson plan;
- producing a descriptive evaluation of the quality of each lesson plan produced.

Main studies (Part 1 and Part 2)

Four students were identified to provide the focus for studying their patterns of LPS usage over a two week period. These students were volunteers and novices in lesson planning (ie. first year Faculty of Education students in their first year of a four year Education degree programme). The students were tutored in the use of the LPS, to the point at which they felt comfortable with their skill in the use of the technologies (ie. computer and software use); and where all students had accumulated a similar, minimal, experience with the use of the LPS. It was important ethically that students' use of the LPS should not exclude their requirement and obtaining more conventional aids and support to learning lesson planning. Certainly, all students would expect as part of their normal preparation for teaching, optional guidance and support from peers and university supervisors assigned to them. For the purposes of this research, additional support given to the target students in this respect was simply recorded where possible (ie. questions to elicit this type of information from students, were asked as part of the follow-up [to task] interview process) and used to provide a more complete analysis of students' cognitive strategies in generating lesson plans with the LPS.

Students then used the LPS to plan a minimum of six lessons, over a period of two weeks—lesson plans that were intended for implementation in placement

schools that students would be assigned to in later weeks¹⁷. They were all encouraged to make greater use of the LPS, although this use went unobserved and unrecorded; however, students were asked to keep a written record of extra usage, and account for that usage when interviewed.

Observational data were collected by video camera-recorder, providing a complete record of use of the LPS for each student for each session of use. This provided data to determine students' cognitive patterns or strategies in the use of the LPS, over time. Individual follow-up interviews were conducted at the completion of the two week period, to determine how all students managed aspects of the lesson planning task. The recorded videos were also available at this point, to elicit a delayed think-aloud procedure, acting as prompts for students to offer explanatory comment on their actions in using the LPS. However, following testing of this procedure at an earlier stage in the research programme, only the final (sixth) video tape was ever used to prompt each student to recall and reflect on their total experience over all (six) lesson plans¹⁸.

This process of stimulating students' recall of and reflection on their thinking during their experiences of planning lessons using the LPS, allowed for the richer documentation of students' cognitive processes and also increased accuracy in interpretations offered by the researcher in analysis of the video data. In addition, each of the lesson plans produced was evaluated by an expert lesson planner (ie. lecturer or teacher), as a measure of product quality. Further, as a means of gaining an indication of the strength of transfer in students' learning over media, these lesson plans were then compared to a lesson plan produced by each of the students by 'pen & paper' means, following their use of the LPS.

At a second stage (part two of the main study), this process of data collection and analysis was then repeated with additional volunteer students, planning six or more lessons over a two week period, during professional practice. These students were of the same profile as those in the first part of the main study,

¹⁷ As part of the B.Ed programme at Edith Cowan University, students are required to spend pre-determined periods in schools, 'on professional practice'.

¹⁸ At this earlier stage, where the open-interview questions were tested and refined, it was projected that far too much unnecessary data would be generated if interviews were held following each students' separate uses of the LPS; that this amount of data gathering would be difficult to manage; and finally, that students could be guided to describe and explain the changes in their cognitive strategies they might have experienced over multiple uses of the LPS, by only using the last (most recent) video tape of their lesson planning using the LPS to help stimulate both recall and reflection of all previous sessions with the LPS.

being novice lesson planners, in their first year of a four year Education degree programme; and they were provided with sufficient yet minimal experience with the LPS, to the point at which they had basic skills in its use. Again, four students were initially scheduled for the study, although using a data validation technique of saturation one further student was subsequently added to the study, at which point it was found data were being repeated and not continuing to offer unique properties (Glaser & Strauss, 1967, p. 67; Hopkins, 1983, p. 111). The students in this latter scenario were expected to plan lessons to use in their own teaching, within a day or so of their planning—in other words, this data collection exercise differed from the previous one (at stage two) simply in the context of use of the LPS. In this scenario, students were expected to pursue their planning with greater urgency, since their plans will be intended for near-immediate implementation and also, were subject to evaluation by one or more of the following, under normal operating expectations in the professional practice period: university supervisor, classroom teacher, and perhaps school principal or representative.

A comparison of the data obtained from both sets of students was then used to enrich analysis and provide a better understanding of both cognitive patterns and task management in the LPS under different conditions of usage. In all cases of data collection, students used the LPS at a central computer facility, based at Edith Cowan University, largely so that video recording could be conducted. However, where students requested to use the LPS on computers away from this central resource, full support was provided (ie. help in setting up the software and computer; and, access to the LPS), other than the provision of off-campus university computing resources. However, it was not possible to conduct data collection by video recorder off-campus, although students were invited to discuss with the researcher their use of the LPS outside the periods of video recorded data collection.

A phenomenological framework within a qualitative methodology was chosen for this study since these approaches are seen to be particularly sensitive to processes (Guba & Lincoln, 1982), and because they allow for interpretative accounts of student data which will describe *why* and *how* the LPS might function as both cognitive tool and PSS to improve performance and learning in individuals. The data collected for individual students were analysed to identify patterns, similarities and differences, and explored in light of theoretical

perspectives created to explain the nature and value of both PSSs and software as cognitive tools. However, care was exercised throughout, that the data obtained here were used to presuppose the LPS operates effectively either as a PSS or cognitive tool.

Reliability and validity

In qualitative or mixed methodology studies, there are a number of recognised ways to increase the internal strength of an investigation, the reliability of data collected therein and the validity of the measures used (Cav. 1990, pp. 155–163). Perhaps one such method that has received much attention is triangulation (Hopkins 1985). Denzin (1994) identifies four basic types of triangulation—data triangulation, investigator triangulation, theory triangulation and methodological triangulation. However, triangulation in all these aspects is an ideal; at a pragmatic level it is more realistic to employ multiple methods, measures, researchers and perspectives, as much as is reasonable and practical. In this case, concentration is upon data triangulation, using three different types of data to inform the process of lesson plan construction.

For all aspects of this research programme, three types of data were collected: observations (using video tape recordings to capture voice and visual movements during the process of planning lessons using the LPS); interviews in conjunction with the video tape recordings to stimulate recall of and reflection on previous thinking processes whilst using the LPS to plan lessons; and product evaluations (i.e. descriptive, outcomes-based assessments of the lesson plans produced by students using the LPS). Each type of data collected was intended to provide convergent evidence to better understand the processes by which novice student lesson-planners used the LPS to both perform and learn the task of lesson planning. It is in this sense that data triangulation was achieved.

At a pre-pilot stage, conducted to test instruments and data collection methods, the alpha coefficient for rater reliability was calculated at 0.83. This figure was reached after both the principal researcher and an experienced teacher marked 12 lesson plans produced by novice student teachers, each student teacher producing one lesson plan. These lesson plans were provided by students who had recently completed a professional practice, and who had produced the lesson plans for use in their own professional practice. (Note: none of these lesson plans

were produced by students involved in the main or pilot studies of this research programme; and none were produced using the LPS). The lesson plans were rated according to their worth as a plan for teaching one or more lessons, using standard and published criteria applied by university supervisors in assessing all aspects of student teachers' professional skills, including planning skills (see appendix B). The criteria were used to correspond to six grades or outcomes:

- Outstanding (A);
- Outstanding (B);
- Highly Competent (C);
- Highly Competent (D);
- Competent (E);
- Unsatisfactory (F)

Whilst there is no differentiation between the grades 'Outstanding' (A and B), and 'Highly Competent' (C and D), in the criteria applied by the university in assessing student-teachers²⁰, it was considered desirable for this research programme, to further isolate the skill level of student teachers, to be able to better assess their skill development over relatively short periods of time (ie. 2 weeks). Therefore, the grading scheme used here (A–F) is unique and somewhat artificial for students, and was intended to allow for greater differentiation between students' skills in lesson planning. However, no special criteria was assigned to the two levels of 'Outstanding' (A and B), or to those of 'Highly Competent' (C and D)—rather, the raters of student-teachers' skills were expected to make informed judgements as to whether student-teachers' skills were of the upper (ie. A and C), or lower (ie. B or D) order. Whilst this may not have been entirely objective, it was thought there lay enough flexibility in the existing criteria for both 'Outstanding' and 'Highly Competent', to allow for further differentiation in these grades; and that experienced educationalists would be able to make such judgements. Indeed, the satisfactory findings for inter-rater reliability (see below), bear this out.

Out of 12 lesson plans assessed by both the principal researcher and experienced teacher, there was grading agreement for ten lesson plans; and only

²⁰ In university assessments made of their teaching skills on professional practices, student-teachers are subject to only four grades or outcomes: Outstanding, Highly Competent, Competent and Unsatisfactory (Fail). See, Appendix B.

disagreement by a measure of one grade for each of the two remaining lesson plans. Further, this level of agreement was reached using five out of the six available grades in assessing these 12 lesson plans (Unsatisfactory [F] was not applied to any lesson plan assessed in this exercise). This provided an inter-rater reliability alpha coefficient of 0.83, where there was agreement between raters for 83.33% of lesson plans assessed. Moreover, after re-assessing the remaining two lesson plans, the reliability coefficient was increased to 0.91.

As a research technique, interviews are known to attract a number of problems that impact on their validity, where the data achieved by their use are affected by bias, defined by Cannell and Kahn (quoted in Cohen & Manion, 1985) as 'a systematic or persistent tendency to make errors in the same direction, that is, to overstate or understate the true value of an attribute' (Cohen & Manion, 1985, p. 302). Potential sources of bias lie with the characteristics of the interviewer, those of the respondents and the nature of the questions; and more particularly, bias will often arise from the way in which the interviewer and respondent inter-relate, where this relationship is coloured by poor perceptions and misunderstandings. Indeed, Cohen & Manion (1985), referencing a number of sources, paint a thorough critique of the interview as a research tool; and importantly, remind us that it is important to look for a 'judicious compromise' between validity and reliability when devising and using an interview to gather data: 'where increased reliability of the interview is brought about by greater control of its elements, this is achieved... at the cost of reduced validity' (Cohen & Manion, 1985, p. 303). In other words, interviews remain valid as a research tool only so far as they tap into an unpredictable and interpersonal encounter (this is particularly so for unstructured or semi-structured interviews), generating a conversation which is natural, revealing insights and truisms.

In this light, the interviews conducted in this research programme were open-ended—the questions were suggested by reviewing and observing a video tape of each interviewee using the LPS to create a lesson plan. The purpose of the interview here was to access and enter into the perspective of the student-teacher being interviewed, a perspective that only the student-teacher could have. To gain access to this perspective, the interview questions were generated to engage the interviewees with their own thinking about their performance in using the LPS. The same questions were used, when appropriate, for more than one interviewee; and all interviews were refined as they proceeded (note: the pilot

study did not include interviews). In all interviews conducted, it was left to the interviewees to offer comment on their performance using the LPS by way of reflecting on their thinking as they created the lesson plan that had been video-taped. As with all 'qualitative interviewing' (Patton, 1990), however, it was necessary to prompt the interviewees at times, to engage their reflections more thoroughly, providing what Patton calls a 'framework within which people can respond comfortably, accurately and honestly' (Patton, 1990, p. 279). A transcript of one part of an interview is provided in appendix A, to provide a picture of this framework.

At the pilot stage, it was also decided to test rater reliability for differentiating and recording use of performance and instructional components by student-teachers. Whilst it was not appropriate to provide an alpha coefficient for rater reliability (ie. there was no judgement required in assessing user behaviours), experience did suggest that lapses in concentration by the rater could easily result in errors. To minimise such errors and to facilitate observation and recording of each occasion a function was used in a given session, a simple checklist was devised that listed all the functions of the LPS (see appendix C). These functions are described in Table 4.2, below. Each time a function was used, a mark was made on the checklist. At the conclusion of each session for each student-teacher, these marks were totalled and recorded in spreadsheet format for analysis.

Table 4.2. Instructional and performance components in the LPS

Instruction	Learning	Lesson Structure
		Effective objectives
		Evaluating learning outcomes
		Preparation
		Ways of writing the lesson plan
		Evaluating self
		What is a lesson plan?
		What is a good objective
		Planning methods
		Using the LPS
		How do I ensure my evaluation will be effective?
Performing	Task performance	Reflection
		Verb Database
		Example Lesson Plans
		Work Pad
		Example Objectives
		Example Evaluation Processes
		Find
		Print

This process of using this checklist to record observations of function use in the LPS, was tested over one video taped session during the pilot stage of the research programme. Both the researcher and an experienced teacher, used the checklist to record observations in the video tape, of the behaviour of one student-teacher in using the LPS. The video taped session was 34 minutes in total. Agreement was reached for 94% of observations (ie. 32 out of a total of 34) recorded for function usage. The discrepancy of two recorded observations was caused by rater error, and was subsequently amended on reviewing the video tape.

Conclusion

At this point in the thesis, a theoretical or conceptual framework for the empirical investigations has been established, firmly premised upon a review of relevant literatures (Section 2); and the methodology and procedures used to carry out these investigations has been described (Section 4). The next three Sections (5, 6 and 7) deal directly with three empirical investigations, each investigation being part of a coherent research model, and each building methodologically and in

terms of data, upon its predecessor. Whilst each of the three studies is represented separately, in different Sections, in this thesis, it is important that they are seen as part of a 'single picture', where findings from each investigation were used to developmentally build an understanding of the use of the LPS and its effects on users' performance and learning.

SECTION 5

Pilot study: Accounting for the LPS as PSS and cognitive tool

Introduction

In light of the phenomenological framework appropriated for this study, where the focus was on the experience of use of the LPS (Patton, 1990, p. 70), it was vital that data be analysed after first examining the preconceptions of the researcher—undoubtedly, given the researcher's central role in conceptualising and developing the LPS as both a cognitive tool and an effective PSS, there is likely to be a number of expectations built into this research programme that need to be accounted for before data analysis can proceed. In particular, the design intention that the LPS would operate as both cognitive tool and PSS prejudices a number of issues which may not be supported by the data; and it may become evident that the LPS operates neither as an effective cognitive tool or PSS for novice teacher education students.

In particular, a research orientation central to the investigation of the LPS, and indeed, to its development and implementation, is that its use would result in individual students creating better quality lesson plans, and more efficiently (ie. more quickly), than they do by pen & paper means. In this context, there was a need to obtain data early on in this programme, that indicated the LPS can not only operate as a PSS but that it can specifically improve or support improvements in students' lesson planning performance skills.

Indeed, although conceptually it is relatively simple to obtain measures to test this notion as an hypothesis in an experimental design, the complexity of a PSS in terms of the ways and contexts in which it might be used, make it difficult to isolate the effects of the use of the system on performance alone, or even to compare alternative ways of completing the same task (Collis & Verwijns, 1995). However, it is somewhat easier to describe the actions or behaviours, and the cognitive strategies that originate these behaviours, that students employ in making use of the system. Indeed, Barker and Banerji (1995) point to the value of doing this, when they suggest that any evaluation of a PSS should make account of task execution in terms of its context, the use of resources available to perform that task, and the skill and knowledge levels required by the task in relation to those possessed by the user.

In this context a quasi-experiment was conducted, after an approach followed by Barker and Banerji (1995), to map the use of the LPS in terms of context of use, types of user and system resources made available. Two groups of potential participants were identified—a novice (N) and an expert (E) group. Both groups were created from first year and third/fourth year students, respectively, currently studying Education full or part-time, as part of either a three-year or four-year degree program. The expert and novice groups were self-selecting and differentiated by students' experience with lesson planning, as well as by their own individual perceptions of their lesson planning skills. Thus, expert students could be described as students who had completed 2 years or more of an education degree course; whereas novices were those who had completed 6 months or less of the same course; expert students were those who perceived themselves as 'very capable' in lesson planning; novices were students who considered their lesson planning skills as 'poor' or 'non-existent'²¹. In this process of selecting students to participate, it was put to all potential participants (in writing and verbally) in this pilot study, that they would be expected to use the LPS as a computer tool to help them develop their lesson planning skills over a two week period at a central location (ie. a computer laboratory) at the university, in preparation for professional practice (where lesson planning is a required and assessed performance skill of the students). In addition, it was made clear to these students that use of the LPS would not, in any sense, be

²¹ These self-assessments were undertaken by students using a 5 point Likert Scale questionnaire, designed to assess students' perceptions of their lesson-planning performance skills.

regarded as part of their 'normal' studies, and not influence any part of their assessment in their Education course. It was also clarified, again in both a verbal and written invitation to take part in this study, that experience with the LPS would not preclude students undertaking 'normal' preparation for professional practice as part of their course²².

There was a total of 12 students who identified themselves as suitable participants in the selection process: four of these fitted the criteria for the 'expert group', and eight fitted the criteria for the 'novice group'²³. Of these, all students were invited to participate in using the LPS²⁴, although data were collected from only eight students in total (i.e. four 'experts'; four 'novices')²⁵. All students were initially tutored in the use of the LPS, to the point at which they felt comfortable with their skill in the use of the technologies (i.e. computer and software use). This point of 'comfort' was self-determined and reached without interference in the decision-making by the tutor (i.e. the researcher). In all cases, students advised the tutor that they had reached this point within about 40 minutes of continued use of the LPS, and over one sitting (i.e. all students were tutored together and in one laboratory).

Students were then asked to use the LPS to plan at least four lessons, over a period of two weeks—lesson plans that might be implemented in placement schools that students would be assigned to in later weeks²⁶. All students were recorded by use of video camera, in their completion of four lesson plans using the LPS; and taping occurred, for all students, over the first two and last two days of the two week period. This was to maximise the chances of collecting a

²² Instruction in lesson planning is, in fact, only offered to students as part of a more general approach to the practice of classroom teaching. Specific preparation for professional practice is provided for students during a two-hour period, where expectations for drawing up lesson plans are described. There is no explicit lesson planning skill development in students at any part of their formal course in the Education degree, except as part of incidental teaching whilst on professional practice.

²³ There were two corresponding criteria for 'expert' and 'novice' groups: (i) Expert students had completed 2 years or more of an Education degree course; whereas novices had completed 6 months or less of the same course; (ii) Expert students perceived themselves as 'very capable' in lesson planning; novices considered their lesson planning skills as 'poor' or 'non-existent'.

²⁴ All 12 students were invited to participate in using the LPS to provide for equality of opportunity. Indeed, it seemed somewhat unethical and unfair to invite students to participate, only to deny some of the volunteers an opportunity to engage in an experience that might prove to be both advantageous and fun.

²⁵ In the final analysis, students who were in the 'expert group' and who provided data for this study, were randomly chosen at will by the researcher.

²⁶ At the time of student participation, individual students all knew their placement schools, as well as the year-group of children they would be teaching. Some students even visited their supervising class teacher over the two week period of this study, feeding various elements and factors into their lesson planning, including subject themes, broad capabilities of the children they would be teaching, etc.

range of data for each student, that might reasonably be expected to demonstrate a development in lesson planning skills, with the expectation that in performance, these skills, for each student, would become more refined by the last two days of the study. Students were encouraged to make greater use of the LPS, but this went unobserved and unrecorded.

The position of the researcher in this study has been fully described earlier, in Section 4—briefly, this included operation of the video camera, and as such participant observation (Hopkins, 1985). The video cameras set-up for this study, were positioned to obtain a view of the computer screen and a partial view of the computer keyboard, for each student. In two cases of data collection, two cameras were used simultaneously, and as a pragmatic response to difficulties in timetabling individual and separate data-collection sessions.

The video tape footage for each student and each session using the LPS, was then subject to coding and analysis by the researcher. This process involved:

- monitoring and recording student use of various components of the LPS during the completion of a lesson plan, differentiating between use of performance and instructional components; and,
- determining the total time taken to complete each lesson plan.

Finally, each of the lesson plans produced by the novice and expert student-teachers was subject to a descriptive evaluation and consequent grading by a lecturer in Education at Edith Cowan University. The criteria and outcome statements used to guide the assessment of each student's lesson plans are fully described in Tables 5.3 and 5.4, further on in this Section (see: *Results—lesson plan products*), and also in Appendix C. These criteria and outcomes were articulated into six grades for use in this research programme:

- Outstanding (A);
- Outstanding (B);
- Highly Competent (C);
- Highly Competent (D);
- Competent (E);
- Unsatisfactory (F).

Presentation of data

The results for this pilot study are presented as data represented in tabular and figure formats, for both groups of students. One type of graph has been used to represent two data types: line charts are used to represent, (i) the degree of student interactivity with both instructional and performance interactions; and, (ii) the time taken for students to complete the lesson planning tasks using the LPS.

Line graphs are logically applied to data of a continuous type, to indicate change over time; whereas bar graphs, for example, are applied to non-continuous data, to indicate a given value at one point in time. However, in this case, line rather than bar graphs have been chosen to represent non-continuous data types (ie. the number of interactions in each of four tasks, and the individual times taken to complete them), to better track the nature of the expected change in student use-behaviours and cognitive strategies, over time. That is, there was an assumption made in this research programme, that it would be possible to detect change in student use-behaviours and cognitive strategies in their completion of lesson planning tasks, over time. Furthermore, that there was likely to be an interaction between students' use of performance and instructional components in the LPS, over the period in which the LPS was used to complete a number of lesson planning tasks. Thus, it is argued, the nature of the expected changes and the point in time of the interactions in students' use-behaviours, can be better represented when the data is presented in the form of line graphs.

Results—novices

These results were used to provide an indication of the operational effectiveness of the LPS as a PSS, for both novices and experts in lesson planning; and further, helped to guide and validate the nature and the direction of the main study.

For students N1 and N2, there was evidence of a gradual and sustained decrease in all measures taken—the number of interactions with the instructional components [N1: 27–8, or 70.3%; N2: 25–9, or 64%]; the number of interactions with performance components [N1: 20–10, or 50%; N2: 20–12, or 40%]; and the time taken to complete a single lesson plan [N1: 40–19, or 52.5%; N2: 46–17, or 63%], (see Tables 5.1.1 and 5.1.2). These results suggest that these two students developed strategies in using the LPS, that are efficient and were refined over the

two week period used to collect this data. Indeed, for both students (N1, N2) the time taken to produce the third and fourth lesson plans might be evidence of these students finding the optimum strategies of effective use—after witnessing a rapid decrease in the time taken to produce the first two lesson plans, the time taken to produce the last two lesson plans appears to have stabilised at approximately 18–19 minutes.

Table 5.1.1. Novice student N1: Lesson plans 1–4.

Lesson plans	Novice student N1		
	LPS components		
	Instruction	Performance	Time (mins)
L1	27	20	40
L2	18	17	42
L3	15	13	19
L4	8	10	19

Table 5.1.2. Novice student N2: Lesson plans 1–4.

Lesson plans	Novice student N2		
	LPS components		
	Instruction	Performance	Time (mins)
L1	25	20	46
L2	15	20	37
L3	12	14	18
L4	9	12	17

Correspondingly, there was evidence of a decrease in the number of interactions made with both the performance and instructional components for students N1 and N2, the most substantial parts of the decrease occurring over the first and second (for instructional components) [N1: 27–18, or 33.3%; N2: 25–15, or 40%], and third and fourth (for performance components) lesson plans [N1: 17–13, or 20%; N2: 20–14, or 30%]. Furthermore, the relationship between student interactions with performance components and student interactions with instructional components, was reversed over the four lesson plans created. Initially, each of the students, N1 and N2, interacted more with the instructional components of the LPS; but by the fourth and second lesson plan, respectively, this pattern of interaction had been reversed, with students interacting more with performance components.

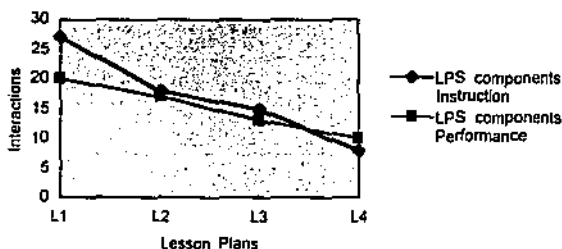


Figure 5.1.1. Novice student N1: Lesson plans 1—4.

Figure 5.1.1, clearly shows how for student N1, there was an interaction between her use of instructional and performance components in the LPS, which occurs between the third and fourth lesson plans. This interaction in the data indicates that it is at this point the student experienced use behaviours, perhaps indicative themselves of cognitive strategies, that are likely to reflect expertise in the task and its domain. Figure 5.1.2, shows that for student N2, a similar interaction in the data occurred at a much earlier level, and was sustained thereafter. The interaction occurred between the first and second lesson planning tasks, indicating that this student developed expert use behaviours in the domain and the task, at a much earlier point than student N1.

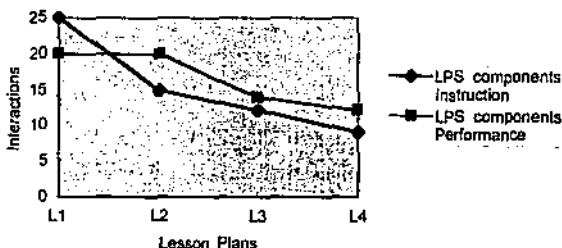


Figure 5.1.2. Novice student N2: Lesson plans 1—4.

The same general patterns are in evidence with both students N3 and N4, although there are also important differences (see Tables 5.1.3 and 5.1.4). For example, for student N3, the time taken to produce the fourth and final lesson plan was greater than that to produce the first (by one minute); and whilst student N4 experienced a progressive decline in the amount of time taken to produce the first three lesson plans (the greatest proportion of this decline being between the second and third lesson plans), there was a slight increase in the time taken to the fourth lesson plan, over the third lesson plan (an increase of two minutes).

Table 5.1.3. Novice student N3: Lesson plans 1–4.

Novice student N3			
Lesson plans	LPS components		
	Instruction	Performance	Time (mins)
L1	14	23	23
L2	9	13	19
L3	12	10	13
L4	3	8	24

Furthermore, whilst again we can see a gradual decrease in the interactions with both instructional and performance components of the LPS for students N3 [N3 (instruction): 14–3, or 78.5%; N3 (performance) 23–8, or 65.2%], and N4 [N4 (instruction): 16–3, or 81.25%; N4 (performance) 19–9, or 52.6%] over the four lesson plans, it would seem that for both students, that there was no reversal in their respective patterns of interactions with performance and instructional components.

Table 5.1.4. Novice student N4: Lesson plans 1–4.

Novice student N4			
Lesson plans	LPS components		
	Instruction	Performance	Time (mins)
L1	16	19	31
L2	10	10	24
L3	13	12	14
L4	3	9	16

That is, for these students, interactions with performance components outstripped interactions with instructional components for all lesson plans produced here (although there is a slight anomaly in this pattern in lesson plan

three, for both students N3 and N4, where the number of interactions with performance components momentarily dips below the respective number of interactions with instructional components).

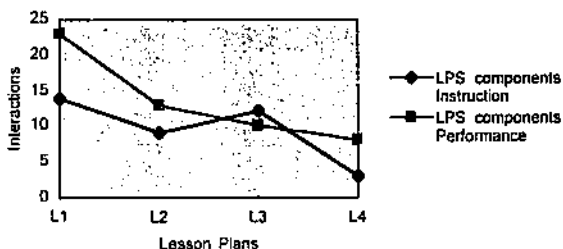


Figure 5.1.3. Novice student N3: Lesson plans 1–4.

Figure 5.1.3, shows how for student N3, there were two interactions between his use of instructional and performance components in the LPS, which initially occurred between the second and third lesson plans, and again just after the third lesson plan. These two interactions in the data, being very close together, suggest only a fragile and unsustained change in use behaviour on the part of student N3. Figure 5.1.4, shows that for student N4, similar interactions in the data occurred at the second and also immediately after the third lesson planning tasks. The implication of these two interactions for student N4 is of the same order as those for N3, namely that the apparent change in use behaviour is fragile and unsustained.

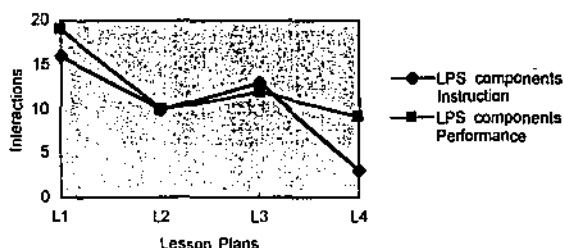


Figure 5.1.4, Novice student N4: Lesson plans 1—4.

In calculating a mean value for numbers of student interactions (for N1, N2, N3, N4) with both performance and instructional components, and for the time taken to produce the lesson plans, we find that:

- (i) the number of interactions with performance components is equal to or greater than the interactions with instructional components, apart from a slight reversal in this pattern at the third lesson plan;
- (ii) there is a gradual and sustained decrease in the numbers of all interactions;
- (iii) there is a sustained decrease in the time taken to produce the first three lesson plans, with a slight correction to this pattern in the fourth lesson plan, representing an increase of three minutes over the third and fourth lesson plans. (See Table 5.1.5).

Table 5.1.5. Mean use of LPS for Novice students N1—N4.

Novice students N1—N4			
Lesson plans	LPS components		
	Instruction	Performance	Time (mins)
L1	21	21	35
L2	13	15	31
L3	13	12	16
L4	6	10	19

Figure 5.1.5, demonstrates that two interactions occurred in the composite data representing all students, N1—N4; and that these interactions occurred immediately prior to and following, lesson planning task #3. This pattern might

suggest that, when taken together, the changes in the use behaviours of the students is unsustained, momentary and therefore, signifies little concerning the development of expertise in these novice students.

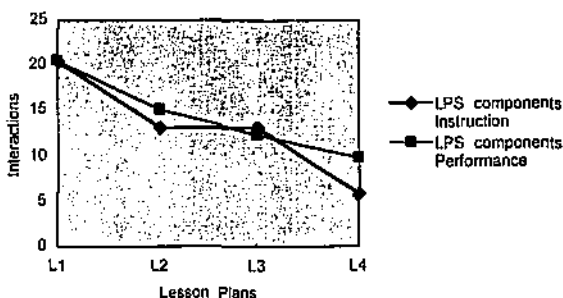


Figure 5.1.5. Mean Interactions in the LPS for Novice students N1–N4.

It does seem to be apparent, however, that by lesson planning task #4, there is on average, for all students, an increasing divergence between the number of performance and instructional interactions, marked by a growth in the former and a decline in the latter. This could suggest a development of expertise in cognitive strategies, something which would be more apparent perhaps in subsequent lesson planning tasks (ie. where more than four lesson planning tasks are completed).

Indeed, at this stage in the research programme, it was apparent that with additional data it would probably be possible to validate this suggestion. For example, additional data concerning the various types of components used within the broader categories of performance and instruction, would be likely to reveal more about students' cognitive strategies underpinning their LPS use behaviours. Similarly, interview data would be likely to reveal more about these strategies.

Figure 5.1.6, shows the comparative patterns in the temporal data representing all lesson planning tasks and all students. For the most part, the individual student patterns are similar, with a gradual decline in time taken to complete the tasks, between the first and second lesson plans (with the notable exception of

student N1); a steeper decline between the second and third lesson plans; and finally, a levelling or slight incline between the third and fourth lesson plans. The great similarity in these patterns suggests that whilst all students worked at a different pace, a convergence occurred at lesson planning task #3, where all students took approximately the same amount of time to complete the task (ie. the standard deviation from the mean at lesson planning task #3, was minimal). Furthermore, this convergence in the data was maintained for lesson planning task #4, where again, all students took about the same amount of time to complete the task.

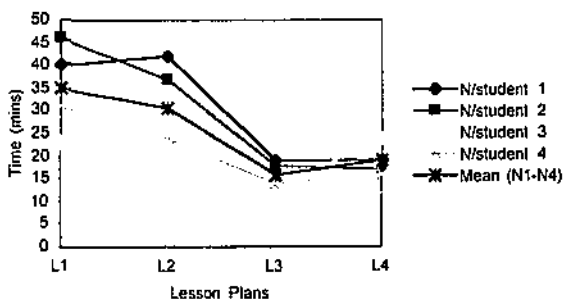


Figure 5.1.6. Time taken for task completion in the LPS for Novice students N1–N4.

Discussion

There are a number of ways in which the findings described above might be explained. In the first place, the patterns evident in the results are not likely to be attributable to a process in which students sought and gained a satisfactory skill level in using the LPS over the period of the four lesson plans. All students had reported themselves as having achieved appropriate and satisfactory skills in using the LPS, prior to attempting planning the lesson plans for which data has been collected here. The patterns evident in this data are not consistent across all four students, although it is apparent that for these students, as novices in lesson planning:

- (i) the time taken to produce lesson plans with the LPS decreases with its use;

- (ii) there is a substantial decrease in the number of interactions made with both instructional and performance components of the LPS, over the production of at least four lesson plans;
- (iii) the mean ratio of student interactions with instructional components and performance components in the LPS, is equal or near-equal for the first three lesson planning tasks (ie. 21:21, 13:15, 13:12), before being weighted towards performance related interactions in the completion of the final lesson plan (ie. 6:10).

These results suggest that novice students initially use the LPS for instructional support in the completion of a lesson plan, before committing that instruction to memory as learning, to concentrate more on using the LPS to perform the task of lesson planning. Also, that over a certain period (in this case, two weeks and four lesson planning tasks) there is some stabilisation in the process of use of the LPS, both in terms of moving towards greater interactivity with performance functions in the LPS, and at the same time, finding an appropriate amount of time to take to produce a satisfactory lesson plan.

However, the patterns revealed in the numbers of interactions with various types of components in the LPS, and in the time taken to produce lesson plans using the LPS, are limited in value. They provide insights into patterns of behaviours when using the LPS, of student-teachers as novice lesson planners; and in this limited sense they might also serve as nascent indications of the cognitive strategies being developed by students in using the LPS to plan lessons. However, it was necessary to obtain additional data, such as interviews, and greater detail in existing informational data regarding students' usage of particular components in the performance and instructional categories in the LPS, to confirm and explain the existence of these cognitive strategies in students. Whilst additional data were not collected in this pilot stage, it was collected in the main study (parts I and II—see Sections 6 and 7, respectively).

Results—experts

For those student-teachers who were designated as possessing expertise in lesson planning, the development of use behaviours or strategies was more consistent, progressive and noticeably different to the experiences of the novice students. In all cases (E1, E2, E3, E4), students very quickly reduced their interactions with instructional components of the LPS [E1: 15–5, or 66.6%; E2:

16–4, or 75%; E3: 13–2, or 84.6%; E4: 16–0, or 100%], (see Tables 5.2.1–5.2.4). Three of these students made the greatest reduction in these interactions, between the first and second lesson plans; whilst a fourth student made a similar reduction by the third lesson plan.

Table 5.2.1. Expert student E1: Lesson plans 1–4.

Expert student E1			
Lesson plans	LPS components		
	Instruction	Performance	Time (mins)
L1	15	14	16
L2	9	14	14
L3	4	12	19
L4	5	8	19

The same students reduced their interactions with performance functions somewhat more gradually [E1: 14–8, or 42.85%; E2: 17–9, or 47%; E3: 16–5, or 68.75%; E4: 17–6, or 64.7%], (see Tables 5.2.1–5.2.4). In particular, the most significant reductions in these interactions had been made by all students by the third or fourth lesson plan. Interestingly, the time taken to produce a lesson plan did not reduce consistently for all students; and more significantly, three out of the four expert student–teacher lesson planners, actually increased the time taken to produce a lesson plan, between the first and fourth lesson plans.

Table 5.2.2. Expert student E2: Lesson plans 1–4.

Expert student E2			
Lesson plans	LPS components		
	Instruction	Performance	Time (mins)
L1	16	17	18
L2	5	15	17
L3	0	16	17
L4	4	9	26

Students E2, E3 and E4 each registered no interactions with instructional components for either lesson plan 3 (E2, E3) or lesson plan 4 (E4), (see Tables 5.2.2–5.2.4). Furthermore, the number of interactions with performance components is always greater than interactions with instructional components for all expert students, apart from a slight reversal in this pattern in the completion of the first lesson plan, for student E1, (see Tables 5.2.1–5.2.4).

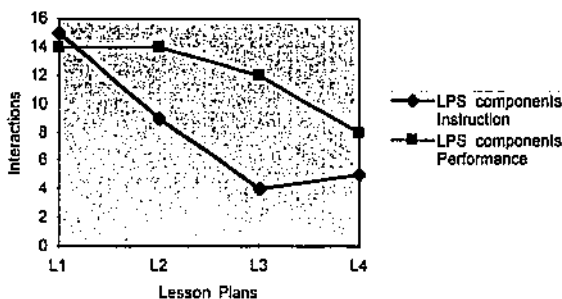


Figure 5.2.1. Expert student E1: Lesson plans 1–4.

Figure 5.2.1, clearly shows how for student E1, there was an interaction between her use of instructional and performance components in the LPS, immediately after the first lessoning planning task. This early interaction in the data indicates that the student adopted a use behaviour, perhaps indicative itself of cognitive strategy, that reflects the application of expertise in the task.

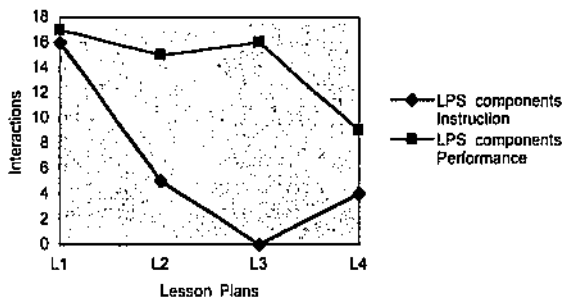


Figure 5.2.2. Expert student E2: Lesson plans 1–4.

Figure 5.2.2, shows that for student E2, a similar interaction in the data did not occur, although the close proximity between the starting numbers of interactions in instructional and performance interactions, at lesson plan #1, as well as the direction in the patterns in the data thereafter, might suggest an interaction in the

data occurred *prior* to the first lesson planning task—that this student adopted, in practice, expert strategies from the beginning.

Table 5.2.3. Expert student E3: Lesson plans 1–4.

Expert student E3			
Lesson plans	LPS components		
	Instruction	Performance	Time (mins)
L1	13	16	25
L2	12	16	20
L3	0	12	15
L4	2	5	18

The ratio of interactions between instruction and performance components for all expert students is similar by the fourth lesson plan, although with a slightly larger ratio weighted in terms of interactions with performance components for student E4 [E1: 5–8; E2: 4–9; E3: 2–5; E4: 0–6], (see Tables 5.2.1–5.2.4).

Table 5.2.4. Expert student E4: Lesson plans 1–4.

Expert student E4			
Lesson plans	LPS components		
	Instruction	Performance	Time (mins)
L1	16	17	18
L2	9	19	20
L3	6	10	15
L4	0	6	20

Figures 5.2.3 and 5.2.4, demonstrate similar use behaviours, for students E3 and E4, as does Figure 5.2.2, for student E2. For example, for both students, E3 and E4, the starting numbers of interactions in instructional and performance interactions, at lesson plan #1, as well as the direction in the patterns in the data thereafter, suggest that these students adopted, in practice, expert strategies from the beginning.

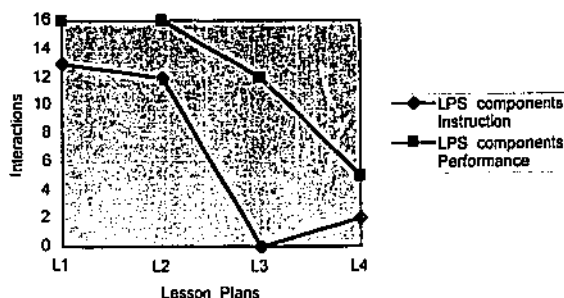


Figure 5.2.3. Expert student E3: Lesson plans 1—4.

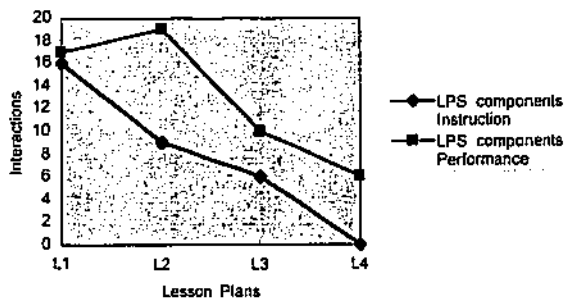


Figure 5.2.4. Expert student E4: Lesson plans 1—4.

In calculating a mean value for numbers of interactions with both performance and instructional components, and for time taken to produce the lesson plans, for all expert students (E1, E2, E3, E4—see Table 5.2.5; and Figures 5.2.5 and 5.2.6), we find that:

- (i) the number of interactions with performance components is always greater than interactions with instructional components, for all lessons planned using the LPS (except for student E1 in lesson planning task #1, where there is a use ratio of 14:15 interactions, slightly in favour of instructional components);
- (ii) there is a gradual and sustained decrease in the numbers of interactions, for both instructional and performance components;

- (iii) the average time taken to produce the four lesson plans remained very similar at about 17–21 minutes, with an increase in this attribute between the first lesson planned (19 minutes) and the fourth lesson planned (21 minutes), (see Table 5.2.5).

Table 5.2.5. Mean use of LPS for Expert students E1–E4.

Expert students E1–E4			
Lesson plans	LPS components		
	Instruction	Performance	Time (mins)
L1	15	18	19
L2	9	16	18
L3	3	13	17
L4	3	7	21

Figure 5.2.6, shows the comparative patterns in the temporal data representing all lesson planning tasks and all students (E1–E4). For the most part, the individual student patterns run in the same direction, with a gradual decline in time taken to complete the tasks, between the first and second lesson plans (with the notable exception of student E4); and between the second and third lesson plans (with the notable exception of student E1).

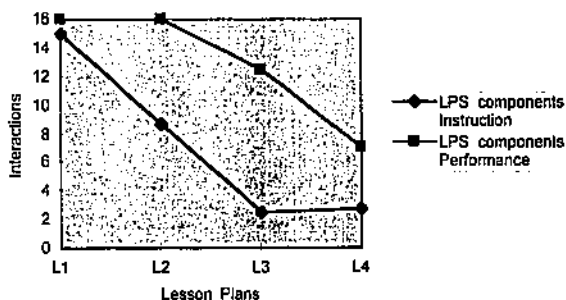


Figure 5.2.5. Mean Interactions in the LPS for Expert students E1–E4.

As with the novice student lesson planners, the patterns then change, and there is an incline in the data between the third and fourth lesson plans (apart from student E1, for whom the data remains constant). Again, as with the novice student lesson planners, a convergence occurs in the data at lesson planning task #3, where all students took approximately the same amount of time to complete

the task (ie. the standard deviation from the mean at lesson planning task #3, was minimal). Furthermore, this convergence in the data was maintained for lesson planning task #4, where again, three out of the four students (excepting student E2) took about the same amount of time to complete the task.

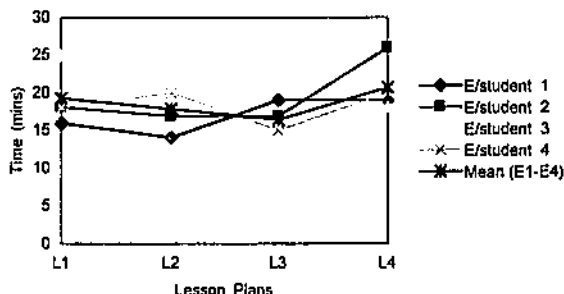


Figure 5.2.6. Time taken for task completion in the LPS for Expert students E1—E4.

Discussion

It appears that the expert students quickly discarded use of instructional components in the LPS, and even experimented with having no interactions at all with these components. This might suggest that after initial explorations into the nature and extent of the instructional components, these expert students formed the opinion that their access was not necessary in the production of satisfactory lesson plans. The pattern of use of performance components was more consistent across all students, reducing most dramatically by the fourth lesson planning session. It is perhaps possible to infer from this data that by the fourth and final lesson plan, each student had evolved an efficient strategy to produce satisfactory lesson plans. Moreover, a corresponding increase in the time taken to produce the fourth lesson plan could suggest that these students are taking more time to think about their lesson planning task, rather than using this time to operationally interact with the LPS. With additional (interview and component use) data it would, perhaps, be possible to confirm and explain these suppositions about students' LPS usage and corresponding cognitive strategies in their lesson planning tasks.

Comparing the results for novice and expert students, it would appear from the interactions data alone, that by the fourth lesson plan, both sets of students were performing the task in almost the same way, with similar levels of interactivity with instructional and performance components of the LPS, and approximately taking the same amount of time to complete the task. This does suggest that by use of the LPS, novice students finally developed strategies or approaches for producing satisfactory lesson plans that resembled those of the expert students. It seems, especially from the novice student data, that with further use of the LPS to produce more lesson plans, over and above the four tracked in this pilot study, we might witness an even closer alignment in novice and expert students' use strategies.

Results—lesson plan products

All lesson plans created by both novice and expert student-teachers (as lesson planners), were subject to grading, in this instance, by a lecturer in Education at Edith Cowan University who teaches lesson planning. The criteria and outcome statements used to guide the assessment of each student's lesson plans are described in Tables 5.3 and 5.4, below, and also in Appendix B. The criteria were taken from an internal document published for the guidance of university supervisors, school principals, teachers and student-teachers²⁷, and adapted on the advice of, and collaboration with, a senior lecturer in Education at Edith Cowan University; these criteria and outcomes correspond to six grades used in this research programme:

- Outstanding (A);
- Outstanding (B);
- Highly Competent (C);
- Highly Competent (D);
- Competent (E);
- Unsatisfactory (F).

The process of adaptation was necessary to provide a tool by which lesson plan assessments could be standardised, since such a tool was not already available.

Table 5.3. Lesson planning assessment criteria

Grade	Criteria	Marks
Unsatisfactory	<ul style="list-style-type: none"> • Incomplete lesson planning, by omission of objectives, instructional methods and/or evaluation process. • Demonstrates an inadequate knowledge of planning for teaching a lesson. • Demonstrates poor understanding of the related processes in planning a lesson (ie. stating lesson objectives; creating methods by which these objectives can be met; evaluating learning). 	F
Competent	<ul style="list-style-type: none"> • Plans straight forward learning experiences thoroughly and clearly. • Attends to effective pre-lesson organisation. • Demonstrates an adequate knowledge of content in planning learning experiences. • Specifies objectives (cognitive, affective, psychomotor) in terms of what the students will learn. • Selects learning resources and structures the environment (eg. group-work) to contribute to the achievement of learning objectives. • Plans appropriate teaching strategies for whole class or single group teaching. • Demonstrates appropriate timing in lesson plans. • Plans for evaluation in accordance with learning objectives, using basic techniques such as observation, questioning, discussion, supervision and teacher/student marking. 	E
Highly Competent	<ul style="list-style-type: none"> • Plans related learning experiences across more than one subject to develop a skill, topic or theme. • Plans more complex learning experiences. • Plans learning content to reflect multiculturalism, where this is appropriate. • Plans for teaching strategies which promote problem solving and creativity. • Allows for modifications to lesson as a result of lesson evaluation. • Plans for evaluation in accordance with learning objectives, using basic techniques such as observation, questioning, discussion, supervision and teacher/student marking. 	D C
Outstanding	<ul style="list-style-type: none"> • Plans for coherent organisation and continuity of learning experiences over an extended period of time. • Structures objectives which reflect progression in learning over a series of learning experiences. • Planning reflects the special needs of individuals and/or groups. • Plans to use teaching strategies for multiple groups within a class. • Plans for multiple learning experiences within a single environment. • Plans for specific strategies to cater for students with special needs. • Plans for use of a variety of resources and media in a single learning experience. • Plans for evaluation in accordance with learning objectives, using advanced techniques such as rating scales, criterion assessment, diagnostic tests and student self-assessment. 	B A

²² Faculty of Education Professional Teaching Programme 1997: *Early Childhood, Primary, Secondary. Guidelines for Principals, Teachers and Assistant Teachers*. Edith Cowan University. Internal Document P-876-12-96-1800.

Table 5.4. Student-teacher outcome statements in relation to lesson planning skills

Grade	Student Outcomes
Competent	Plans an appropriate and functional lesson, which is appropriately timed; displays an understanding of lesson content to be taught; has one or more objectives describing what students are expected to learn as a result of the lesson; and demonstrates an awareness of (i) checking for student learning, and (ii) checking for self-performance.
Highly Competent	Plans a lesson which may be one part of a wider learning experience; plans for use of more than one instructional technique in a single learning experience; uses a range of resources and media meaningfully; and demonstrates use of one or more evaluation techniques, formal and informal.
Outstanding	Demonstrates appropriate planning for a range of student abilities, progressive learning over a number of objectives, extended learning experiences and more complex lessons. Evaluation planning displays a personal belief system about how evaluation is an integrative part of the teaching/learning process. Specifies elements of teaching skills (as part of self-assessment) which will be given special consideration.

Data, representing the grades for novice student-teachers' lesson plans over four lessons, are given in the Table 5.5.1, below. The data in this table suggests a definite progression in lesson planning skills over lesson plans 1–4, for two novice students (N1, N3); and an unsustained development of skills for the remaining two students (N2, N4). For these first two students (N1, N3), there is a development in lesson planning skills that moves them between two major grades, from Competent to Highly Competent (ie. from grade E to D/C).

Table 5.5.1. Novice students N1–N4: Grades for lesson plans 1–4.

Lesson plans	Novice Students			
	N1	N2	N3	N4
L1	E	E	E	D
L2	D	E	C	C
L3	D	C	D	D
L4	C	E	D	D

Data, representing the grades given for expert student-teachers' lesson plans over four lessons, are shown in the Table 5.6.1, below. The data in this table provides a somewhat mixed picture, and in this context is similar to that for the novice student-teachers. For two expert students (E1, E3), there appears to be no change in lesson plan quality, with one student (E1) outputting four lesson plans

each graded as Outstanding (B/A); and the other student (E3), producing three out of four lesson plans graded as Outstanding (B). A third student (E2), produced three lesson plans graded as Highly Competent (C), but only after creating an Outstanding lesson plan (B) at their first attempt. A fourth student (E4) appears to have demonstrated a consistent development in lesson planning skills, moving their grades from Highly Competent (C) to Outstanding (B) over the four lesson plans.

Table 5.6.1. Expert student E1: Grades for lesson plans 1–4.

Lesson plans	Expert Students			
	E1	E2	E3	E4
L1	B	B	B	C
L2	B	C	B	C
L3	A	C	C	B
L4	B	C	B	B

Broad comparisons between the data in Table 5.5.1 and 5.6.1, suggests that the LPS has allowed novice student-teachers to enhance the quality of their lesson plans over a relatively short period to time; and that it has not served to stifle or otherwise hinder the quality of the lesson plans produced by the expert student-teachers. We must, of course, bear in mind that student-teachers can be expected to enhance their skills in any complex task, if practiced repeatedly over a period of time, due to a natural maturation process in the task (Cohen & Manion, 1985, p. 194).

Discussion

Whilst there is some evidence, in this pilot study, of novice student-teachers using the LPS to move their lesson planning skills towards (if not reaching) the level of their expert counterparts, over only four lesson plans, we should not read too much into the results. Certainly, the data are limited in value, since all students might be expected to show some development in lesson planning skills over a two week period, as a natural result of sustained practice in the task. Moreover, the degree and consistency of the changes in lesson plan quality over the four lesson planning sessions for novice student-teachers is, despite being positive, somewhat fragile. It is necessary to obtain other data to help validate and explain the nature of the apparent trends seen in this present data. Also, it would be desirable to obtain an extended sample of data revealing the quality of

lesson plans produced by students, to allow observation of apparent trends in the data over more time and more tasks. Both these limitations in the pilot study are addressed in the main study, and in particular, the second part of the main study (see Section 7).

However, despite the limitations in the data provided by this pilot study, they did suggest that the use of the LPS by novice student-teachers over a two-week period, led to developments in lesson planning skills, to the extent that these students begin to move towards a similar (but not equal) skill level, to those of their expert student-teacher counterparts. When, in addition, this data are related to the interactions and temporal data sets, there does appear to be a significant convergence in the data overall. For example, it was seen that by the fourth lesson plan, both sets of students (novices and experts) were performing the tasks in almost the same way, with similar levels of interactivity with instructional and performance components of the LPS; and furthermore, both sets of students were taking approximately the same amount of time to complete the tasks. That is, all data taken together in this pilot study, tentatively suggests that by use of the LPS, novice students developed skills in producing lesson plans that moved them towards expertise.

Conclusion

The results for this pilot study provided an indication of the operational effectiveness of the LPS as a PSS, for both novices and experts in lesson planning, but particularly for novice student-teachers. There is an unequivocal and convergent picture that emerges in the three types of data accounted for here, (interactions, temporal and product data), that validates the LPS as a PSS, and points to its potential in developing expertise in novice student-teachers, learning and performing the complex task of lesson planning. However, a clear indication arose in this study, prompting a need to obtain data that helps explain and validate the apparent trends seen here, data that will provide richer insights into how both novice and expert student-teachers use the LPS to develop learning and performance skills in a complex task.

Furthermore, whilst we have in this pilot study, data sets that reveal patterns in students' use behaviours as perhaps being indicative of cognitive strategies applied to the task of lesson planning using the LPS, only with additional data

sets will it be possible to identify these cognitive strategies that no doubt underlie students' use behaviours. The next two sections (Sections 6 and 7), then, describe and analyse data from a second or main study, which was designed and conducted in two parts. Taken together, both parts of this main study were formulated to:

- address the limitations revealed in the pilot study; and,
- collect more and different types of data, to reveal more about students' cognitive strategies in using the LPS for lesson planning.

In particular, both parts of the main study extended the numbers of tasks completed by the students; and, in the second part of the main study (see Section 7), also varied the circumstances in which the tasks were completed. For example, the tasks in the second part of the main study were completed *during* the period of the students' professional practice, rather than preceding it, as in the pilot study. It was thought that the situations in which students would be using the LPS would have greater authenticity and therefore provide data of increased validity, if the LPS was made available to students at a point of need, and at times when students themselves would expect to complete their lesson planning tasks on a day-to-day basis.

SECTION 6

Investigation of the effects of the LPS: Main study I**Introduction**

In the framework appropriated for this research programme, the main study was intended to build upon the outcomes and procedures of the pilot study and to address its shortcomings. Where the focus in the pilot study was largely upon exploring and validating the ways in which the LPS actually functioned as a PSS, the focus in the main study was to explain in greater depth and with increased validity, how the LPS is used by novice student-teachers to learn and perform the complex task of lesson planning. In terms of the research orientations provided for this programme, the main study addressed the third and fourth orientations:

- 3 Investigate how novice student-teachers engage the instructional and performance components in the LPS to produce a lesson plan.
- 4 Investigate the effectiveness of the LPS as a PSS to support the completion of lesson planning.

In this context, data were collected by video recording student's use of the various functions and features in the LPS, with the intention of identifying their cognitive strategies and patterns in use, by considering such questions as:

- which functions were used in the LPS;

- what was the frequency of use of various function types (instruction cf. performance);
- what action or sub-task was the student performing in their use of each of the functions in the LPS.

Additional data were also collected by interview, where video tape recordings of students completing their sixth and final lesson plans, were shown to the same students to help stimulate recall of their strategies, approaches and thinking processes engaged in their use of the LPS to produce the lesson plans. Interviews were conducted one-to-one, and comprised a series of open questions which sought to identify how students perceived they completed the lesson planning task; but more importantly, probed why students performed and managed the task in the manner they described. Interviews were held only once for each student, and at the completion of the two-week use period. Therefore, students were asked to reflect on the lesson planning task as a whole, also addressing the notion of change over time—did students think they changed their cognitive strategies (how they used the LPS) over time; and did students change their management of the task over time?

Also, as in the pilot study, the output of students' use of the LPS was accounted for, with each lesson plan produced subject to criterion and outcomes based assessment, together with a measure of how long it took to be produced. Furthermore, an additional lesson plan produced by traditional 'pen & paper' means, by each student immediately following their final use of the LPS, was also subject to temporal, criterion and outcomes based assessment, and used to ascertain the degree of skill and knowledge transfer in individual students.

Procedure

A procedure similar to that provided for the pilot study was followed here, with the main study occurring approximately one year following the pilot, and therefore including students from a different cohort and year. Four students, two male and two female, were identified to provide the focus for studying their patterns of LPS usage over a two week period. These students were volunteers

and self-confirmed novices in lesson planning²⁶. It was clarified, in both a verbal and written invitation to take part in this study, that experience with the LPS would not preclude students undertaking 'normal' preparation for professional practice as part of their course²⁷.

The students were tutored in the use of the LPS, to the point at which they felt comfortable with their skill in the use of the technologies (ie. computer and software use). This point of 'comfort' was self-determined and reached without interference in the decision-making by the tutor (ie. the researcher). However, unlike the preparations for the pilot study, these students advised they had reached this point after about 120 minutes of non-continual use of the LPS, following two or, as in one student's case, three sittings. As in the preparations for the pilot study, it was expected and encouraged, that these students in their normal development of lesson plans for later use in teaching children, would tap into support of any type, including peers and university supervisors soon to be assigned to the students, for example. Any support given, of course, has been documented for each student, and used to illuminate data analysis.

Students then used the LPS to plan a minimum of six lessons, over a period of two weeks—and as in the pilot study, students were asked to produce these lesson plans so that they might be implemented in their professional practice placement schools (to which they had already been assigned). They were all encouraged to make greater use of the LPS, although this use went unobserved and unrecorded; however, students were asked to keep a written record of extra usage, and account for that usage when interviewed. Observational data were collected by video camera recordings, providing a complete record of use of the LPS for each student for each session of use. This provided data to determine

²⁶ As with the pilot study, these were Faculty of Education students in their first year of a four year Education degree programme, who, in a five-point likert scale questionnaire, perceived their lesson planning skills as 'poor' or 'non-existent'. In the process of inviting students to participate in the research programme, it was put to all potential participants (in writing and verbally), that they would be expected to use the LPS as a computer tool to help them develop their lesson planning skills over a two week period at a central location (ie. a computer laboratory) at university, in preparation for professional practice (where lesson planning is a required and assessed performance skill of the students). In addition, it was made clear to these students that use of the LPS would not, in any sense, be regarded as part of their 'normal' studies, and not influence any part of their assessment in their Education course. The first four students to verbally volunteer for this study were chosen: it was coincidental and of no significance, that these students happened to be equally divided in gender.

²⁷ Instruction in lesson planning is, in fact, only offered to students as part of a more general approach to the practice of classroom teaching. Specific preparation for professional practice is provided for students during a two-hour period, where expectations for drawing up lesson plans are described. There is no explicit lesson planning skill development in students at any part of their formal course in the Education degree, except as part of incidental teaching whilst on professional practice.

students' cognitive patterns or strategies in the use of the LPS, over time. Individual follow-up interviews conducted at the completion of the two week period, helped determine how all students managed aspects of the lesson planning task. Interviews were conducted one-to-one, and comprised a series of open questions which sought to identify how students perceived they completed the lesson planning tasks, and probed why students performed and managed the task in the manner they described. The sixth and final video tape recorded for each student, was played back to the student at this point, to elicit a delayed think-aloud procedure, acting as a prompt for each student to offer explanatory comment on their actions and behaviours in using the LPS, over the whole period of use. Interviews were held once for each student, and at the completion of the two-week use period (ie. within 10 days of the completion of the final lesson plan observed) so that students could also be asked to reflect on the lesson planning tasks as a whole, addressing the notion of change—did students think they changed their cognitive strategies (how they used the LPS) over the period of use; and, did students change their management of the lesson planning task over the same period? All interviews were recorded by use of an audio cassette recorder, and later transcribed for use in analysis.

Further, each of the six lesson plans produced was evaluated by an expert lesson planner (ie. lecturer or teacher), as a measure of product quality; and, as a means of gaining an indication of the strength of transfer in students' learning over media, these lesson plans were then compared to a lesson plan produced by each of the students by 'pen & paper' means, following their use of the LPS.

It had been anticipated, within a methodology of data saturation (Glaser & Strauss, 1967, p. 67; Hopkins, 1985, p. 111), that additional data might be required, from either additional students and/or additional lesson plans produced by the same students. However, it was found within the four students and 24 lesson plans initially targeted, that data were already being repeated sufficiently for patterns to be identifiable within this data. In this context, additional students or the production of extra lesson plans were not required for this study.

In all cases of data collection in this study, the target students used the LPS at a central computer facility, based at Edith Cowan University, largely so that video recording could be conducted and managed more fluidly. However, as in the

pilot study, where students might request to use the LPS on computers away from this central resource, full support would have been made available (ie. help in setting up the software and computer; and, access to the LPS), other than the provision of off-campus university computing resources. However, in the event, no requests of this type were made by the student-teachers employed in this study.

In recording students' use of the LPS, taping occurred, for all students, over both weeks of the two week period (ie. no student was only recorded in one of the weeks). Furthermore, similar to the experience in the pilot study, all students were recorded producing at least one lesson plan within the last two days of the data collection period, to maximise the chances of obtaining data that might reasonably be expected to demonstrate a development in lesson planning skills, with the expectation that these skills would have become more refined by the final stages of the professional practice period.

The same video taping procedure was followed as in the pilot study, where the researcher, as operator of the video camera, was present at all video taping sessions for all students. In this context, the researcher also operated as a participant observer (Hopkins, 1985), helping students if and when they requested it, both with operational use of the LPS and the computer, as well as with requests for support which addressed issues of lesson plan construction. All interventions by the researcher, however, were only completed as a response to a student request for support, and were recorded³⁰ and referred to in analysis of the data, if relevant.

In most cases of observation in this study, taping occurred of two students simultaneously. It had been clear at the pilot stage, that managing a timetable for observing and recording 24 lesson plans or more from four students was extremely difficult. This study proved be similar in this respect, and students often had to break and/or rearrange designated data collection periods³¹. However, rather than being a disadvantage, students seemed to enjoy the opportunity to work alongside a peer, and the situation seemed to engender a

³⁰ Interventions by the researcher were recorded in terms of: (i) their frequency for individual students (ii) their nature (ie. whether technical or content related); and, (iii) their specific relationship to particular aspects of the LPS (ie. instruction or performance).

³¹ Indeed, even in these circumstances, the data collection period had to be extended by two days, to allow four students to produce their final two lesson plans.

more natural, social atmosphere for the students to work within. As in the pilot study, each of two video cameras set-up for this study, were positioned to obtain a view of the computer screen and a partial view of the computer keyboard, for each student.

The video tape footage for each student and each session using the LPS, was then subject to coding and analysis by the researcher, involving:

- recording student use of the various components of the LPS during the completion of a lesson plan, differentiating between use of performance and instructional components; and,
- determining the total time taken to complete each lesson plan.

Finally, each of the lesson plans produced by the student-teachers were subject to a descriptive evaluation and consequent grading by a lecturer in Education at Edith Cowan University, as in the pilot study. The criteria and outcome statements used to guide the assessment of each students' lesson plans are described in Appendix B.

In addition, an extra lesson plan was produced by each of the student-teachers in this study, approximately one week following the end of the initial two-week data collection period, and as part of their normal requirements for the professional practice period. This lesson plan was produced by each student at the beginning or immediately preceding their first professional practice, for implementation in the their classroom. It was also produced without the support of the LPS, and by means of 'pen & paper'. This final lesson plan was also graded in the same manner as, and the outcomes compared to, those produced for this study by use of the LPS. In this way, the level of skill transfer was assessed for students across two media: LPS and 'pen & paper'.

Presentation of data

The results for this study are presented as data represented in tabular and figure formats. Also, in the table data, the presentation of raw numbers of students' interactions with instructional and performance components in the LPS, is accompanied by an instructional-performance (IP) coefficient, to more effectively represent the changing nature of LPS usage over all lesson planning tasks. This coefficient is calculated by dividing the total number of instructional (I)

interactions for each lesson plan, by the corresponding number of performance (P) interactions. For example, an equal number of instructional and performance interactions for one lesson plan, would provide an IP coefficient of one (1). Whilst there is no optimum IP coefficient index, when calculated over a range of lesson planning tasks, for each student-teacher, the IP coefficients can provide an indication of the development of expertise in students' lesson planning skills.

As in the pilot study (see Section 5), and for the same reasons, one type of graph has been used to represent two data types: line charts are used to represent, (i) the degree of student interactivity with both instructional and performance interactions; and, (ii) the time taken for students to complete the lesson planning tasks using the LPS. Also, to distinguish references to particular lesson planning tasks (ie. the task of completing a lesson plan), in quotes presented from the student interview data and in general discussion, lesson planning tasks are referred to by a hash sign (#) and a number—for example, #3, is used to refer to lesson planning task 3.

Results—interactions

For the first student (1), there was a gradual reduction in the use of instructional components in the LPS over the six lesson planning tasks (28–17, or 39.2%); and a corresponding increase in use of performance components, to reach a maximum in the third lesson planning task (20–28, or 28.6%), to fade back by the final (sixth) task (20–20, or 0%), (see Table 6.1.1). Interestingly, there was a gradual reduction in the time taken to produce the first three lesson plans, followed by a more dramatic reduction between the third and fourth lesson planning task, followed again, by a stabilisation in the task times over the final two lesson plans. From the figures produced for all measures (ie. interactions and task time), this first student appeared to have stabilised his use strategies by the fourth lesson planning task, and maintained these strategies for tasks 4–6. The IP coefficient for this student reinforces this view, reaching a level of stability at 1.2, for lesson planning tasks #3, #5 and #6.

Table 6.1.1. Student 1 (Study 1): Lesson plans 1–6.

Lesson plans	LPS Components			Time (mins)
	Instruction (I)	Performance (P)	IP Coefficient	
L1	28	20	0.7	39
L2	27	21	0.8	34
L3	23	28	1.2	35
L4	18	25	1.4	20
L5	18	22	1.2	19
L6	17	20	1.2	18

Figure 6.1.1, reveals an interaction in the data somewhere between the second and third task, indicating that this student adopts and maintains a use behaviour, perhaps itself indicative of cognitive strategies, that reflects the initial application of a level of expertise in the task, at about this point.

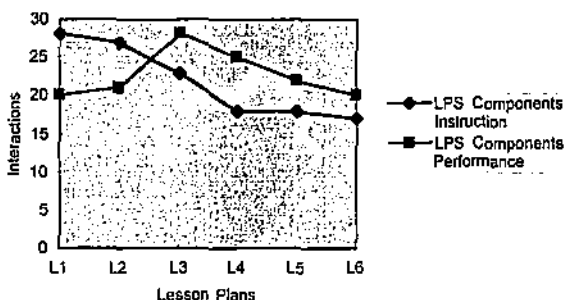


Figure 6.1.1. Student 1 (Study 1): Lesson plans 1–6.

The second student (2) provides evidence of a greater yet equally consistent decline in the number of interactions with instructional components, over six lesson planning tasks (33–15, or 54.5%), (see Table 6.1.2). Again, there was some fluctuation in the interactions with performance components over the same tasks—generally, there was a decline in these interactions, except for lesson planning tasks four and six, where the number of interactions reversed the dominant pattern, and increased slightly. Interestingly, there was a consistent decrease in the task times over the completion of the six lesson plans, with the final task taking less than half the time spent on the first (a decrease of 21 minutes, or 52.5%).

Table 6.1.2. Student 2 (Study 1): Lesson plans 1–6.

Lesson plans	LPS Components			Time (mins)
	Instruction (I)	Performance (P)	IP Coefficient	
L1	33	30	0.9	40
L2	31	28	0.9	36
L3	25	25	1.0	35
L4	20	26	1.3	26
L5	17	23	1.4	21
L6	15	28	1.9	19

Furthermore, despite the fluctuations in the performance interactions over the six tasks, the IP coefficient over the same span does indicate a steady development in use strategies, rising from 0.9 to 1.9. Arguably, the IP coefficient data for this student represents a relatively strong pattern in the growth of expertise. This notion is reinforced by reference to Figure 6.1.2, where an interaction in the instructional–performance interactions data, occurring at task #3, and strengthened thereafter (i.e. as indicated by the widening area between the two lines on the graph, each line representing, respectively, the instructional and performance interactions data sets) suggests that a level of expertise is reached at this point.

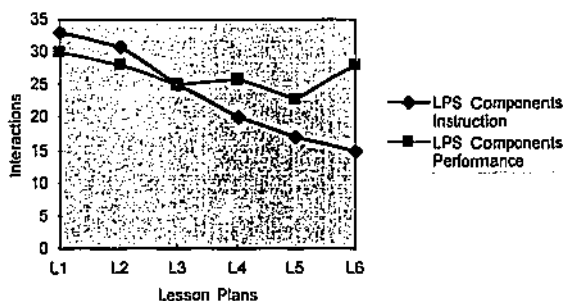


Figure 6.1.2. Student 2 (Study 1): Lesson plans 1–6.

There is less consistency in the figures provided by the third student (3), (see Table 6.1.3). Whilst the interactions with instructional components decreased over the six lesson planning tasks (28–15, or 46.4%), there was a big fluctuation in

this pattern at the second task. At this point, the interactions with instructional components fell from 28–11 (60.7%), only to rise again to an overall maximum of 31 interactions at task #3, and to decrease more steadily thereafter. Similarly, there was an overall increase in the number of interactions with performance components (16–20, or 20%), but with a marked fluctuation at the third task, where interactions increased dramatically (16–28, or 42.9%), only to fall back into a more gradual pattern of increasing in the fourth task.

Table 6.1.3. Student 3 (Study 1): Lesson plans 1–6.

Lesson plans	LPS Components			Time (mins)
	Instruction (I)	Performance (P)	IP Coefficient	
L1	28	16	0.6	45
L2	11	18	1.6	44
L3	31	28	0.9	48
L4	25	19	0.8	22
L5	18	18	1.0	24
L6	15	20	1.3	20

Again, whilst there was an overall decrease in task time over the six lesson planning tasks (45–20 minutes, or 55.6%) there were significant fluctuations in this pattern at the third (ie. rising to 48 from 44 minutes) and, to a lesser extent, the fifth tasks (rising to 24 from 22 minutes for the preceding task).

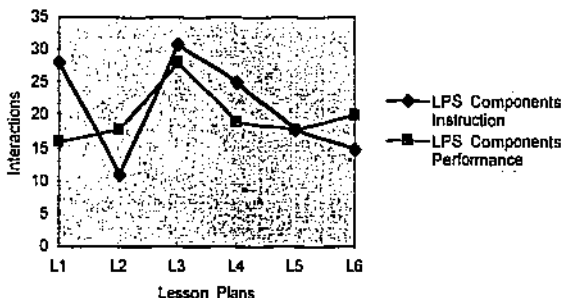


Figure 6.1.3. Student 3 (Study 1): Lesson plans 1–6.

The IP coefficient data for this student are similarly inconsistent, rising from 0.6 to reach 1.3 by the final task. However, this apparent development masks uneven

fluctuations in the IP coefficients throughout the tasks between these two extremes. Indeed, the patterns in the interactions data represented in Figure 6.1.3, reflect the same inconsistencies in use behaviour, providing little evidence that a level of expertise in cognitive strategies is developed by this student.

Table 6.1.4. Student 4 (Study 1): Lesson plans 1–6.

Lesson plans	LPS Components			Time (mins)
	Instruction (I)	Performance (P)	IP Coefficient	
L1	27	19	0.7	33
L2	25	21	0.8	25
L3	19	20	1.1	20
L4	22	27	1.2	25
L5	16	28	1.8	17
L6	16	27	1.7	18

The fourth student (4) provided evidence in the resulting patterns of interactions with both instructional and performance components of the LPS, of the development of 'classical' use strategies (see Table 6.1.4). That is, there was a smooth decrease in the number of interactions with instructional components (27–16, or 40.7%), matched by a corresponding increase in the use of performance components (19–27, or 29.6%), over the six lesson planning tasks. Furthermore, there was a similar, decreasing, pattern revealed in the task times (33–18 minutes, or 45.5%). However, it is noteworthy, that where there was a momentary lapse or reversal in these patterns, it was in the same task—so that, at the fourth lesson planning task, the interactions with instructional components momentarily increased (from 19 to 22); and the time taken to complete this task also increased (from 20 to 25 minutes).

The IP coefficient data for this student reflect an even development in use strategies, ranging from 0.7 at task #1, to 1.5 at task #6. Figure 6.1.4, reinforces the consistency and strength in this pattern, suggesting that a level of expertise is reached by task #3 and maintained and strengthened thereafter.

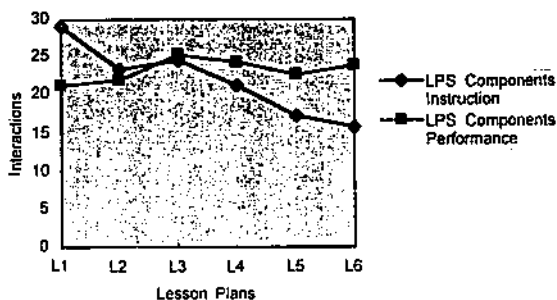


Figure 6.1.4. Student 4 (Study 1): Lesson plans 1—6.

Taken together (see Table 6.1.5), all students over all six lesson planning tasks, the patterns in the data are more or less regular. The decrease in use of instructional components was consistent and gradual over the six tasks (29–16, or 44.8%); there was also a corresponding increase, less rapid and less consistent, in the use of performance components over the same tasks (21–24, or 12.5%); and finally, we see a smooth, consistent and overall, very significant decline (ie. a difference of 20 minutes between the first and last task, or 51.3%) in the task times recorded.

Table 6.1.5. Students 1—4 (Study 1): Lesson plans 1—6.

Lesson plans	LPS Components			Time (mins)
	Instruction (I)	Performance (P)	IP Coefficient	
L1	29	21	0.7	39
L2	24	22	0.9	35
L3	25	25	1.0	35
L4	21	24	1.1	23
L5	17	23	1.3	20
L6	16	24	1.5	19

Again, the average IP coefficient data for the entire group of students, demonstrate a clear and steady growth in use strategies, rising from 0.7 at task #1, and reaching 1.5 at task #6 in regular steps of 0.1 or 0.2. Figure 6.1.5, also reveals a clear and strong interaction in the composite data, occurring just before task #3, with the diverging data patterns thereafter clearly marking the reaching of, and a strong development in, expertise.

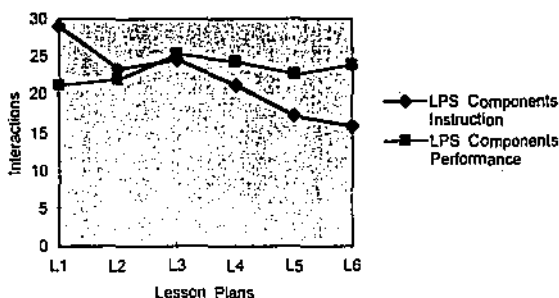


Figure 6.1.5. Students 1—4 (Study 1): Lesson plans 1—6.

The temporal data for the students, when plotted on a single graph, show that for all students, the time taken to complete a lesson planning task declined over the entire span of tasks (#1—#6). Also, for most students, this pattern of reduction is almost identical: starting at or near 39—40 minutes for the first lesson planning task; falling to around 35 minutes by the second task; holding steady for the third task, and then falling rapidly for the fourth task, before adopting a more gradual and even decline for the fifth and sixth tasks. Of the two students (3, 4) who did not conform to this pattern, neither is entirely out of sympathy with the broader design. Indeed, student 3 follows a similar temporal data

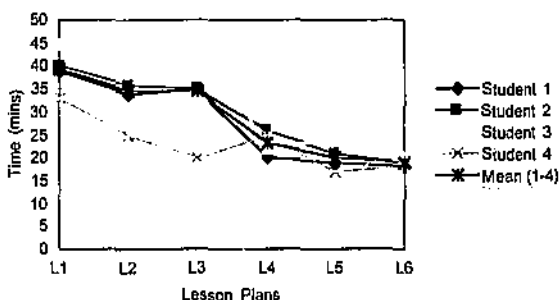


Figure 6.1.6. Time taken for task completion in the LPS for lesson plans 1—6 (Study 1).

pattern as the majority of others in this sample, except that she starts at a higher point, only to decline more rapidly at task #1, to come back into line with the others; whilst student 4, joins the broader pattern by the same task (#4). The data for all students increasingly converge over the last three lesson planning tasks, so that all students complete the final task in approximately 19 minutes.

Discussion

Generally, the patterns revealed in the interactions and the task-time data for these four students over all six lesson planning tasks, tell a remarkably similar story—decreases in use of instructional components, less significant and less consistent increases in the use of performance components; and dramatic reductions (ie. up to 56%, with an average of 51.2%) in the time taken to complete the tasks. It is in the IP coefficient data that we find the most consistent patterns: all students develop from below the 1.0 mark (approximately 0.7) in the initial task, to reach up to 1.9 by the closing task; and on average, all students experience a growth of 0.8 over this span of tasks.

When these data are matched with that revealed in the Figures 6.1.1–6.1.4, we can see that the students develop and sustain a marked level of expertise in their production of lesson plans; and further, that the point at which expert strategies are first in evidence, is, on average, at or very near the third lesson planning task. Indeed, Figure 6.1.5 shows an interaction in the data at these points, revealing the stage at which the students have a ratio in the use of instructional:performance components, of one. The exception to this, is for the third student (3), where such a development may not occur (if at all) until the fifth task.

Of course, it could be suggested at this point, that results similar to those obtained in this study, might be obtained in a study of students where they were not using the LPS to plan lessons, but doing so using traditional media (ie. pen & paper) and in traditional circumstances (ie. pre-task learning, where learning is independent of task completion, and where task performance is not necessarily supported with instruction or performance help at the point of need). However, we need to remember that this study was intended to identify the cognitive strategies employed by students to plan lessons using the LPS to better understand the way in which PSSs can be used as cognitive tools to support and enhance performance in complex tasks, such as lesson planning. Indeed students

may well use the LPS to the same overall effect as traditional media, whilst the manner of this use may be very different.

Interviews

The observational data captured by video camera-recorder, were intended to reveal, on analysis, students' cognitive patterns or strategies in their use of the LPS in the completion of all six lesson plans observed. Individual follow-up interviews, conducted at the completion of the two week period, to determine how all students managed aspects of the lesson planning task, made use of these video recordings to elicit a delayed think-aloud procedure, as prompts for students to offer explanatory comment on their actions in using the LPS³². The process of stimulating students' recall of and reflection on their thinking during their experiences of planning lessons using the LPS, allowed for the richer documentation of students' cognitive processes and also increased accuracy (reliability) in interpretations offered in analysis of the video data.

The interviews were all captured on audio tape, using a cassette tape recorder and single multi-directional microphone. These interviews were later transcribed in full and the researcher worked solely from these transcripts for purposes of analysis. Where a student made a specific and explicit reference to what they were observing at any one point on the video playback screen, the nature of the behaviour being referred to on screen was noted in writing by the interviewer (ie. the researcher), and if appropriate, referred to in analysis. Interviews with each of the four students lasted approximately 18 minutes, and not longer than 27 minutes.

The researcher implemented the interviews by following a similar procedure³³ for each student:

- (i) an explanation to the student as to the reasons and procedures for conducting the interview;

³² At an earlier stage in this research programme, where the open-interview questions were tested and refined, it was projected that too much unnecessary data would be generated if interviews were instigated for each students' six separate uses of the LPS; that this amount of data gathering would be difficult to manage; and finally, that students could be guided to describe and explain the changes in their cognitive strategies they might have experienced over multiple uses of the LPS, by only using the last (most recent) video tape of their lesson planning to help stimulate both recall and reflection of previous sessions with the LPS.

- (ii) set-up of video tape replay facility so that the researcher and student can view the screen; set-up of the audio tape recording facility, to record the interview; start to replay the videotape of lesson planning task #6;
- (iii) initial generalised discussion about how the student felt about their experience using the LPS; how valuable they thought it had been; important points recalled concerning their use of it over the six lesson planning tasks recorded, together with any other additional occasion that had gone unrecorded;
- (iv) invitation to comment on strategies or approaches they thought they might have followed in completing this and any other lesson plan using the LPS;
- (v) prompt to recall previous lesson plans constructed using the LPS, and how the student might have experienced any change in patterns of use over the six lesson planning tasks;
- (vi) invitation for the student to add any other comments, of any type, on this research exercise and/or their use of the LPS;
- (vii) at any point in the procedure the video tape might be stopped and re-wound or forward-wound, to get to a place in the video tape that the researcher or the student might be referring in their comments. Other tape recordings for each other lesson planning tasks engaged by the student using the LPS were available at this session to be replayed if necessary. However, only the video tape recording of the sixth and final lesson planning task (#6) was replayed in any of the students' interviews.

The quotes given here are taken from the interview transcriptions, and have been edited and selected for their relevance and significance to the research questions in this study. In some extracts, the verbal prompts from the interviewer have not been included³³; also, in transcription, periods of silence and other non-verbal breaks in the interviews have been ignored unless thought to be relevant.

Student 1

The first student (1) was interviewed during a professional practice period, 8 days following the production of the final (sixth) lesson plan produced using the LPS. In the case of this student, the interview data revealed broad explanations for the nature of use of the various components over the two week period.

³³ This procedure is also provided in Appendix A.

³⁴ A full description of such prompts and questions, and the manner in which they were used to elicit verbal responses from the students, are available in Appendix A.

Even though I thought I had got to know the software (LPS) pretty good, it took me sometime before I could use it, and I didn't find it helpful to start. Here (ie. during the sixth lesson planning task), it was fine, I knew what it could do and it helped me produce good lesson plans.

I used it at for the first couple of times, to learn about lesson plans. I didn't know much about how to go about it, we weren't really told much in class. So I thought this would be a good way of finding out.... Yeah: well it did tell me a lot about the parts of a lesson plan and how to write it properly. And I used the program (ie. the LPS) to explore everything I could at first, to find out how to write a lesson.

When I felt happy with knowing what to do, I started to think more about the lessons I was supposed to be teaching. I knew what lessons I had, sort of; and I told the teacher (ie. the student's supervising classroom teacher) I was using something new to write my lesson plans; that I had to write them at uni. I suppose I really felt like I got better at it at the end (ie. at the completion of the two week data collection period).

Here, I didn't have to use the stuff about how to do the lesson plan, I already knew what to do... how to do it. But I did sometimes need to check things, and the program makes you look at your evaluation carefully³⁵. I spent sometime getting the print-out right, it wouldn't print out at first.

I did get faster at producing the lesson plans, I know that. But it didn't matter to me about how long it took. I just needed to make sure the plan was right. My teacher is a formal type of teacher, wants to have things done on time and his way. It was good in a way, coming into to uni to write my lesson plans, before getting out to the school, it made me do them on time and get them out of the way. But I also did some of the lessons (ie. lesson plans) at the school and at home, I couldn't really spend the time coming back to uni to write them here. It would be better if we had a computer at home to do this, or even at the school, so we could use the program during prac. I used the program a few times more than the six lessons you asked me to do but I

³⁵ The student is referring to that part of the LPS which guides the user, on completion of the lesson plan, to reflect on the relationship between the objectives and the evaluation processes put into place—did the lesson plan allow for appropriate evaluation of intended learning outcomes?

didn't come in any more (ie. six times, once for each lesson plan produced by use of the LPS), I did a few other lesson plans when I was already here (ie. being recorded completing the lesson plans).

Yeah, I did feel that my lessons improved over the practice. The teacher was very happy with them, they weren't an issue for him. I know the marks I got (for the lesson plans) were OK, but I think, the teacher said this, they were much better now, during the practice, that they are as good as I need at this stage. I don't really know how I could make them better. I mean, it's what goes in the classroom, anyway, not the plan. I need to think about how to be a good teacher, not just planning the lessons.

No, if I had a chance again, I don't think I would use this program. It's good to get to know about lesson plans, how to do them, what's a good lesson plan; but once you know what to do you don't really need to use this program, it's too... inconvenient. I could write them just as well normally, without a computer.

Interviewer: Did you develop a 'best' way of using the Lesson Planning System for writing your lesson plans?

No, not really. I did concentrate less on getting to know how to do the lesson plans, you know, learning about lesson planning. And at the end I was just checking on whether the lesson was well planned, by looking at the sample lessons, at the evaluation—this is the hardest thing to do, to keep changing the way I can tell how children were learning or not. You can't have tests all the time, or work-sheets to tell you if they are learning, I know that... And what about individual children, I mean I had two kids who found writing really difficult, and I had to set them special things to do, making sure they were working but also keeping up with the progress of the rest of the class. This was really hard going. It's so easy to sit back and just let the kids, the whole class, get on with things, like doing a work-sheet, without knowing how some kids cope with it. You really have to plan for the range of abilities. The program was good at this, I could check how to do this when I realised what a problem it was; I could check the way to go about doing this—it was all there, in the program. So I suppose I would use the program again, but it's not a very convenient way to write lesson plans. It would have to be easier to use, say at school.

Interviewer: Do you think you developed effective strategies for writing lesson plans?

A strategy? I'm not sure what you mean... Yeah, OK, I probably did. Not at the beginning, I mean, at the end I found it better, quicker, to work from previous lessons, from their plans. So I opened them and then saved them under a different name, a different lesson plan name. I then changed the content. This was easier, especially for follow-up lessons, where much of the plan was always the same. Even for other lessons, this is a good way of going, especially when you know what you were doing. It's certainly a faster way of operating. But this was the only real way I can think of, how I stuck to one way of doing things. I spent a lot of time at the end of these weeks, thinking about the lesson, not working out how to do it but thinking about what the kids were supposed to be learning, how I was trying to get them to learn something. And like what I was saying before, thinking about individual kids in the class, those two or three kids that struggled with things. The teacher really helped me here. But I learnt a lot from the program, the information its got on working with groups of kids and setting out different ways of teaching the same thing to different kids. It would have been good if there had been more examples of this sort of thing—all the lessons, the examples, are from easy lessons, from teaching the whole class... Yeah, it needs more examples of more unusual lessons, of different teaching approaches. I guess I could have worked from these examples, to produce my own lessons, not copying, just using them as... guides, (prompted by interviewer with the word, 'templates') yeah, as templates. I can't think of anything else really.

I don't think I would have used the program differently later on, if I'd used it more later on. I don't think, perhaps anyway, I wouldn't use it at all. But it really does help, especially at first, when you don't know much about what to do first. But it can take a long time to get something out, to get the printing of the lesson plan.

For this student (1), then, there is a clear validation of the analysis of the video data: an initial concentration on instructional components, primarily to compensate for a paucity of personal knowledge in this task, of all types (declarative, procedural and metacognitive); and then a gradual decline in the use of these components and a corresponding, if somewhat inconsistent, development in use of performance components. The student is aware of his own

increasing skills, not only in the use of LPS (shown by his identifying (i) the preferred strategy of template use; and, (ii) the limited value of the LPS as a long-term tool) but also as product outcomes—the completed lesson plans. In fact, the student is slightly concerned that the grades given for the lesson plans, for this research programme, did not reflect his own perception of his skills in this task, by the beginning of his professional practice period. But perhaps the LPS was of greater value in supporting task completion than this student thought, given the single grade decline between the final (#6) lesson plan created with the LPS and that produced by 'pen & paper' means (#7), (see Table 6.3).

In terms of his view on the longer-term usefulness of the LPS, it is interesting that a significant issue for this student is the excessive amount of time he perceives it takes to write a lesson plan by use of the LPS. In fact, by the completion of the data collection period, he is producing a lesson plan in 18 minutes. It is doubtful that this time would be determined as excessive by either novices or experts in this task.

There is evidence in this interview data, that the student initially saw the LPS as a 'value adding' tool, where there was clear benefits to be had from being able to word process to a template; to be prompted to check aspects such as lesson evaluation; and also to be able to provide well-formatted print-outs of lesson plans—for example: '...the program makes you look at your evaluation carefully... (and)...I spent sometime getting the print-out right'. There is additional evidence that this student came to see his use of the LPS as a scaffold, which could be removed 'once you know what to do'. Indeed, this student clearly evolved a confident and critical practice in his lesson planning, as a result of his using the LPS together with the feedback he received in the implementation of his lesson plans: this is illustrated well throughout the extract of his interview given above, and particularly in the statements:

...this is the hardest thing to do, to keep changing the way I can tell how children were learning or not. You can't have tests all the time, or work-sheets to tell you if they are learning. I know that... And what about individual children, I mean I had two kids who found writing really difficult, and I had to set them special things to do, making sure they were working but also keeping up with the progress of the rest of the class. This was really hard going. Its so easy to sit back and just let the kids, the whole class, get on with things, like doing a work-sheet, without knowing how some kids cope with it. You really have to plan for the range of abilities. The program

was good at this, I could check how to do this when I realised what a problem it was; I could check the way to go about doing this—it was all there, in the program.

And also:

I spent a lot of time at the end of these weeks, thinking about the lesson, not working out how to do it but thinking about what the kids were supposed to be learning, how I was trying to get them to learn something. And like what I was saying before, thinking about individual kids in the class, those two or three kids that struggled with things. The teacher really helped me here. But I learnt a lot from the program, the information its got on working with groups of kids and setting out different ways of teaching the same thing to different kids. It would have been good if there had been more examples of this sort of thing—all the lessons, the examples, are from easy lessons, from teaching the whole class...

Providing a critical evaluation of one's own practice, tools and/or cognitive processes in completing a complex task, is strongly representative of expertise; indeed, the critical dimension of knowing is regarded by this author, as rationalised elsewhere, as being indicative of the highest cognitive order:

Without a critical dimension, knowledge cannot be transformed to have a wider or more universal application—in an approximation to Laurillard's view (1993), knowledge learnt without a critical dimension is knowledge learnt without abstraction. Moreover, understanding without a critical dimension is not true understanding. (Wild, 1998)

The critical cognitive dimension developed by this student in his use of the LPS and more widely in his development of lesson planning skills, led him to make a number of statements which reveal his appreciation of the limitations of the LPS, and the more appropriate ways in which it can be used.

Student 2

This student (2) was interviewed 6 days after completing the final lesson plan with the LPS, and immediately prior to embarking on the two-week professional practice period. In this case, the student has much the same interactions profile as the first (1); and the interview here again, lends some insights into the cognitive strategies developed.

I knew exactly what I wanted to do with the Lesson Planning System program. I had explored quite well beforehand, you know when we were getting to know how to use it properly. I spent ages on looking at the (instructional) information. So I just went straight in and started typing. I brought in some ideas for lessons I talked over with my teacher, I had written these down. Look, you can see me looking at them, here (pointing to the screen). I used notes all the way through.

I thought I wouldn't need to use the help information (ie. instructional information) so much, but I did, especially things like the evaluation. This was really good. And the way to write objectives—I never find this easy to do. I don't think I really like the way we're supposed to do this. I can't see why we can't just write what we want the children to learn, it's all so detailed.

I did work out a way of working. You can see this (pointing to the screen). I began to look at the sample lessons in the program but didn't copy these. I started from a blank lesson, a new lesson, most times. I know others used to change their lessons, using one they had already done as the way, the model, for their next one. I never really thought of this. It was just as quick for me to start a new lesson plan each time I used it. It was easy, to use the verb database to choose a verb to start the objectives, Then to use my own notes to write out how I was going to teach the children. I did find myself checking things as I went but perhaps not so much at the end. I think I just got bored with looking up and checking things with the example lessons, in the end. I didn't think I needed to. Did I?

The program was brilliant for making me think about what I was doing with the children. Even though I wrote lessons quickly in the end, (ie. using the LPS) I still was thinking more about what I was teaching, and things like how I was evaluating the children. I never really understood how to evaluate what children were learning, when we had this in lectures. I knew about tests and things, but not about how to tie in, to link different ways of testing with checklists, with the teaching objectives. I do now, I think. I don't even bother checking my evaluation any more, you know, that way the LP (LPS) program makes you check your evaluation at the end, before you print it or save it (ie. referring to the Reflection tool).

Yeah, yes, I think my strategy (prompted by the interviewer to use this word) was to sit and think about things more, at the end... Look, this is what I'm doing here, not just doing nothing (referring to her behaviour currently on view on the video tape). I didn't do this so much at the beginning, so yeah, it's something I learnt to do as I went on.

I really think I would like to use the LP program more, on prac, in the classroom. It's going to be too rushed in the classroom now, there's too many things to do in the day to sit and write good lessons. But the LPS could help me think about what's important, especially help me check what I've written, to make sure it's a good lesson.

Whilst this student (2) is not explicit about her strategy development, she is clearly aware that she grew in confidence and expertise, and indicated that to do this, she spent increasingly more time on reflecting on her lessons whilst performing the task of planning them. In this sense, it might be expected that the time taken to complete the lesson plans would have increased over the six tasks—whereas in fact, this time actually decreased, and was more than halved by the completion of the final task. This outcome lends some weight to a performance centred design view (Gery, 1995) that the development of both competence and expertise in a person for a certain task or skill set, comprises not only greater automation in the completion of sub-tasks or sub-skills (eg. in this case, sub-tasks or sub-skills might include the writing of objectives, instructional methods and evaluation processes) but also, and consequently, allows for greater amounts of time to be spent on less certain aspects of the overall task—which in this case, would include thinking at a higher level, about the nature, content and processes in a lesson. Moreover, the design features of the LPS, and in particular, one of the performance tools (Reflection Tool), was intended to help students develop their cognitive and metacognitive skills in the task.

Taking into consideration the results of this student's grade achievement in the post-LPS produced lesson planning task (#7), there is little support for her perception that the LPS was necessary to further effective lesson planning; but perhaps, more support for the notion that she had experienced successful transfer in learning across two media. The sixth (#6) and seventh (#7) lesson plans produced, spanning the two media, LPS and 'pen & paper', reveal an increase of

one grade (from D to C), the latter grade equalling that achieved previously, in the fifth task (#5).

This student developed a sound strategy early on in her experience with the LPS: aspects of the first and third paragraphs given above are clear indications of this. For example:

I knew exactly what I wanted to do with the Lesson Planning System program... So I just went straight in and started typing. I brought in some ideas for lessons I talked over with my teacher, I had written these down. Look, you can see me looking at them, here (pointing to the screen). I used notes all the way through.

I did work out a way of working. You can see this (pointing to the screen). I began to look at the sample lessons in the program but didn't copy these. I started from a blank lesson, a new lesson, most times. I know others used to change their lessons, using one they had already done as the way, the model, for their next one... It was just as quick for me to start a new lesson plan each time I used it... I did find myself checking things as I went but perhaps not so much at the end. I think I just got bored with looking up and checking things with the example lessons, in the end.

The statements above, are also indicative of the student's early development of confidence in her use of the LPS and in her approach to lesson planning more generally. Moreover, like student 1 in this study, she is keenly aware of the strengths of the LPS, how it benefited her development of skills and expertise, and how she could make best use of the LPS, as a cognitive tool, in the future. For example:

The program was brilliant for making me think about what I was doing with the children... I never really understood how to evaluate what children were learning, when we had this in lectures. I knew about tests and things, but not about how to tie in, to link different ways of testing with checklists, with the teaching objectives. I do now... I think my strategy was to sit and think about things more, at the end... I really think I would like to use the LP program more, on prac, in the classroom. Its going to be too rushed in the classroom now, there's too many things to do in the day to sit and write good lessons. But the LPS could help me think about what's important, especially help me check what I've written, to make sure its a good lesson.

Student 3

This student (3) was also interviewed 6 days after completing the final lesson plan with the LPS, and immediately prior to embarking on the two-week professional practice period. In this case, the student has a slightly different interactions profile from the first (1) and second (2) students; and the interview is particularly illuminating as to the development of specific cognitive strategies.

I think I did like using the LPS. I really noticed the difference in my confidence before I used it, like with now. I didn't have a clue what to do to write a lesson plan before (but) by the time I did this one (referring to the lesson plan currently being shown on screen), it was easy, yeah really easy. I still don't think I know everything about the computer (ie. the LPS) but I don't think you need to. You just need to get into a rhythm, a way of doing things. Just do what you know.

Interviewer: When did you find a 'rhythm', do you think?

It's just practice using it, it's not difficult. Hmmm, yeah, probably about half way through using it. I got a bit frustrated with how long it was taking me to produce a lesson plan, and almost asked to drop out of this trial with you (ie. this research programme); but it came together for me when I spent a few days on-end, together, coming to use it. I came in twice for a couple of hours to... explore the information it had on lesson plans. I went through, printed some of it out and thought about it, on my own. I didn't produce a lesson (plan) then, not one I was going to use. I just tried it out, looked at what it could do.

Interviewer: An earlier video shows you using another resource, a book, at some point. Why did you use this?

Yeah, I used the textbook, Barry and King³⁶. I needed to read about lesson planning and teacher preparation in one go, without jumping around the place. The book was good, I hadn't really looked at it before. It was only a chapter or two, and I could see how to plan a lesson. I still used the computer, later on, to make sure of some things,

³⁶ Barry, K., & King, L. (1993). *Beginning Teaching: A developmental text for effective teaching* (Second Ed.). Wentworth Falls, NSW: Social Science Press. This was one of the students' main textbooks for the first year in the B.Ed course.

like the verb database (ie. a performance tool). I really started to feel good about what I was doing by, I don't know.... not long anyway.

I started to build up some lessons and then just opened them onto the screen and saved them after making them different, as a new lesson plan. This made it easier or faster at least. I lined up the lessons I was going to teach with the school, and went through them, doing a whole subject at a time. The ones I did here were Maths' lessons. I planned about six lessons in Maths, one after the other. So the objectives were more or less the same, and I just made built up the methods, using groups and the like. I really thought about the group of lessons I was asked to teach, not just one at a time. I got a bit bogged down with the printing, though. You had to get the printing finished for one of my lessons, remember? (Here the student is referring to the need for the researcher to help out with technical problems encountered in getting a printout of the fifth lesson plan). Yeah, but it was good in the end, easy to use and I just felt good about what I was doing, how my lessons were coming together. Even when I did that last lesson (#7), I didn't have any problems. .. It was another Maths lesson.

The student here clearly reveals a strongly identified cognitive strategy, focused upon planning a coherent series of lessons, and using templates, drawing a similarity with a strategy described by the first student (1). Of particular interest though, is that this student found it necessary to use an external resource in addition to the LPS, to help in formulating her strategy, namely a standard textbook. In fact, much of the information in this textbook was used to provide the instructional support in the LPS (unbeknown, it would seem, to this student)—it was simply that the student appeared to prefer to access this information in a linear form of presentation, 'without jumping around the place'. It should be remembered here, that the instructional support in the LPS is highly structured and split over various sub-tasks in lesson planning; and it is accessed within a hypertext system. In this context, Jonassen's (1990) remarks are sobering:

Few designers of hypertext believe that hypertext knowledge bases should be unstructured and totally non-sequential so that users would have no guidance about the information they access. Even Nelson (1981) concedes that totally non-sequential hypertext can be disorderly and could lead to "Idiosyncratic and exceptional forms of connections". Non-sequential

hypertext also results in navigation problems (getting lost in hyperspace), as well as integration and synthesis problems. (Jonassen, 1990:85)

Again, as this author has written elsewhere, (Wild, 1997a; Wild, 1997b), we are reminded:

Hypertext does not possess a single or normative information structure—hypertext documents are created to conform or fit to a structure, imposed by their authors. At one extreme this structure might be highly ordered, supported by a constrained and sequential set of links; whilst at another extreme, the hypertext may be non-sequential and supported only by referential links. In many cases, a coherent hypertext document, such as a Web site, might comprise a mix of these structures. It is, then, the nature and application of these structures that determines the effectiveness of engagement with knowledge carried in the Web. Furthermore, to maximise engagement, the knowledge needs to conform to a structure that best fits or suits both the type of knowledge being conveyed, and the objectives set by the author for the types of interactions a user should have with it. (Wild, 1997b, p. 47)

In the case of this student (3), there appears to be something of a mismatch between the way in which the instructional information is structured and fragmented within a hypertext navigation system; and the individual students' preference to be able to access the information, as in a book—in a linear format, contained within a narrative, description and/or argument.

Furthermore, a PSS might be regarded by some to have failed in its design if a user does not succeed in obtaining all task-necessary support, performance and instruction, by its use. Certainly this is the view of Mauldin (1996):

If an EPSS succeeds in providing only seventy percent of the information required by the worker and the worker has to spend time looking to other sources for the missing thirty percent, the EPSS might not be considered very successful. (Mauldin, 1996, p. 125)

This view is one that would probably be shared by other authorities in the field of electronic performance support, if only implicitly, in their determinations of necessary attributes and behaviours of performance centred systems—see, Gery's

(1995) seminal work in this regard, for example. Although for others who have offered commentary and opinion on various design issues in PSSs, the matter and role of external support structures obtains no mention—Mülheim's (1992; 1997) work, for example, totally ignores them. However, Clark (1992) and Gery (1995), in particular, do acknowledge the potential offered by external support mechanisms to performance—that is, support which is 'not integrated with the computer-mediated workspace' (Gery, 1995, p. 3), suggesting that:

the designer's goal for a performance-centered system is to integrate as much as 80% of the required performance support as intrinsic support with plus or minus 10% each in the extrinsic and external categories. (Gery, 1995, p. 3)

And further, that the role of external support, particularly in training and instructional contexts, can be a vital one, particularly where there is a lack of user engagement in the instructional components of the PSS (Clark, 1992).

In the case of this student (3), there does not appear to be any sort of frustration with the fact that she has had to consult an external source of information. Further, we should not forget that in this situation, she is choosing not to source additional information, but information contained within the LPS, that is simply structured and embedded in a different format to that obtainable elsewhere. Thus, it is not the content or nature of the external instructional information that is of value to this student, but rather the format and structures in which it is contained and accessed.

Student 4

This student (4) was interviewed 5 days after completing the final lesson plan with the LPS, and prior to embarking on the two-week professional practice period. In this case, the student has what might be termed a 'classic' interactions profile³⁷; and the interview was able to probe the nature of this profile and its meaning in terms of the cognitive strategies developed.

³⁷ In this context, a 'classic' interactions profile would be characterised as a gradual and significant decline in a student's use of instructional components in the LPS; a corresponding increase in their use of performance components; and a corresponding reduction in the time taken to complete the lesson planning tasks.

I found the software easy to use and I felt good about how I was using it. Look, the whole thing about this was to use it to become better at planning school lessons. I know what I am supposed to be teaching during the next few weeks (ie, on professional practice). I didn't really know much about the software but I thought it was easy. To be honest, I didn't think it was going to help much. Lesson plans are pretty easy to do, just a lot of effort in doing the same things over, setting objectives using the right type of words, writing out what you are doing with the kids, how long things would take. I mean, it's no problem. It takes time. And the lecturer says it has to be right, the way it's put has to be just so. I think if I went on using it, even for this prac, I would use it to just print out the lessons, not to really go through the information. Once you've got that you don't really need to use it any more.

Interviewer: But even in this last lesson plan (#6), you spend some time reading the instructional information, look here (pointing to the screen)—where you seem to be considering different ways of evaluating children's learning?

Yes, OK. I did use it for some things still... I don't really remember this part. How long did I take to do this lesson plan? It was pretty quick, wasn't it? (Note: The interviewer informed the student it took 18 minutes, a little below the average time taken for this lesson plan by all four students). I thought it was quicker, it seemed quicker than this. Yeah, I suppose I did use the information more than I thought, maybe. But I don't think I had to spend much time on this piece of information. See, you can see we going back to the lesson already (pointing to the screen). I don't think I would have continued to use it like this. I would spend more time just on the lesson plan, you know, just getting it done, just for some questions, like the evaluation processes I could use... checklists, tests... which ones were the best ones. I guess it depends on how much you use it, how much you can remember from one go to another.

Interviewer: Did you have strategies for using the LPS, ways of using it that you felt worked for you?

Yes, I did have a strategy. I think, I started to concentrate more on doing it, like printing it and making it look good when I handed it in. It was neat to print it out, it

looked much better than by hand. But I found the printer didn't always get the lines right³⁸.

The strategy. Well, I suppose it was to get quicker at it, so that I could build up my speed in getting the lessons out, printed. And I tried not to waste time reading everything. OK at first, but afterwards, it just took too long. I used the other tools more, the verbs (ie. the Verb database), the example evaluations, templates, that sort of thing. That's what helped me more. You really need to provide help when things go wrong though, like the printing. I had problems with using the printer. Its not like, creating the lesson plan; its more about coping when things go wrong, like the printer. How are we supposed to know what to do? I tried to search for this information but it wasn't there³⁹.

Interviewer: Did you get really involved, wrapped up in the task, of producing your lesson plans? Did time go quickly, for example? Did you aim to produce better lesson plans for their own sake, rather than say, just get good marks for them?

I'm not sure what you mean. I did... I think ... I guess, forget how long things took. Time seemed to go quickly. I was just after good marks. I suppose I enjoyed using the computer for this work... but I still just wanted to get better marks, to help with doing a great prac. I'm like this in whatever I do, really, I suppose. I want to do the best, to get good marks. I mean the computer helped me but I didn't come in to use the computer for fun. I wanted to do well in my prac and to get good marks, better marks for my lessons. If you're don't get Outstanding in the final year, you're not going to get a job easily.

In some respects, this student does not tell the same story in his interview, as the interactions data reveal, for the full extent of his use of the LPS, for six lesson plans. There is an implicit assumption made by the student throughout his interview, that he very quickly modified his strategic use of the LPS to

³⁸ This student did experience transitory problems with the use of the printer. In particular, he found it difficult to get a good print-out for some of his lesson plans. This problem was solved by the researcher, after a different printer resource was provided to all the students.

³⁹ This might explain the momentary and relative increase in the use of instructional components at the fourth lesson planning task (#4), and the increased time taken to complete this same task).

concentrate on performance functions, and in particular to use that part of the software that helped him produce lesson plans that 'looked good'—that is, appropriately formatted. Also, as a part of this strategy he was concerned to produce lesson plans quickly and efficiently. However, the video recording of this students' use of the LPS, even for the sixth and final lesson planned, clearly demonstrates periods where he becomes engrossed in reading and reflecting in the instructional information available, and especially that concerned with (i) the setting of appropriate objectives; and, (ii) the place and nature of evaluation processes. Certainly, the interactions data reveal a reduction in the number of interactions made with instructional components, but it fails to show what is clear in the video recordings of the lesson planning tasks, especially the recordings of tasks #5—#6, namely the student spending increasingly more time on a few aspects of those functions. Interestingly, however, the student does not seem to appreciate this, dismissing the evidence of this approach seen on the video recording as untypical, and restating his view that the strategy he evolved, quite early on, 'was to get quicker at it (ie. producing lesson plans)... and not to waste time reading everything' and to concentrate his use on performance tools.

In other words, there is something of a mismatch between what the student perceives his evolving strategy to be, how he actually used the LPS and the evidence captured on video tape. Even after further prompting by the researcher, the student only reluctantly agreed that he did use the instructional components 'for some things still'. It is possible that the student experienced a level of involvement in the use of the LPS, that eclipsed his sense of time and perhaps also, of the reality of his strategic completion of the lesson planning task. He certainly thinks that he produced this lesson plan (#6) more quickly than he actually did; and he appears to be unaware of aspects of his uses of the various components of the software, even when prompted to recall them in view of the evidence presented on the video tape recording.

An explanation of this phenomenon might be found in the notion of 'flow'—where total immersion takes place and self-consciousness and time disappear, and where the experience is so gratifying that people will undertake it for its own sake (Csikszentmihalyi, 1990). However, in this case, where the interviewer actually searched for this notion of 'flow' in follow-up questions, the explanation does not appear to be present in the student's responses: indeed, quite the opposite, with the student consciously determining that his motivation

in the use of the LPS, as in other academic tasks he engages, is to get the best marks. Indeed, we might find a more credible explanation of the student's motivation and hence his strategy in use of the LPS, in Biggs and Moore's (1993) exposition of motivation, where the motivation for engagement in a task can occur in the student by virtue of a range of stimuli—extrinsic, achievement or intrinsic. For example, extrinsic motivation will occur when the student is motivated to perform the lesson planning task using the LPS, because of the value or importance attached to completion of that task. An achievement stimulus to engage will occur as a result of striving to perform better than others in the task, or perhaps better than some arbitrary measures (scores), and is fuelled by competition. An intrinsic stimulus is a function of the student being interested in the task for its own sake: importance is attached to the process not the product of the task or activity (Biggs & Moore, 1993). Clearly, here, the student is consciously motivated by the quest for higher achievement. However, the strategy he actually forms in completing the task is guided, perhaps unknowingly, partly by an intrinsic motivation in the task itself.

It is likely that the student would continue, beyond the six lesson planning tasks captured here on video tape, to refine his strategy. He seems to be convinced that once the necessary instructional information is committed to memory, or in other words, is learnt, he would be able to concentrate on his aim to produce lesson plans efficiently and quickly, and of a high standard, without the distractions of needing to access instructional information, of 'reading everything'. Further, there is some limited evidence that this student had begun to play this strategy out to good effect, at least by the seventh (#7) lesson planning task, where he increased the grade assessment for this lesson plan, produced by 'pen & paper', by two grades (from D to B), successfully transferring his learning and performance across media, from using the LPS to 'pen & paper' (see below).

Discussion

Perhaps a point of particular significance to arise from this interview data, has to do with a limitation in the interactions data—that is, counts of the number of interactions of use of the various components in the LPS do not, in themselves, give a reliable indication of the nature of the cognitive strategies developed by each student-teacher. Counting interactions masks the amount of time a student might spend with a particular component or function of the LPS, or perhaps the

amount of time they might spend in simply thinking, on- or off-task, without use of any part of the LPS. Clearly the interactions data need to be analysed alongside the video recordings of these interactions, together with the interview data. Further, as with the fourth (4) student, the various data items, interview and video recordings (of interactions), will not always converge, to tell the same story. Thus, where an analysis of different data items does not triangulate, the analysis is less valid.

A number of factors worthy of comment arise in the interview data, and in particular shed some light on the development of students' cognitive strategies in making use of the LPS. For example, there is evidence of high task involvement, to a point where at least one student (4) remains largely unconscious of the ways in which he is actually using the LPS in task completion. There are also other instances where high task involvement might provide a credible explanation for certain student behaviours—such as with the second student (2) who is unaware of the increased skill base the use of the LPS has provided her, and the increasingly automated approach she takes towards some of the lesson planning sub-tasks. However, this study has not sought to account for measures of off-and on-task behaviours, making it difficult to be more definite in this area of analysis.

It should perhaps be noted that the LPS has no in-built means whereby users can formally assess their knowledge or skills during or following completion of a lesson planning task, such as test questions or case problems. According to the views of Milheim (1997) and Puterbaugh (1990), the absence of a formal user-evaluation component is a significant omission in the design of any PSS. Certainly, in this context, the implementation of such a component in the LPS might lend support to students in their conscious development of appropriate cognitive strategies.

There are some common elements to the strategies employed by two or more of these students: for example, initially exploring and accessing instructional information; working from previous lesson plans as templates for later ones; automating approaches to certain sub-tasks, such as writing lesson objectives; spending increasing amounts of time in higher-order sub-tasks which require reflection (ie. matching learning objectives to evaluation processes); and, actively

seeking ways to produce lesson plans more efficiently, and in particular, more quickly.

It is likely that students' motivations could provide at least part of the explanation for the development of their respective cognitive strategies. For example, the motivation to develop their independent skill base in lesson planning; or to obtain better marks for their lesson plans; or to teach better. There is evidence of all these motivational forces in the student-teachers here. Certainly, motivation as a factor in the formation of cognitive strategies should be investigated in subsequent studies—and as such, has been incorporated in the second part of the main study reported in the next section (Section 7).

Results—lesson plan products

As with the procedures established in the pilot study reported earlier, all lesson plans created by student-teachers here were subject to grading by a lecturer in Education at Edith Cowan University. Six grades were used in this research programme; and, for use in providing a graphical representation of data in Figure 6.2, below, the grades F—A were each articulated to a numerical equivalent (ie. a mark), 1—6.

Table 6.2. Articulation of lesson plan assessment: Outcome—Grade—Mark

Outcome	Grade	Mark
Outstanding	A	6
Outstanding	B	5
Highly Competent	C	4
Highly Competent	D	3
Competent	E	2
Unsatisfactory	F	1

The grades for each of the four students in the first six lesson plans, show an improvement of at least one grade, and for three of the students (1, 2, 4) one major grade category (ie. from Competent to Highly Competent), (see Table 6.3, below). In the case of one student (1), there was an improvement of three grades spanning the six lesson plans assessed.

Table 6.3. Students 1–4 (Study 1): Grades for lesson plans 1–7 [shaded areas indicate those lesson plans produced by means of ‘pen & paper’].

Students 1–4				
Lesson plans	Lesson plan grades			
	Student/1	Student/2	Student/3	Student/4
L1	E	E	D	E
L2	D	E	E	E
L3	D	E	D	E
L4	D	D	D	D
L5	C	C	B	D
L6	B	D	C	D
L7	C	C	C	B

The first student (1) demonstrated a steady development in his grades, over all six lesson plans; the second and third students (2, 3) fluctuating in their grade attainment between the fifth and sixth lesson plans (2), and between the first and second and fifth and sixth lesson plans (3). The fourth student (4) increased her assessment by one grade, between the third and fourth lesson plans and maintained this grade for the remaining three lesson plans produced.

The improvement in grades achieved by the student–teachers between the first and sixth lesson plans assessed, was also maintained by three (2, 3, 4) in a seventh lesson plan produced by means of ‘pen & paper’ and without the support or use of the LPS. The remaining student (1) witnessed a decline of one grade over the two media, from Outstanding (B), to Highly Competent (C). In one case (4), the student not only maintained their initial improvement in grade assessment, but also bettered it by gaining two grades in the seventh lesson plan. The movements in grades for all students over the seven lesson plans assessed can be seen in Figure 6.2, below.

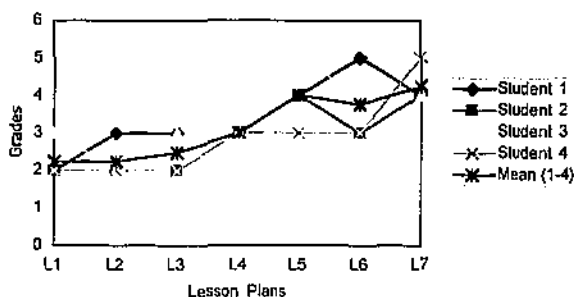


Figure 6.2. Students 1-4 (Study 1): Grades for lesson plans 1-7 (where 1-6 corresponds to F-A).

Table 6.4, below, reveals the range of average grades achieved by students in this study, for all seven lesson plans, together with the mean grades, calculated over all lessons (L1-L7) and for all students (1-4). Whilst the grades achieved by each student do not follow a continuous path of improvement, the similarity in the standard deviations for the range of lesson plans, L1-L7, suggests that similar degrees of growth were achieved in lesson plan quality by all students.

Table 6.4. Students 1-4 (Study 1): Grades for lesson plans 1-7 [where 1-6 corresponds to F-A].

Lesson plans	Lesson plan grades				
	Student 1	Student 2	Student 3	Student 4	Mean (1-4)
L1	2	2	3	2	2.3
L2	3	2	2	2	2.3
L3	3	2	3	2	2.5
L4	3	3	3	3	3.0
L5	4	4	5	3	4.0
L6	5	3	4	3	3.8
L7	4	4	4	5	4.3
Mean (L1-L7)	3.4	2.9	3.4	2.9	3.1
St. Dev.	1.0	0.9	1.0	1.1	0.9

Conclusion

The convergence in the data sets analysed as part of the pilot study, presented in Section 5, suggested that the use of the LPS by novice student-teachers over a two-week period, led to significant developments in lesson planning skills, to the

extent that these students begin to move towards a similar (if unequal) skill level, to those of experts in the task of lesson planning. That is, the pilot study suggested that by use of the LPS, novice students developed skills in producing lesson plans that moved them towards expertise.

Additional data collected in the first part of the main study, reported in this section (Section 6), served to confirm and clarify findings made in the pilot study, namely that novice student-teachers developed and sustained a marked level of expertise in their production of lesson plans relatively early on (i.e. at or near the third task observed) in their use of the LPS. Furthermore, interview data spotlighted cognitive strategies that were commonly and increasingly used by these students in their development of expertise in the task, such as templating lesson plans (i.e. using early lesson plans as templates for later ones), automating approaches to sub-tasks and concentrating on higher-order sub-tasks, and finding motivation in a conscious bid for self-improvement in the task.

The second part of the main study, reported in the next section (Section 7), continued the analysis started in the pilot and main (part 1) studies, but altered the situation or context of use of the LPS by novice student-teachers—in the second part of the main study, lesson planning was completed during the period of students' professional practice rather than preceding it. In this way, the context of use provided for more authenticity in the completion of the lesson planning task, since student-teachers 'in the real-world' were more likely to design and produce their lesson plans during rather than before, periods of teaching. In addition, data in the second part of the main study were subjected to extended analysis, with concentration placed on individual components used in the LPS, with a view to reveal more about the nature of students' cognitive strategies applied in their development of expertise.

SECTION 7

Investigation of the effects of the LPS: Main study II**Introduction**

The focus in this second part of the main study was centred upon an analysis and explanation of how the LPS was used by novice student-teachers to learn and perform the complex task of lesson planning; and addressed the third and fourth orientations of the research programme:

- 3 Investigate how novice student-teachers engage the instructional and performance components in the LPS to produce a lesson plan.
- 4 Investigate the effectiveness of the LPS as a PSS to support the completion of lesson planning.

The same types of data were collected in this second part of the main study, as in the first, including video recordings of students' use of the LPS, with the intention of identifying their cognitive strategies or patterns in use, and interview data, where video tape recordings of students completing their sixth and final lesson plans, were shown to the same students to help stimulate recall of their strategies, approaches and thinking processes engaged in their use of the LPS to produce the lesson plans.

The main difference between this second part of the main study and the first, lies with the context of use of the LPS—the student-teachers here were expected to plan lessons to use in their own teaching, within a day or so of their planning, and were expected to pursue their planning with greater urgency, since their plans would be intended for near-immediate implementation, and also subject to evaluation by a university supervisor, classroom teacher, and/or perhaps school principal or representative, as part of the normal operating expectations in the professional practice period.

A comparison of the data obtained from both parts of this main study, was then used to provide a better understanding of both cognitive patterns and task management in the LPS under different conditions of usage.

A second difference between the first and second parts of the main study lies in the analysis of the data collected. The first part of the study demonstrated that broad analysis of performance and instructional components in the usage of the LPS serves to limit the conclusions that can be drawn regarding the formation of cognitive strategies in the student-teachers. In this Section then, in addition to the broad categorisation of LPS component usage, a more detailed analysis of the use of particular functions in the LPS has been conducted.

In all other respects, this second part of the main study is similar or identical to the first. A summary of procedural matters, where they differ from those implemented in the first part of the main study, is given below:

- Four volunteer students were initially scheduled for the study, planning six or more lessons over a two week period during professional practice. However, using a data validation technique of saturation one further student was subsequently added to the study⁴⁰, at which point it was found data were being repeated and not continuing to offer unique properties (Glaser & Strauss, 1967, p. 67; Hopkins, 1985, p. 111).

⁴⁰ A fifth student was added to the study, after one of the four original students, during the first week of the study, indicated that she would not be able to fulfil a commitment to the research programme, to come into university and produce the required number of lesson plans. Lesson planning data was only obtained from this fifth student during the second week of the professional practice period.

- Each lesson plan produced was subject to criterion and outcomes based assessment, together with a measure of how long it took to be produced. Furthermore, an additional three lesson plans produced by traditional 'pen & paper' means, by each student immediately following their final use of the LPS, was also subject to temporal, criterion and outcomes based assessment, and used to ascertain the degree of skill and knowledge transfer in individual students⁴¹.
- In all cases of data collection, students used the LPS at a central computer facility, based at Edith Cowan University. However, one student requested to additionally use the LPS on a personal laptop computer away from this central resource, and whilst it was not possible to conduct data collection by video recorder off-campus, this student discussed with the researcher, her use of the LPS outside the periods of video recorded data collection.
- This second part of the main study occurred approximately eight months into the students' B.Ed undergraduate degree course in Education, and about five months after their first professional practice experience. Four students, all female, were identified to provide the focus for studying their patterns of LPS usage over a two week period. A fifth student, also female, was subsequently identified (during the first week of the data collection period) to provide data for this study, with data from this student being gathered only in the second week of the professional practice period. These students were volunteers and self-confirmed novices in lesson planning⁴². It should be noted, that these students had already completed one professional practice period, and had in this context, obtained some experience in the task of lesson planning. Therefore, it was expected that these students might show greater aptitude, together with some skills and knowledge, for the task by the time their second professional practice experience occurred. This was accounted for when comparing the outcomes from both parts of the main study.
- The students were tutored in the use of the LPS, to the point at which they felt comfortable with their skill in the use of the technologies (ie. computer and

⁴¹ In the first part of the main study, only one lesson plan produced by 'pen & paper' means was assessed. It was thought here, that a better sense of skill and knowledge transfer over media would be gained by assessing at least three such lesson plans. It was not feasible, within the two week period of professional practice, for students to produce any further lesson plans.

⁴² As with the pilot and main (part one) studies, these students were in their first year, second semester, of a four year Education degree programme, who, in a five-point likert scale questionnaire, perceived their lesson planning skills as 'poor' or 'non-existent'. The first four students to verbally volunteer for this study were chosen: it was coincidental that these students were all of one gender.

software use). This point of 'comfort' was self-determined and reached without interference in the decision-making by the tutor (i.e. the researcher). All these students advised they had reached this point after about 90 minutes of non-continual use of the LPS, extending over no more than two sittings.

- Students then used the LPS to plan a up to six lessons, over a period of two weeks—planned and implemented during professional practice. One of these students made greater use of the LPS, on a personal laptop computer, although this use went unobserved and unrecorded. Two students produced all six lesson plans (plus three others produced by 'pen & paper'); two others only submitted three and four lesson plans, respectively, and only two lesson plans each, by 'pen & paper'; the additional student submitted four lesson plans by use of the LPS, and two lesson plans by 'pen & paper'.
- Individual follow-up interviews were conducted at the completion of the two week period and within 15 days of the completion of the final lesson plan observed⁴¹.
- The final video tape recorded for each student, was played back to the student at this point, to elicit a delayed think-aloud procedure, acting as a prompt for each student to offer explanatory comment on their actions and behaviours in using the LPS, over the whole period of use.
- In recording students' use of the LPS, not all taping occurred for all students, over both weeks of the two week period—it proved difficult to manage this part of the data collection, where students were unable to commit themselves equally over two weeks.
- All lesson plans produced by the students using 'pen & paper' means, were volunteered by the students from their lesson planning portfolio, and had been written sometime during the professional practice.
- In some cases of observation in this study, video taping occurred of two students simultaneously, a practice that had already been employed in the pilot and main

⁴¹ It had been planned to conduct these interviews earlier, and closer to the period of professional practice. However, all students in this study were unavailable for one week following their two-week professional practice (i.e. due to a university short-vacation period), making it necessary to reschedule the interviews.

(part one) studies. Furthermore, some students in this part (two) of the study, completed two or three lesson plans sequentially, at one sitting; although this fact was recorded and noted in the analysis of the data.

Presentation of data

The results for this study are presented as data represented in tabular and figure formats. Also, as in the first part of the main study (see Section 6), in the table data, the presentation of raw numbers of students' interactions with instructional and performance components in the LPS, is again accompanied by the instruction-performance coefficient, to more effectively represent the changing nature of LPS usage over all lesson planning tasks. Furthermore, a more detailed analysis of the use of particular functions in the LPS is presented in an extra layer of table data. These data were used to help better identify the development of cognitive strategies in the student-teachers.

As in the pilot and the first part of the main study (see Sections 5 and 6), and for the same reasons, one type of graph has been used to represent two data types: line charts are used to represent, (i) the degree of student interactivity with both instructional and performance interactions; and, (ii) the time taken for students to complete the lesson planning tasks using the LPS. Also, as in the first part of the main study, to distinguish references to particular lesson planning tasks, in quotes presented from the student interview data and in general discussion, lesson planning tasks are referred to by a hash sign (#) and a number—for example, #3, is used to refer to lesson planning task 3.

Where quoted data are presented for individual students at various points in this Section, they can be found fully referenced and in context, in the sub-section that offers an analysis of the interviews conducted with each student (ie. Interviews).

Results—interactions

For the first student (1), there is a gradual reduction in the use of instructional components in the LPS over the six lesson planning tasks (16–7, or 56%), with a slightly larger decline for the final three tasks (14–7, or 50%) when compared to that over the initial three tasks (16–3, or 18.7%). This pattern corresponds to a similarly gradual, if somewhat uneven and smaller, decrease in the use of performance components (18–13, or 28%). There is also a definite and gradual

reduction in the time taken to produce the six lesson plans (38–14 minutes, or 63%), (see Table 7.1.1).

Table 7.1.1. Student 1 (Study 2): Lesson plans 1–6.

Lesson plans	LPS Components			Time (mins)
	Instruction (I)	Performance (P)	IP Coefficient	
L1	16	18	1.1	38
L2	13	17	1.3	30
L3	13	15	1.2	24
L4	14	16	1.1	24
L5	10	16	1.6	20
L6	7	13	1.9	14

Given the correspondence there is in the three sets of data (i.e. interactions with instructional components, interactions with performance components and task time), this first student might be seen to have increasingly refined her cognitive strategies, perhaps reaching an optimum in this respect by the sixth lesson planning task. Certainly a maximum IP coefficient of 1.9 is reached in the final lesson planning task, representing a steady growth of 0.8 (42%) between the first and sixth tasks. This degree and direction of growth in the IP coefficient suggests a well-defined development in lesson planning skills.

Interestingly there is no interaction in the data sets recorded in Figure 7.1.1 for this student, since the numbers of interactions with performance components is always higher than the corresponding numbers of interactions with instructional components. However, there is a notable divergence between the two data sets, after task #4, and especially at tasks #5 and #6, reinforcing the view that a certain level of expertise is reached and somewhat strengthened and refined in the tasks at or about these points.

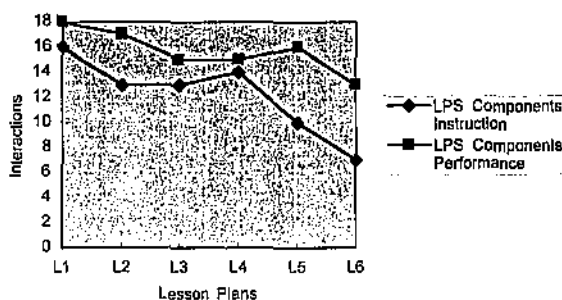


Figure 7.1.1. Student 1 (Study 2): Lesson plans 1–6.

For the second student (2), there is a stark unevenness in the initial interactivity figures. From a very low level of interaction with instructional components, she then reverts to a more stable pattern (ie. 'stable' in relation to her own subsequent experience), developing a slow yet gradual reduction in the use of these components in the LPS over the last five lesson planning tasks (15–10, or 33.3%), (see Table 7.1.2). However, her use of performance components showed a more consistent and gradual decline, apart from a small and momentary increase in task 5 (18–14, or 22.2%). This same pattern also occurs in the time taken to complete the lesson planning tasks—a gradual reduction in the time to produce the six lesson plans, other than a momentary increase at the second lesson planning task (17–12 minutes, or 29.4%). Indeed, this overall reduction is even more significant, given the short amount of time this student takes to complete even the first and second tasks (17 and 19 minutes, respectively).

Table 7.1.2. Student 2 (Study 2): Lesson plans 1–6.

Lesson plans	LPS Components			Time (mins)
	Instruction (I)	Performance (P)	IP Coefficient	
L1	8	18	2.3	17
L2	15	16	1.1	19
L3	15	15	1.0	15
L4	12	15	1.3	16
L5	12	17	1.4	14
L6	10	14	1.4	12

Interestingly, there are reasons suggested in the cognitive strategies data analysed further on (see Table 7.2.2), to explain why this student takes so little time to complete the range of lesson planning tasks completed here, when compared with other students in the study; and also goes a long way to explain her concentration on performance rather than instructional components, in task #1 (18:8 interactions, respectively). Indeed, this student is seen to concentrate her initial interactions with the LPS (ie. in lesson planning task #1) on printing materials and information from the LPS, to be consumed away from the task itself. It would seem, that study of these materials between the lesson planning tasks being observed in this study, allowed this student to more radically reduce the amount of time taken to complete subsequent tasks. However, it should be noted that by task #6, this student is found to be taking about the same amount of time to complete a lesson plan using the LPS as others in this second part of the main study.

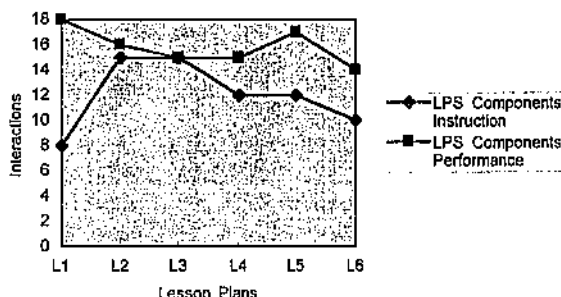


Figure 7.1.2. Student 2 (Study 2): Lesson plans 1–6.

Figure 7.1.2 does not reveal a definite interaction in the instructional and performance interactions data sets for this student, for the same reason as given for the first student (1)—since the numbers of interactions with performance components is always higher than (or equal to) the corresponding numbers of interactions with instructional components. However, as with the first student (1), there is a divergence, if a somewhat less significant one for this second student (2), between the two data sets, this time occurring after task #3. This gives rise to the notion that the student is beginning to evolve cognitive strategies more indicative of expertise in the tasks after this point.

There are similarities in all the measures taken between the first (1) and second (2) students, and particularly so by the completion of the sixth and final task. Furthermore, whilst the IP coefficient for the second student (2) does not grow to the same extent (i.e. rising to 1.4 in task #6, from a low of 1.1 in task #2), the growth is in a positive direction, and is, after an anomalous first task, consistent (see Table 7.1.2). Indeed, it would be possible to read the three sets of figures (i.e. interactions with instructional components, interactions with performance components and task time), for both students (1 and 2) as evidence of emerging and efficient cognitive strategies.

The third student (3) has only three lesson planning tasks available for data analysis, although as the interview data will show further on, this same student undertook the use of the LPS during her professional practice experience more frequently than the video data reveals. Indeed, the patterns revealed in the data recorded from this student's LPS usage, are significantly different from those identified elsewhere, and it could be speculated that these patterns are the result of more frequent usage: the use of instructional components is reduced quickly, by the second lesson planning task, and maintained for the third task (15–8, or 46.6%); conversely, interactions with the performance components is increased, gradually, over the three recorded tasks (16–20, or 20%); whilst the time taken for each of these tasks is uneven, yet reduced overall (26–16 minutes, or 38.5%). Whilst it is not possible to invest confidence in the few data given here, it should be remembered that these data were all taken from the student's first week of the professional practice period, and thereby in this context, corresponds, if only approximately, to the data taken for the first three lessons for the other students (see Table 7.1.3).

Table 7.1.3. Student 3 (Study 2): Lesson plans 1–3.

Lesson plans	LPS Components			Time (mins)
	Instruction (I)	Performance (P)	IP Coefficient	
L1	15	16	1.1	26
L2	8	17	2.1	13
L3	8	20	2.5	16

Furthermore, the IP coefficient rises steeply for this student, over the three lesson planning tasks observed here, (from 1.1 to 2.5), suggesting that a high level of proficiency was reached in lesson planning tasks using the LPS. Indeed, the IP

coefficients recorded for this third student, for both tasks, #2 and #3, indicate that she was able to evolve strong and efficient cognitive strategies; and probably did so as a result of her additional use of the LPS outside those periods observed and recorded here (see the analysis of this student's interview data, further on). This view is also demonstrated clearly in Figure 7.1.3, where there is a strong divergence between the instructional and performance interactions data sets, that occurs almost immediately after the first task (#1), and is widened thereafter.

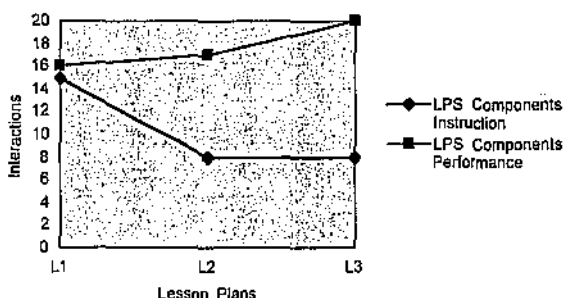


Figure 7.1.3. Student 3 (Study 2): Lesson plans 1–3.

For the fourth student (4), there were four lesson planning tasks made available for data analysis. Of interest is the high number of interactions with both instructional and performance components in the first task (33 and 29, respectively). This comparatively high level of interactivity is maintained, in general terms, for subsequent tasks, a phenomenon also reflected in the correspondingly high task times recorded over the four lesson planning tasks. Moreover, whilst there is a reduction from an exceptionally high starting point in this student's interactions with instructional components (33–18, or 45.4%), the initial reduction in her interactions with performance components, is reversed, so that by task #3 the number of these interactions begins to grow again, and by the fourth and final task, is almost at the same point from which it started (see Table 7.1.4).

However, whilst the numbers of interactions this student develops may differ substantially from those represented in other students' experiences, the patterns in these numbers are closer in nature and altogether more familiar—a gradual

reduction in the use of instructional components; an uneven and smaller reduction in the use of performance components; and a well-spaced reduction in the time taken to complete the four tasks. Indeed, the IP coefficients reveal something of this more familiar pattern, rising from 0.9 in the first task to reach 1.5 in the fourth and final task, after momentarily lapsing in the second task (0.7). This is very similar to the experience of the first student (1) in this part of the study (see Table 7.1.1), and also to that of the second (2), (see Table 7.1.2).

Moreover, there is a clear and well-defined interaction in the instructional and performance interactions data sets, demonstrated in Figure 7.1.4, occurring at a point shortly before the third task (#3). This interaction is followed by a growing divergence between the two data sets, indicating the point at which expertise is beginning to be developed by this student, reflected in the cognitive strategies used to produce the lesson plans with the LPS.

Table 7.1.4. Student 4 (Study 2): Lesson plans 1–4.

Lesson plans	LPS Components			Time (mins)
	Instruction (I)	Performance (P)	IP Coefficient	
L1	33	29	0.9	41
L2	27	19	0.7	31
L3	20	24	1.2	28
L4	18	27	1.5	22

This particular student provides some evidence, in terms of evolving cognitive strategies for lesson planning using the LPS, of finishing at the fourth and final task, at a point from which the other students might have started. Indeed, this view is supported by reference to both the interview and cognitive strategies data, examined in detail further on. It would seem that this student preferred to practise a cognitive strategy, that was premised upon her understanding each and every part of the LPS—thereby explaining her overly high numbers of interactions with both instructional and performance components. That is, rather than access the informational resources or the performance functions at a time when they were needed, she appeared to access them both at a time of need, and at other times, when she was exploring their value and significance without reference to a particular need. Only when she had internalised their usefulness, did she reduce the number of interactions with various components, using the LPS more like other students did early on in their experiences—when she perceived a value or benefit existed.

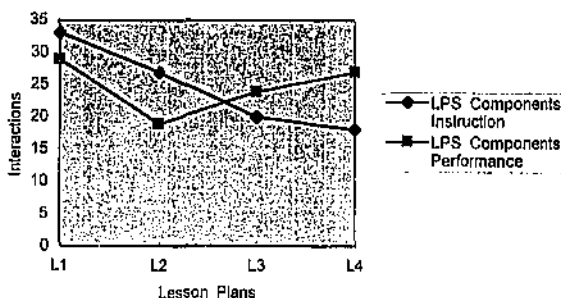


Figure 7.1.4. Student 4 (Study 2); Lesson plans 1–4.

The fifth student (5) recruited for this research programme, only provided data from her second and final week of the professional practice experience. In this short time, she completed four lesson planning tasks for analysis. The patterns in these data are, again, familiar: a reduction in the use of instructional components (31–14, or 55%); a corresponding reduction in task times (46–15 minutes, or 67.3%); and an uneven increase in the use of performance components (20–25, or 20%), (see Table 7.1.5).

Table 7.1.5. Student 5 (Study 2); Lesson plans 1–4.

Lesson plans	LPS Components			Time (mins)
	Instruction (I)	Performance (P)	IP Coefficient	
L1	31	20	0.6	46
L2	29	26	0.9	30
L3	15	27	1.8	19
L4	14	25	1.8	15

There is evidence of quite dramatic changes found in the first two sets of these figures (ie. for the numbers of instructional interactions, and for task times). The IP coefficient recorded over the four tasks tells a similar story, rising from 0.6 to 0.9 for the first two tasks (#1, #2), and then jumping to 1.8 for the latter two lesson planning tasks (#3, #4). The data here, does perhaps suggest this student developed sound and strong cognitive strategies for lesson planning using the LPS, by at least the third and fourth tasks, an interpretation supported by the interview data, where the student revealed that she changed and consolidated

her strategic approach to lesson plan writing at or near the second task (see the analysis of the interview data, further on).

This interpretation is further reinforced, and clarified, by reference to Figure 7.1.5, which demonstrates a clear interaction in the instructional and performance interactions data sets, just after the second task (#2). This interaction, together with the following increased divergence between the data sets, is indicative of the growth of expert cognitive strategies.

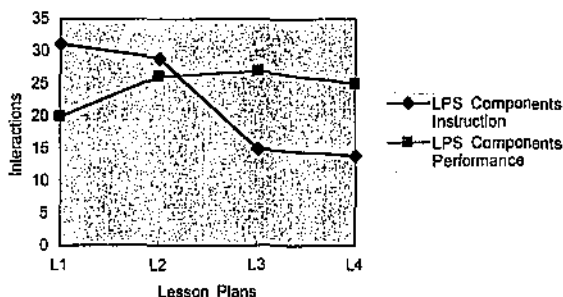


Figure 7.1.5. Student 5 (Study 2): Lesson plans 1–4.

Taken together, and allowing for the disparate number of lesson planning tasks recorded for students in this second part of the main study, there emerges consistent and strong patterns in the data (see Table 7.1.6). For example, the reduction in the use of instructional components is strong (21–9, or 57.1%), although less so if the fifth and sixth tasks (#5, #6) are discounted as unrepresentative (for which only two students [1, 2] provided data), (becoming 28.6%). Again, the reduction in the time taken to complete the lesson planning tasks, (34–13 minutes, or 61.8%) is very apparent—although, again, less so if the latter two tasks are removed from the calculations (becoming 44.1%).

Table 7.1.6. Students 1–5 (Study 2): Lesson plans 1–6.

Lesson plans	LPS Components			Time (mins)
	Instruction (I)	Performance (P)	IP Coefficient	
L1	21	20	1.0	34
L2	18	19	1.0	25
L3	14	20	1.4	20
L4	15	21	1.4	19
L5	11	17	1.5	17
L6	9	14	1.6	13

Perhaps of more interest are the figures for students' use of performance functions in the LPS: very little change from one task to another over the first four tasks; and being reduced only when the first two students (1, 2) are accounted for, in the fifth and sixth tasks (20–14, or 30%). However, the most telling figures lie in the IP coefficients: the trend here is of a gradual and positive change, rising from 1.0 in the first task, to 1.4 in the third and fourth, and then peaking at 1.6 in the sixth task. The story in all these sets of figures and particularly those for the IP coefficients, is of students who develop their cognitive strategies in lesson planning using the LPS by the fourth task, and then refine those strategies thereafter, improving upon them more gradually over the remaining two tasks. Indeed, Figure 7.1.6 reveals more of the same story, suggesting the interaction in the instructional and performance interactions data sets that occurs just before the second task (#2), is the point at which the development in expert cognitive strategies first takes hold; but is only refined and consolidated at, or after, the fourth task (#4).

However, as a cautionary note, it should be remembered that generalising in this way, does serve to mask the differences in the sets of figures recorded and analysed for individual students.

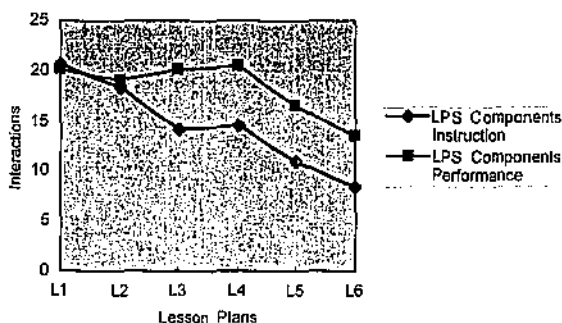


Figure 7.1.6. Students 1–5 (Study 2): Lesson plans 1–6.

The temporal data, when plotted on a single graph (Figure 7.1.7), show that for all students, the time taken to complete a lesson planning task declined over the entire span of tasks (#1–#6). Also, for most students (ie. excepting students 2 and 3), this pattern of reduction is very similar: starting in the region of 34–46 minutes for the first lesson planning task; falling quite rapidly for the second and third tasks; and then declining more gradually for the remaining tasks. Of the two students (2, 3) who did not conform to this pattern, student 3 completed only three lesson planning tasks, making it more difficult to read patterns of any type into her data; and student 2 experienced a hiatus in the earlier data (where for tasks #2 and #4, the completion time rose by one to two minutes), but followed the broader pattern after task (#4). The data for all students increasingly converge over the last three lesson planning tasks, so that all students complete the final task in approximately 13 minutes.

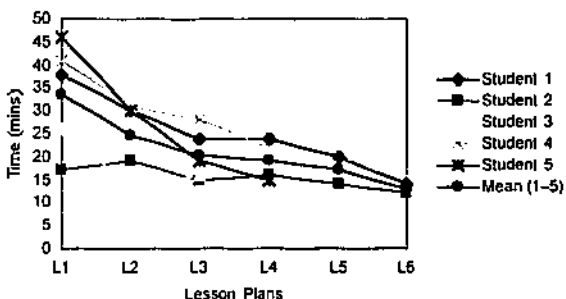


Figure 7.1.7. Time taken for task completion in the LPS for lesson plans 1—6 (Study 2).

Discussion

Although there are similarities in both the interactions and the task-time data between these five students in their completion of the submitted lesson planning tasks, there are also some significant differences. Whilst each of the students experienced a reduction in the use of instructional components in the LPS, over the series of tasks attempted and recorded here, together with a strongly evident and corresponding reduction in task completion times, the patterns in their usage of performance functions are comparatively less alike—although, apart from two students (3, 5), overall there are reductions in these interactions.

Beyond this, the data also suggest there is evidence of all students developing appropriate cognitive strategies for lesson planning using the LPS. For example, the data for two students (4, 5), when charted as line graphs, show interactions in the instructional and performance components interactivity data, at points somewhere between the second and third lesson planning tasks (Figures 7.1.2, 7.1.4, and 7.1.5, above). It is at these points that the students have a ratio in the use of instructional–performance components, of one (1), and where their use of performance components begins to outstrip their use of instructional components. In addition, for these two students, the divergence between these two data sets that follows their interaction, suggests that such patterns in the data indicate the prevalence of cognitive strategies representative of expertise in the task. Even for those students for whom there is no interaction in the instructional

and performance components interactivity data (ie. 1, 2, 3), there is a pronounced divergence between these data sets at some point on individual students' interactions graphs (see Figures 7.1.1, 7.1.2 and 7.1.3), a phenomenon which in itself is perhaps enough to indicate the development of expertise in the cognitive strategies being deployed.

Indeed, Figure 7.1.6, displaying the mean average in the interactions data for all students, suggests that the stage at which they begin to develop expertise in their cognitive strategies when using the LPS for planning lessons, (ie. the point at which there is an interaction in the instructional and performance components interactivity data) occurs very early on, at or just after the first task. However, it is evident that the phenomenon of the interaction in the data sets must be read in context, and in particular, that governing the nature and strength of the following divergence between these data sets. In this case, when all students are taken collectively, as represented in Figure 7.1.6, the pattern of divergence does not become soundly established until some point during or after the fourth lesson planning task (#4)—it is at this point on the graph, that the divergence pattern in the data stabilises.

When the interactions data from the second part of the main study (MS/2)⁴⁴, are compared to that from the first part (MS/1), there are perhaps two major points to note. First, the relative numbers of interactions for almost all students in MS/1 are considerably lower than for those students in MS/2, with the exception of perhaps two students (4, and to a lesser extent, 5; see Tables 7.1.4 and 7.1.5). This is also the case, to a more limited extent, for task completion times. Second, whilst in both studies, MS/1 and MS/2, student interactions with instructional components of the LPS and task completion times, are generally reduced, the patterns in the interactions with performance components are largely reversed over the two studies: in MS/1 growth is, overall, positive and incremental; in MS/2 change is negative and somewhat more severe (cf. Tables 6.1.5 and 7.1.6). However, this reversal in the patterns of interactions with performance components in the LPS over the two studies, has little apparent effect on the two sets of IP coefficients for MS/1 and MS/2. In MS/1 the IP coefficient rises steadily and consistently from 0.7–1.5 (see Table 6.1.5)—a growth of 53.3%.

⁴⁴ The use of the abbreviations MS/1 and MS/2, for Main Study 1 (first part of the main study) and Main Study 2 (second part of the main study), are introduced at this point for the convenience of the reader, and to avoid repetitive use of the full phrase.

Whilst in MS/2, the IP coefficient is also seen to rise steadily and consistently, starting slightly higher at 1.0 and finishing, again slightly higher, at 1.6 (see Table 7.1.6)—a growth of 37.5%. Indeed, the IP coefficients for both parts of the study, suggest a certain amount of comparability in the nature of use of instructional and performance support components by beginning student-teachers over a short period of time. More particularly, there is a convergence in the IP coefficients for both studies at the conclusion of the studies—that is, at the point of completion of the final lesson planning tasks. This might indicate that all students, from both MS/1 and MS/2, reach a similar level of expertise in lesson planning using the LPS.

Looking further into the nature of students' interactions with the LPS

By broadly categorising student-teachers' use of the LPS in both parts of this study, in terms of instructional and performance functions, it is possible to obtain insights into their patterns of use of the LPS. In turn, the strength and nature of these patterns can be interpreted as revealing something of the students' developing cognitive strategies as they use the LPS to complete a number of lesson plans, as complex cognitive tasks. However, further analysis of the LPS usage data, contained within the video-tape recordings, in terms of the specific functions or components of the LPS, tells us more about these strategies as they are taking form. Tables 7.2.1–7.2.5, below, represent the data for student-teachers in the second part of the main study (MS/2) as they used various components in the LPS to complete each of the lesson planning tasks recorded.

The task-focused environment of the LPS is built around the production of a lesson plan. Hence, the component described as the 'lesson plan writer' in the Tables 7.2.1–7.2.5, is a reference to that central part of the LPS where the user writes a lesson plan. In strict terms, it is actually a part of the performance support functions (and without it, the user could not 'perform', as such), but for the analysis of the data given in this Section, it has been isolated as a separate component of the LPS.

Table 7.2.1. Students cognitive strategies in their use of the LPS: Student 1: Lesson plans 1-8 (shaded areas indicate totals and sub-totals for LPS component usage).

Student 1: Lesson plans 1-8	Lesson plans (LP)						
	LP1	LP2	LP3	LP4	LP5	LP6	Means
LPS Functions (I + P)	42	39	33	35	33	27	36
Instructional Support (I)	18	13	13	14	10	7	12
Lesson structure	2	1	1	2	0	1	1
Effective objectives	2	2	1	3	2	0	2
Evaluating learning outcomes	1	3	2	2	2	2	2
Preparation	1	0	0	1	2	2	1
Ways of writing the Lesson plan	2	0	0	0	1	0	1
Evaluating self	2	0	2	1	1	1	1
What is a lesson plan?	1	1	1	0	0	0	1
What is a good objective?	3	4	0	1	0	0	1
Planning methods	0	1	2	2	0	0	1
Using the LPS	2	0	2	0	0	0	1
How do I ensure my evaluation will be effective	0	1	2	2	2	1	1
Performance Support (P)	18	17	15	15	16	13	16
Reflection	1	2	1	1	2	4	2
Verb database	4	5	2	1	2	2	3
Example lesson plans	4	4	3	0	1	1	2
Work pad	2	0	2	6	5	2	3
Example objectives	5	4	2	3	2	1	3
Example evaluation processes	0	1	2	1	3	2	2
Find	0	0	0	0	0	0	0
Print	2	1	3	3	1	1	2
Lesson plan writer	8	9	5	8	7	7	7
Lesson plan writer	8	9	5	6	7	7	7
IP Coefficient	1.1	1.3	1.2	1.1	1.6	1.9	1.3

In the first student (1), there is evidence here of exploratory strategies used to develop the first lesson plans. In the first and second lesson plans, almost all the instructional support components are initially explored, with a concentration of this strategy being conducted in the area of lesson (learning) objectives (What is a good objective?; Ways of writing the lesson plan; Effective objectives). At the same time, the student also spent a large amount of her interactions with the LPS in the performance support areas of the Verb database, the Example lesson plans and the Example objectives. This concentration of the student's interactions are not surprising, particularly in light of the data obtained by interview (the interview data, is analysed further on), which indicate how she felt compelled to

explore almost all aspects of the information base in the LPS before evolving a more direct and immediate method of writing the lesson plans. In this latter strategy, the student accessed supporting information only when it was thought necessary, and then by using the Work pad, to save relevant information from both previous lesson plans and from the instructional support components in the LPS. Indeed, the dramatic reduction in the times taken to complete the first and third and fourth lesson plans (ie. a reduction of 63% from #1-#3/#4: see Table 7.1.1, above), are supporting evidence of the growing efficiency in this student's cognitive strategies used to engage the LPS to complete the lesson planning tasks.

Towards the latter lesson plans (#4, #5, #6), the student's concentration in her interactions, moves from lesson objectives to lesson evaluation; and simultaneously, she reduced the number of these interactions with instructional support components, and increased those with performance support components. So, in this context, the Reflection tool and Example evaluation processes, were accessed more consistently, along with an increased use of the Work pad. Again, this evolving strategy is supported by the interview data, where she very clearly described how with growing confidence in her lesson planning, she began to spend more time 'thinking about the evaluation methods' and take considerably more time 'thinking about what I was doing'⁴⁵.

The Lesson plan writer is used by this student in the same way across all lesson plans—that is, there is evidence in both this and her interview data, she wrote the lesson plans in a concentrated fashion, once she had evolved a strategy for doing so that she felt comfortable with and had confidence in. The instructional support components, initially in the area of objectives creation and then in the area of evaluation process creation, were accessed to inform her lesson plans as and when the information was needed. Furthermore, the Work pad is used considerably more in lesson plans #4-#6, suggesting that information was collected here before reflecting further on how it might be used by the student.

⁴⁵ Quotes taken from the Interview data; see below for their full context.

Table 7.2.2. Students cognitive strategies in their use of the LPS: Student 2: Lesson plans 1–6 (shaded areas indicate totals and sub-totals for LPS component usage).

Student 2: Lesson plans 1–6		Lesson plans (LP)						
		LP1	LP2	LP3	LP4	LP5	LP6	Means
LPS Functions (1/4)		33	37	38	36	35	35	36
Instructional Support (1)		8	16	15	12	12	10	12
Lesson structure		1	1	1	1	0	0	1
Effective objectives		1	2	2	3	3	1	2
Evaluating learning outcomes		0	0	0	2	3	3	1
Preparation		0	0	0	0	0	1	0
Ways of writing the Lesson plan		1	0	0	0	1	0	0
Evaluating self		1	3	1	4	2	2	2
What is a lesson plan?		1	1	2	0	1	0	1
What is a good objective?		1	3	4	0	1	1	2
Planning methods		0	2	2	0	1	0	1
Using the LPS		1	2	2	0	0	0	1
How do I ensure my evaluation will be effective		1	1	1	2	0	2	1
Performance Support (2)		18	16	15	15	17	14	16
Reflection		1	1	1	1	4	4	2
Verb database		2	4	4	5	2	1	3
Example lesson plans		2	2	1	1	2	3	2
Work pad		3	5	5	5	1	2	4
Example objectives		2	1	1	0	0	0	1
Example evaluation processes		0	0	2	2	4	2	2
Find		0	0	0	0	1	0	0
Print		8	3	1	1	3	2	3
Lesson plan writer		7	6	6	9	9	11	8
Lesson plan writer		7	6	6	9	9	11	8
IP Coefficient		2.3	1.1	1.0	1.3	1.4	1.4	1.3

In both this interactions data (Table 7.2.2) and the second student's (2) interview (see below), there is evidence of initial insecurity in use of the LPS and in the knowledge of what might be required to produce an appropriate lesson plan. In fact, the student clearly approached the use of the LPS with more confidence in printed information—whilst she completed some early exploration of the various instructional and performance support components in the LPS, she also spent a large concentration of her interactions (ie. eight in the first lesson plan) with the PSS in printing material, to be consumed 'at home' and away from the pressure of the task itself. Moreover, the student here and in the interview data,

demonstrated her dislike of reading information from the screen of a computer ('I can't stand reading from the screen').

In the second and third lesson plans (#3, #4), the student explored the instructional support components, using the LPS in a more focused fashion, and concentrated her interactions in the area of lesson objectives (Effective objectives; What is a good objective?). However, the interview and the video data also revealed that she continued to feel more secure in the printed information taken from the LPS during the completion of her first lesson plan, by having it constantly available for reference purposes, whilst she was using the same information on screen. But at the same time, she also gained in confidence in her use of the performance support components, making great use of the Verb database and the Work pad, to build up her lesson plans—these interactions remained particularly high over lesson planning tasks #2–#4. Commensurately, she also increased the number of interactions with the Lesson plan writer across lesson plans #2–#6, perhaps reflecting the evolution of a more confident strategy in using the digital instructional and performance support tools in the LPS (ie. by navigating between them whilst actively constructing her lesson plans), whilst decreasing a reliance on printed matter to provide the necessary support for writing her lesson plans.

In the latter lesson planning tasks (#5, #6), as with the first student (1), she increased her use of performance support functions, and in particular those concerned with supporting the higher order cognitive process of reflection (Reflection tool), and with writing evaluation processes (Example evaluation processes). However, she also continued to access relevant support information in the instructional support functions (Evaluating learning outcomes; Evaluating self).

Interestingly, in this student the IP coefficient is very high (2.3: see Tables 7.1.2 and 7.2.2) in the first lesson planning task, before being reduced and then built more gradually over the second to sixth (#2–#6) tasks. Clearly, however, the data in Table 7.2.2. demonstrate that this first coefficient is unduly influenced by the student's heavy interactivity with the print function!

Table 7.2.3. Students cognitive strategies in their use of the LPS: Student 3: Lesson plans 1–3 [shaded areas indicate totals and sub-totals for LPS component usage].

Student 3: Lesson plans 1–3		Lesson plans (LP)			
		LP1	LP2	LP3	Means
LPS Functions (I + P)		35	33	27	32
Instructional Support (I)		15	8	8	10.3
Lesson structure		1	0	0	0
Effective objectives		2	2	0	1
Evaluating learning outcomes		1	2	3	2
Preparation		1	0	0	0
Ways of writing the Lesson plan		1	1	0	1
Evaluating self		1	1	0	1
What is a lesson plan?		2	0	1	1
What is a good objective?		3	0	0	1
Planning methods		1	1	0	1
Using the LPS		2	0	2	1
How do I ensure my evaluation will be effective		0	1	2	1
Performance Support (P)		18	17	20	18
Reflection		1	1	2	1
Verb database		3	3	3	3
Example lesson plans		1	3	4	3
Work pad		2	3	2	2
Example objectives		4	2	2	3
Example evaluation processes		0	3	4	2
Find		1	0	0	0
Print		4	2	3	3
Lesson plan writer		4	8	9	7
Lesson plan writer		4	8	9	7
IP Coefficient		1.1	2.1	2.5	1.7

This student (3) completed only three lesson plans in total using the LPS, making any patterns in the data regarding component usage more difficult to discern and arguably less valid. Notwithstanding this, there are some significant issues highlighted in this student's (3) use of the LPS. In the first lesson planning task (#1), there was evidently some effort made to look at least once into each of the instructional support functions. Equally apparent is the student's quickly formed recognition of the value of certain performance support functions—particularly the Verb database, the Example objectives, the Print facility and to a lesser extent, the Work pad. It is with these components that most of the student's interactions were made in the first lesson plan (#1). However, in the second and third tasks

(#2, #3), she maintained her interaction with these components and at the same time, increased her interactions with other performance support functions, including the Example evaluation processes. It is also in the last two tasks (#2, #3), that the student also increases (by over 100%) her interactions with the Lesson plan writer, suggesting a more fluid and integrated usage of all performance support functions in completing the lesson planning tasks. Indeed, much of this pattern of usage is also revealed in the student's interview data. Interestingly, her interview data also demonstrate the over-riding confidence this student brought to the task of lesson planning, a confidence which remains evident in her strategic approach to the use of the LPS—quickly concentrating on the performance support components in place of instructional support components. Indeed, the high IP coefficient in this student (2.1; 2.5) reflects this strategy (see Tables 7.1.3 and 7.2.3), where interactions with performance components are rapidly established and sustained (ie. by lesson planning task #2), at a rate of more than double that conducted with instructional support components.

Again, student 4 completed only four lesson plans, and any patterns in the data must therefore be treated with some circumspection (see Table 7.2.4). Generally, the first two lesson planning tasks see this student spending a lot of time in interactions with instructional support components of the LPS. Indeed, she took some 41 minutes to complete the first lesson plan—this, together with the interview data, suggests a lot of time was spent exploring the information available; and also, in resolving the nature of the LPS and how it might be of use (ie. in thinking about cognitive strategies to pursue in its use). Interestingly, whilst this student seemed to spend a relatively high number of interactions with the LPS, with the whole range of instructional support functions, she did, by the third and fourth lesson planning tasks (#3, #4), change this concentration from those that dealt with (i) lesson objectives, (ii) approaches to planning; and, (iii) using the LPS, to those that were concerned with evaluation processes and approaches (ie. Evaluating learning outcomes; Evaluating self; How do I ensure my evaluation will be effective?).

Table 7.2.4. Students cognitive strategies in their use of the LPS: Student 4: Lesson plans 1-4 [shaded areas indicate totals and sub-totals for LPS component usage].

Student 4: Lesson plans 1-4		Lesson plans (LP)				
		LP1	LP2	LP3	LP4	Means
LPS Functions (1-4)		385	248	247	603	321
Instructional Support (I)		330	271	220	483	276
Lesson structure		4	3	2	0	2
Effective objectives		3	2	2	5	3
Evaluating learning outcomes		3	1	1	4	2
Preparation		3	3	0	2	2
Ways of writing the Lesson plan		3	4	2	2	3
Evaluating self		2	2	0	4	2
What is a lesson plan?		3	2	2	0	2
What is a good objective?		4	2	3	0	2
Planning methods		2	1	2	0	1
Using the LPS		5	4	2	0	3
How do I ensure my evaluation will be effective		1	3	4	1	2
Performance Support (P)		29	19	24	27	25
Reflection		3	1	1	3	2
Verb database		6	2	4	4	4
Example lesson plans		6	3	3	4	4
Work pad		4	4	5	6	5
Example objectives		5	4	5	4	5
Example evaluation processes		2	1	3	3	2
Find		0	0	0	0	0
Print		3	4	3	3	3
Lesson plan writer		3	3	3	5	4
Lesson plan writer		3	3	3	5	4
IP Coefficient		0.9	0.7	1.2	1.5	1.0

In addition, this student developed high numbers of interactions with various performance support components (Verb database; Example lesson plans; Work pad; Example objectives) over all lesson planning tasks (#1-#4). In particular, there was a concentration in the use of the Work pad and the Example objectives, that ran consistently through this student's use of the PSS. At the same time, she only engaged the use of the Lesson plan writer on few occasions, supporting findings in the video tape and interview data, that the cognitive strategy evolved here is one in which the student distinguished clearly between learning and performing. Indeed, in the interview data, the student specifically recounted how

she was concerned that she fully understood both declarative and procedural information in the task, before proceeding with it:

Yeah, I just thought about that. I think that's how I always work, I spend a lot of time going through something and then do it, depending on what it is, even in exams... I read the information I didn't know about each time, and then wrote out the lesson plan. Is that the way I was supposed to do it?... I only really did something after I read it, maybe take notes. But if I didn't remember how to do it, I went back to read about it, to get a better idea of how to go on. Like there. Talking to myself as well (laughing)! No, really, I'm just trying to get it into my head, to understand it.

In short, this student works with a cognitive strategy that is based in an approach to learning which has no doubt, been transferred from other learning situations. It is thorough, premised on a comprehensive review of relevant information, and used to construct understanding rather than simply to enable performance. The same instructional support information might be accessed repeatedly and not only when it is appropriate to task performance, but more so when it is thought to be relevant to understanding the full nature of the task.

As with the fourth student (4), student 5 produced only four lesson plans by use of the LPS (see Table 7.2.5); but patterns in the data are nonetheless prevalent and of interest. For example, in the first two lesson plans (#1, #2), there is evidence of high numbers of interactions with information in the instructional support components that reflects the student's concern to understand how to use the LPS (Using the LPS), how to best write a lesson plan (Ways of writing the lesson plan; What is a lesson plan?) and also to construct effective learning objectives (What is a good objective?; Effective objectives). Simultaneously, there was also evidence of high numbers of interactions with almost all functions in the performance support components, from the first to the last lesson plan (#1–#4). In particular, the student increased her use of the Reflection tool, the Verb database, the Work pad and the Print function consistently over all lesson plans; whilst reducing her total interactions with instructional support components by 55% over the same span.

Table 7.2.5. Students cognitive strategies in their use of the LPS: Student 5: Lesson plans 1–4 [shaded areas indicate totals and sub-totals for LPS component usage].

Student 5: Lesson plans 1–4		Lesson plans (LP)				
		LP1	LP2	LP3	LP4	Means
LPS Functions (I + P)		64	62	53	51	58
Instructional Support (I)		31	29	16	14	23
Lesson structure		2	2	0	1	1
Effective objectives		3	6	3	1	3
Evaluating learning outcomes		1	2	0	3	2
Preparation		2	1	0	1	1
Ways of writing the Lesson plan		4	3	1	1	2
Evaluating self		2	1	3	2	2
What is a lesson plan?		5	3	0	1	2
What is a good objective?		5	2	2	1	3
Planning methods		3	1	1	0	1
Using the LPS		3	4	1	1	2
How do I ensure my evaluation will be effective		1	4	4	2	3
Performance Support (P)		20	28	27	25	25
Reflection		3	4	5	5	4
Verb database		4	4	5	6	5
Example lesson plans		4	5	1	1	3
Work pad		3	3	7	6	5
Example objectives		1	4	1	0	2
Example evaluation processes		1	1	4	4	3
Find		1	0	0	0	0
Print		3	5	4	3	4
Lesson plan writer		3	7	11	12	8
Lesson plan writer		3	7	11	12	8
IP Coefficient		0.6	0.9	1.8	1.8	1.1

It seems in this student, there was evidence of a developing cognitive strategy that is based on exploiting the value, and refining the use, of two types of performance support functions in the LPS—the explicit and immediate support offered by the Verb database, which reduces the need to hold and manipulate in memory an array of data; and the Work pad and Reflection tool, that can be used to encourage deeper and higher-order cognitive processes, such as reflection, critical review and metacognition. The interview data are consistent with this interpretation of the interactions data, as reported in Table 7.2.5. For example, the student clearly reported how her use of the LPS ‘made me realise what I knew and what I don’t know’; and how various functions in the LPS prompted her to

review her way of writing lesson plans, encouraging the adoption of more thorough procedures in this task than she had employed before:

I was going to type them (the lessons) into the computer and just print them out. I did that for the first one but the computer made me think about what I was doing. It really stopped me in my tracks. I'm not just saying that! I'm surprised... You could really think about the meaning of the objectives, what you were trying to teach. I went back to think about things I'd already put down. Like I'd written out two Maths lessons, one on different days. And I could see how to now make the objectives I'd set... connect better, so they would follow on... (the LPS encouraged me to go) back over what I'd written to check to see if I had written it correctly, especially to check the evaluation and the objectives, to make sure they matched up.

Discussion

At this point, it is possible to see a number of cognitive strategies arising in the students' use of the LPS to produce lesson plans in the context of a professional teaching practice (ie. an authentic task-based situation). However, it is not possible here to ascertain the stability or the robustness of these strategies; nor to suggest the circumstances under which they might be likely to falter. A summary of students' cognitive strategies are set out below:

Student 1

- Exploratory strategies used to develop initial lesson plans, interacting with almost all instructional support components, with a concentration in the area of lesson (learning) objectives; and later in evaluation processes.
- Identifies immediate value of tools that directly ease cognition—such as the Verb database, from the performance support area.
- Evolves a more direct and immediate method of writing lesson plans, accessing supporting information only necessary, and then by using the Work pad, to save and manipulate relevant information from other lesson plans and instructional support components.
- Reduces the number of interactions with instructional support components, and increases those with performance support components.
- With growth in confidence, increases use of the Reflection tool and Work pad—tools which are more likely to support higher order cognitive processes.

Student 2

- Early exploration of both instructional and performance support components in the LPS.
- Concentrates interactions in printing off material, to be consumed away from the pressure of the task itself.
- Starts using the LPS in a more focused approach, concentrating interactions in lesson objectives; continues to feel more secure in the printed information, by having it constantly available for reference purposes, but whilst she is using the same information on screen.
- Gains in confidence in use of performance support components—Verb database and the Work pad.
- In later lesson planning tasks, increases use of performance support functions, and in particular those concerned with supporting the higher order cognitive process of reflection (Reflection tool), and with writing evaluation processes (Example evaluation processes). Continues to access relevant support information in the instructional support components.

Student 3

- Explores at least once into each of the instructional support functions.
- Quickly recognises the value of performance support functions that directly ease cognition—particularly the Verb database, the Example objectives and to a lesser extent, the Work pad.
- Maintains and expands interactions with these and other performance support components.

Student 4

- Extensive exploration of all information available, to resolve the nature of the LPS and how it might be of use.
- High number of interactions with the whole range of instructional support functions, changing the focus of interactions over the series of lesson plans from planning and objectives to evaluation processes and approaches.
- High numbers of interactions with various performance support components (Verb database; Example lesson plans; Work pad; Example objectives) over all lesson planning tasks; in particular, a concentration in the use of the Work pad and the Example objectives, that runs consistently through all lesson plans.

Student 5

- High numbers of interactions with information in the instructional support components that reflects a concern to understand how to use the LPS, how

to best write a lesson plan and to construct effective learning objectives. Simultaneously, high numbers of interactions maintained with almost all performance support components—increases use of the Reflection tool, the Verb database, the Work pad and the Print function consistently over all lesson plans; whilst dramatically reducing total interactions with instructional support components.

- Exploits the value, and refines the use, of two types of performance support functions in the LPS—the explicit and immediate support offered by the Verb database, which reduces the need to hold and manipulate in memory an array of data; and the Work pad and Reflection tool, that can be used to encourage deeper and higher-order cognitive processes, such as reflection, critical review and metacognition.

As part of these strategies, the students used the Lesson plan writer in a number of ways, each belonging to one of two more general strategies—either as part of a concentrated approach, that clearly distinguishes between the acts of learning and performing; or with more fluidity, navigating between the Lesson plan writer and a range of instructional and support functions.

Interviews

The observational data captured by video camera-recorder, were intended to reveal, on analysis, students' cognitive patterns or use strategies in their use of the LPS in the completion of all six lesson plans observed. Individual follow-up interviews, conducted at the completion of the two week period, to determine how all students managed aspects of the lesson planning task, made use of these video recordings to elicit a delayed think-aloud procedure, as prompts for students to offer explanatory comment on their actions in using the LPS. The process of stimulating students' recall of and reflection on their thinking during their experiences of planning lessons using the LPS, allowed for the richer documentation of students' cognitive processes and also increased accuracy (reliability) in interpretations offered in analysis of the video data.

The procedure established and followed for these interviews has already been documented elsewhere in this thesis, in Section 4, dealing research methodology, as well as in the introductions to the pilot and main (part one) studies (Sections 5 and 6, respectively). Only deviations from this procedure will be described here,

in this present Section. Interviews with each of the five students lasted approximately 25 minutes, and not longer than 30 minutes (ie. slightly longer than those interviews in MS/1). The quotes given here are taken from the interview transcriptions, and have been edited and selected for their relevance and significance to the research questions in this study.

Student 1

The first student (1) was interviewed 12 days following the completion of the professional practice period, and 15 days after production of the final (sixth) lesson plan produced using the LPS. In this case, the interview data afforded insights into the student's cognitive strategies in producing lesson plans; and initially, gave an indication of the student's motivation to use the LPS, as well as her perception of her skills and knowledge.

Great. Brilliant. No, really, this did make planning lessons easy. I was not sure about doing this program, about spending heaps of time on top of my classroom preparation. But I thought it might help with getting better marks on prac. I'm good with kids but I didn't do brilliantly last prac—I had a difficult class, year seven, and I just didn't get on with the teacher. He was so... He was good, but I just didn't get on with him. I brought my lessons at the start but he wanted things done his way, you know, work-sheets, getting the kids to learn every lesson the same. It was good but I think the kids did get bored.

I planned most of my lessons quickly, so I had time to think about other things. I came into uni about, what was it, about four or five times to do the lessons (ie. the lesson plans). It took me a while to get the first one done. I remember thinking I didn't like this much. It was a good program, I just thought I could do it better, quicker, on my own. I didn't really have to do much with the information at first.

No, I did spend quite a lot of time searching for information that could help. And I did find useful stuff, things to help with doing things like the evaluation and the objectives... It's hard knowing how to set out the objectives in the way we're supposed to. I think you can spend too much time on this sort of thing, trying too learn about lesson plans. From how it was explained to me, the program is meant to be used, you know, to make it quicker and easier to write lessons without having to learn everything first. So after the first couple of lessons, I just started writing out

the lessons on my own, getting to know the best ways I wanted to work as I went through it.

Interviewer: Can you describe these? What were the 'best ways'?

I mean I just began to feel more comfortable in using the program, using it in the way I thought it would help me... I didn't use the information it had as much, just when I needed it. The cut and copy thing, the notebook (the student here is referring to the Work pad) was really good for keeping information in until I needed it, for keeping information from other lesson plans as well, so I could re-use stuff.

Interviewer: Did you write some lesson plans together, at the same session?

Yeah I, I think about twice... yes. It is simple to do it that way, you get into the groove of using the program, without a break, just get on and do it.

After a couple of times, I really thought about what I was doing, about how I could make the lessons better. I used one of the... I copied one of the lessons in the program. Not really copied, I suppose... used it to get ideas from. It was really close to an idea I had anyway, of using cooking in science to get the kids to think about heat, the effects of heating water, evaporation. Once I had this lesson worked out, I used it as the foundation for my other lessons—objectives, evaluations. I started a new lesson plan each time, but I used what I did before to speed things up.

Interviewer: Did you actually copy and paste from one to another? How much of the previous lesson plans did you use in subsequent ones?

Yes, I did copy and paste. Mainly I just saved the old lesson with a new name, and wrote over the top of the old one. I know how to do that.

I suppose I really found it helped me think about things. I could use it to write the lessons quickly and then I just re-read them to think carefully about what I was doing.

Interviewer: How about the lesson plans you wrote by hand during this practice? Did you find you were spending more time on these ones as well?

Yes, sort of. It's harder at school. You don't have the kind of time you have when I came to uni. But thinking about it, yes, I suppose I did do the same sort of thing. I mean, I did copy the way of writing objectives, of writing... of putting things in the right places, of getting it to look right. I built up confidence, I think. I knew what I was doing. I knew it was right. The teacher looked at all the lessons, and made comments. Did you see what she wrote on my lessons? I knew I was doing really well from what Miss X (teacher's name) says.

The lessons were going well for me, in the classroom. I know I have to get better at some things, of control. But that's not the plan, is it? ...I can give myself more time, I suppose. To sort things out. Anyway, so I sort of guessed... I know the plans were OK, pretty tight.

I think I would have used the program at school, or maybe at home if I had my own computer. But I learnt a lot anyway, using it only at uni. It was great, it really helped me... I know it helped me. I hope we use it again.

For this student, there are clear indications given here to explain how she used the LPS, and to what effect. For example, she is convinced that the software was a major benefit to her, in both supporting her lesson plan writing directly, and in providing the skills and in particular, the confidence, to tackle lesson planning tasks without the use of the LPS. Furthermore, there are repeated pointers in this interview data, that the student was aware of the strategies she developed in using the LPS, as well as the benefits she perceives it bestowed. There are also indications here, of metacognitive skills being developed, of the student consciously thinking of her own role in the lesson planning process, and of thinking about the best ways of working with the LPS to produce increasingly better lesson plans.

However, up to this point the student has said little that comments directly on her use of the various functions in LPS. With further prompting she does offer some indication of this level of usage.

Interviewer: Can you explain what you are doing here? Perhaps you can say something about what functions you were using here (ie. referring to the video playback of the final lesson planning task)?

I did this lesson plan really quickly. I didn't use the information much, I just wrote the lesson plan. I suppose I knew what I was doing. Yeah... I'm not sure what else to say...

Yes, I'm thinking about the evaluation methods to use (here). I did take a lot of time, more time, thinking about what I was doing. I think I said this before. I thought more about what I was trying to teach, how I was teaching, you know, individual kids. My supervisor asked me to think about setting up groups for maths. This is what I'm doing. I tried to find out about groups (pointing to the screen). This helped. It was easy when I saw how to set out a plan for working with groups, so I used it in my lesson (plan). I can see I thought about what I wanted to do more. Yeh, OK. When I was finishing off, I went through the lesson again, here, like the computer said (when using the Reflection tool). It was good. It makes you think, to think about what you're doing, how things fit together. Yeh, (pointing to adding text on screen) I need to think about some of the special children in the class, there are quite a few really intelligent girls.

I thought (here, pointing to the screen) about the next lesson. It was the same... based on this one.

The student didn't say much about the particular functions used, but repeatedly indicated, by both statement and implication, that she had evolved a largely automated way of working with the LPS, using a series of basic functions to produce a lesson plan, and consequently spending more time refining her approach to certain aspects of the lesson. In fact, the video playback used to prompt this student's memory, revealed a number of periods where she scrolled around the lesson plan on screen, adding text here and there, gradually building up the lesson plan and thinking intensely about most aspects of that plan—the objectives, the methods, evaluation. This student also was shown on the video starting off another lesson plan, basing it on the current one being planned, as a second in a series of maths lessons thematically based. Of interest, also, was her

focus on refining the teaching methods to be used, integrating group work, and building some of the work around individual children. On task time was also very high, with no apparent periods of off-task activity.

In many respects, there is in this student a great deal of self-awareness and accuracy in her perceptions of her growth in ability, aptitude and confidence. Indeed, her lesson plan assessments, described further on in this thesis, demonstrate a gradual improvement in her skills that continues beyond the use of the LPS, to reach grade B (ie. Outstanding).

Student 2

The second student (2) was interviewed 10 days following the completion of the professional practice period, and 15 days after production of the final (sixth) lesson plan produced using the LPS. Again, the interview data afforded insights into the student's cognitive strategies in producing lesson plans; and in particular, her preference for working in linear information structures.

Interviewer: Can you explain what you are thinking whilst you were planning this lesson (pointing to the video screen)?

I really panicked. But I did get the hang of things by now. The notes were what I'd printed off before, the first time I used the program (ie. the LPS). I used the notes to read about writing the lesson plans.

Interviewer: Why did you print them, instead of reading from the screen?

I wasn't sure. I suppose, I didn't really know what to do at first. So I just printed off all the information I thought was interesting, and read it at home. I always find I have to read things over again before I'm confident, you know, before I really know it. Do you know what I mean?

It gives me time to think about it. I used it here, to read about what I was doing. I found it easier that way. I can't stand reading from the screen, having to spend heaps of time... its OK but not when you have to find things quickly. Its much quicker with it in front of you (ie. on paper); I know where it is I want to find. OK,

so here I'm reading the stuff on outcomes—I remember this, and then I wrote an outcomes-based lesson, it was keeping in with our Language lectures. Instead of using standard objectives (ie. behavioural objectives). I remembered quite a lot of the information anyway, I'm just really checking on things.

Interviewer: But why are you accessing the same information in the LPS, if you've got it on paper, in front of you?

Not sure. I can see I did check the same information here. I know, I mean, I don't really know why. Perhaps it might change from time to time. It was just to check it remained the same. But it was hard to find what I wanted on the screen, having to follow one screen to another, and then finding it's not there anyway. It's somewhere else! Really frustrating. Anyway, it's good to be able to read it anytime I like, at home and at school. I could concentrate on writing the lesson plan then, when I came into uni.

Interviewer: Did you also use the print-outs of the information when you planned other lessons, say at school, on paper?

Yeah. I suppose I did. I'm not really conscious of it, I didn't really think about it. Yes, I did though. It's something I do anyway. It really helped when I got stuck on writing a lesson plan for group work, in Science. I hadn't done one for groups... not really. I couldn't see if you did do group-work, how to make sure the children all contribute, all learn something. How do you evaluate each child's... what each child has learnt? I had to do this type of lesson for the teacher but I didn't know really how to start it. I needed to have time to think about it, to read about how to do it. It's not easy to do it all at the same time. Not for me anyway.

This student developed an unusual way of working with the LPS, at the inception of its use. In the first opportunity to use the LPS to write a lesson plan, she printed a selection of the information contained within the instructional components, to take away with her. This action was repeated in subsequent sessions with the LPS, not all of which were recorded for analysis, or even used to produce lesson plans. On every occasion that a lesson plan was produced, the

student produced the printed materials and read appropriate sections. In her interview, the student clearly expressed a preference for working with information that is contained on paper, and not in hypertext structures, as used in the LPS to store and for users to navigate and retrieve instructional information. Also, by inference, the student also established her preference for being able to access largely declarative and abstract information concerned with the task of lesson planning, away from the completion of the task itself; as well as accessing it at point of need, when a lesson plan is being constructed. Interestingly, the interactions data partially hides the fact of her preferring to work with paper-based information, since this student at times, accessed the same information she had on paper, on screen, to check its consistency (ie. that it hasn't been changed since she had printed it).

Student 3

The third student (3) was interviewed 14 days following the completion of the professional practice period, and 21 days after production of the final (third) lesson plan produced using the LPS. This student only produced three lesson plans by use of the LPS, and three others by means of 'pen & paper'. The former were all produced during the first week of the professional practice period.

Interviewer: Can you start by saying why you weren't able to complete more than three lesson plans using the LPS?

Yenli: Like I said before I found it too much work, at school and coming in here. I came in here twice, I think⁴⁶? My school was a way from uni, it took me about 30 minutes to drive in each time. It was just too much. I found prac really hard this time. I'm not even sure I want to teach any more. I'll see I guess... but anyway, what was the question...? Oh yes, no... the computer was hard to use. I didn't like it much...

Interviewer: Can you describe what you were thinking when you used the Lesson Planning Program here (pointing to the video)?

⁴⁶ This student (3) was video-tape recorded on two occasions: the second and third lesson plans produced by use of the LPS were written sequentially, at the same sitting.

Its hard. Its a while ago. But I thought it would be useful at first. And it was good to use, good fun, better than listening to a lecturer talk about this boring stuff for hours in front of you. But it was really fiddly, trying to work out the best way of doing everything, there was just so much to read. In the end I didn't read much of it... I don't think I needed to. So here (pointing to the video playback on screen) I'm just writing the lesson plan. And then, printing it off. I always looked at the verbs to use (pointing to the playback screen). I checked things, I thought I needed to make sure I was doing the lesson in the right way; the example lessons were really good for this. I looked at them heaps of times, to make sure I had the same sort of evaluation ideas at the end. There was too much information to read each time, it just didn't seem worth it, reading it each time.

Interviewer: How did you complete the lesson plans when writing them out, without the computer?

Well, like I did before. By hand. Oh, I see what you mean. Yeah, maybe the information would have been useful, like the verbs and the examples. I could have printed them off and used them... later. But I didn't find lesson plans hard to write anyway, and I picked up quite a lot from the first week I came into uni to use the computer, your program. No, it wasn't a problem. I got good comments from my supervisor and the teacher.

The essence of the interview for this student (3) provides further insights into her interactions data, where, after interacting with instructional components moderately in the first lesson plan produced by use of the LPS, she proceeded in the second and third lesson plans to concentrate on using example plans as models for the construction of her own, greatly reducing her interactions with instructional components. Clearly, the student rejects the effort necessary to both learn about the task and to perform it at the same time, but also makes the judgement that it isn't necessary to access instructional information to complete the task adequately. Indeed, the lesson plan assessment data, described further on, reveals that this student consolidated a mark of Highly Competent (D) over four lesson plans assessed, two of which were produced without use of the LPS, producing a fifth lesson plan (#6), again using 'pen & paper', that was assessed as Outstanding (B).

This student quickly identified a cognitive strategy which largely excludes use of instructional components without compromising her apparent confidence to complete the task well, nor the marks achieved in the assessments made of her lesson plan products. This strategy is based on concentrating use on performance components, and in particular the example lesson plans provided, together with the Verb database. Interestingly, this student is also seen in two out of the three lesson plans video recorded, by-passing system prompts to reflect on the nature and relationship between learning objectives, teaching methods and evaluation processes.

Student 4

The fourth student (4) was interviewed 11 days following the completion of the professional practice period, and 15 days after production of the final (fourth) lesson plan produced using the LPS. This student only produced four lesson plans by use of the LPS, and two others by means of 'pen & paper'. The final two LPS produced lesson plans (#3, #4) were written at one sitting.

Interviewer: How did you go about using the different sections of the Lesson Planning System?

The first time I came in I started slowly. I looked at all the different sections, different parts of the software. It looked good, I liked the way I could get into things when I wanted to know about them. Reading the lecturers' and other teachers' ideas about lesson planning was different—at uni we are told different ways to write a lesson plan by lecturers in different units, but no-one really tells you the right way, it gets confusing. It's not just me, everybody feels like this. In the end, I could see the way these different methods work, using the program. I spent a long time reading this information at first. I went on to write my lesson plans.

Interviewer: You spend a lot of time in each part of the program, first reading the instructional information and then writing the lesson plan.

Yeah, I just thought about that. I think that's how I always work, I spend a lot of time going through something and then do it, depending on what it is, even in

exams. Yeah, I read the information I didn't know about each time, and then wrote out the lesson plan. Is that the way I was supposed to do it?

*You can see (looking at the video playback screen). I only really did something after I read it, maybe take notes. But if I didn't remember how to do it, I went back to read about it, to get a better idea of how to go on. Like there. Talking to myself as well (laughing)! No, really. I'm just trying to get it into my head, to understand it. I needed to be able to explain to the teacher why I'm using a reading centre in the classroom. I had a great teacher but she wanted to know why I was doing something a certain way... a bit hard like that. I had to justify everything. I used the school computers to get the kids to read those moving books, the electronic books—the teacher had never done anything like that before and wanted to know why, the reasons for things, what were the kids learning. It was the same with everything. I really did learn a lot with Mrs X (supervising teacher's name deleted), but she wanted to know everything I did in her classroom—it was *her* classroom, *her* kids (ie. interviewee's emphatics).*

Interviewer: How did you write the lesson plans when not on the computer, when you went back to the school?

I remembered what I had done at uni, using the computer. I did it the same way. I didn't check things as much, well not much at all. I mean I didn't read the information you could get on the computer. I think it would have been good to have the computer, what is it, the Lesson Planning Program, to use at any time. But it is much more rushed at school. I wrote out the lesson plans either at home or school. I didn't take so much time as I did on the computer—I just wrote them out. Sometimes I used one I'd taught before, like the ones from the computer. Especially when I planned a few lessons together, in Language.

This and other video recordings of the lessons planned by this student all demonstrate a consistent cognitive strategy in the task of lesson planning. She read the instructional information, for longer at the early stages of use, for the first and second tasks, and then wrote the lesson plan. She did not have a practice of accessing the instructional whilst she wrote the lesson plan; and apart from when in the first task, did not make use of the various prompts by the system to

check the integrity of her lesson planning product. This is likely to be a strategy replicated from working in other non-related tasks—this is simply how this student works: it is part of a preferred approach or style. Learn first, do later.

Student 5

The fifth student (5) was interviewed 11 days following the completion of the professional practice period, and 15 days after production of the final (fourth) lesson plan produced using the LPS. This student produced four lesson plans by use of the LPS, and two others by means of 'pen & paper'. The final three LPS produced lesson plans (#2, #3, #4) were written at one sitting.

I got bogged down in the computer right at the start. It was better second time around. I planned some lessons when I came in the second time. I had written the lessons out the night before, by hand. One of them was my teacher's. I was going to type them into the computer and just print them out. I did that for the first one but the computer made me think about what I was doing. It really stopped me in my tracks. I'm not just saying that! I'm surprised.

It was the information I read as I went through things. I checked the lesson I'd planned...

Interviewer (interrupting): Why did you do that?

Because the computer said I should. Doesn't it? Well, not always, but there was just so much you could check on the computer, it just jumped out at you. The verb database was really good. You could really think about the meaning of the objectives, what you were trying to teach. I went back to think about things I'd already put down. Like I'd written out two Maths lessons, one on different days. And I could see how to now make the objectives I'd set... connect better, so they would follow on... so the children could be made to build on what they did before. Its difficult to explain. Did you see any of that on the other videos?

Interviewer: Do you mean, like here on the video tape (pointing to the video playback screen)—you seem to be reconsidering what you had already written, and revising your lesson plan on the basis of some of the information you had read in the LPS?

I think so, yeah. I didn't actually change very much, not there anyway (indicating towards the video playback screen) but I hadn't realised some things before... like using learning outcomes instead of ordinary objectives (ie. the student is referring here to behavioural objectives). And I changed my evaluations, to check what the children were supposed to learn each lesson. My first ones were too wide.... general, generalised.

I just felt much more confident about what I was doing. It made me realise what I knew and what I don't know. I mean I didn't always include the information but it is useful for exams.

Interviewer: Did you find you used this information when you went back to your classroom, and planned lessons without the computer?

I know I always went back over what I'd written to check to see if I had written it correctly, especially to check the evaluation and the objectives, to make sure they matched up. I got quicker at writing them by hand, as well, I think... I couldn't remember everything. It would have been better to have given us a computer to use at school or at home for this work. I did start using the checklist that the computer, the LPS gave us—you know? The one that gets you to check all the different... elements are there in the lesson. I copied it down to use at school.

I really started to think about my role in the classroom. I could see everything coming together.

Perhaps the most interesting aspect of this interview is not what it reveals about the cognitive strategies at play in the use of both the LPS and 'pen & paper' to write lesson plans, but more for what it says about the ways in which the student appears to have benefited from the LPS. Clearly the student is herself most pleased at how the use of the LPS has changed the way she now thinks about the

lesson planning task, and in particular, how it has engaged her in thinking more deeply about her response to the task. In fact, the interview is, in parts, rich for the references demonstrating how the student has used her experience with the LPS not only to learn more about the task of lesson planning, but also to transfer strategies for thinking about the task to another ('pen & paper') medium. She appears to be using the LPS, and more importantly, what she has learnt from the LPS, to think at a higher level about the task of lesson planning whilst performing the task.

Results—lesson plan products

As with the procedures established in the pilot and main (part one) studies reported earlier, all lesson plans created by student-teachers here were subject to grading by a lecturer in Education at Edith Cowan University. Six grades were used in this research programme; and, for use in providing a graphical representation of data in Figure 7.2.1, below, the grades F—A were each articulated to a numerical equivalent (ie. a mark), 1—6.

Table 7.3. Articulation of lesson plan assessment: Outcome—Grade—Mark

Outcome	Grade	Mark
Outstanding	A	6
Outstanding	B	5
Highly Competent	C	4
Highly Competent	D	3
Competent	E	2
Unsatisfactory	F	1

The grades for each of the five students over the series of lesson plans produced by use of the LPS and that were submitted and assessed, show an improvement, at best, of two grades and one major grade category (ie. from Competent to Highly Competent), (1, 4); and at worst, of no improvement at all (2). However, not all students experienced increasingly positive results in this respect, over the entire span of lesson plans assessed—for some students (2, 5), their grades fluctuated both up and down, at different junctures in this span (see Table 7.4.1).

The first student (1) showed a steady and positive improvement in her grades, over six lesson plans, beginning at Competent, moving towards Highly Competent by the third lesson plan, and maintaining this grade to the sixth

lesson plan. In this context, there is evidence of a successful cognitive strategy being established early on and gradually refined.

Table 7.4.1. Students 1—5 (Study 2): Grades for lesson plans 1—8 [shaded areas indicate those lesson plans produced by means of 'pen & paper'].

Lesson Plans	Lesson Plan Grades				
	Student 1	Student 2	Student 3	Student 4	Student 5
L1	E	D	E	E	D
L2	D	D	D	C	E
L3	C	C	D	C	C
L4	C	D	D	C	C
L5	C	E	D	C	D
L6	C	D	B	C	C
L7	B	D	—	—	—
L8	C	C	—	—	—
L9	B	D	—	—	—

The second student (2) experienced some fluctuations in grades over the first six lesson plans assessed, and at one point (ie. the fifth lesson plan), achieved a lower grade than that gained at the outset. The third student quickly established herself at the grade of Highly Competent, by the second lesson plan but submitted only three lesson plans produced by use of the LPS, making it difficult to read more from this data. However, as reported earlier, this student did produce at least (or thereabouts) six other lesson plans by use of the LPS and which were not formally assessed in this research programme. This high usage of the LPS may provide the explanation for her achieving progressively higher grades (including Outstanding) in the three lesson plans produced by means of 'pen & paper' (ie. for this student, the fourth, fifth and sixth lesson plans).

The fourth student (4) provided four lesson plans by use of the LPS, and these are assessed initially at Competent, quickly moving to Highly Competent by the second lesson plan and maintaining this grade assessment throughout the remaining tasks. Again, as with the first and third students (1, 3), there is some evidence here of a successful cognitive strategy being established early on and gradually refined and consolidated.

The fifth student (5) experienced a low point of Competent in her second lesson plan (from a start point of Highly Competent), but then re-established the higher grade (Highly Competent), in the following two assessments of her LPS usage.

Any improvement in grades achieved by the student-teachers over the lesson plans produced by use of the LPS, was maintained or bettered in the lesson plans subsequently produced by 'pen & paper' (see Table 7.4.1, and Figure 7.2.1, below). In the case of two students (1, 3) the improvements were by measures of one major grade category (ie. Highly Competent to Outstanding). Although it is difficult to argue a long-term trend or measure of learning or skill-performance transfer from these figures alone, there is clearly an inference here that some level of transfer did take place. In other words, removing the LPS from the student-teachers here, did not hinder or impair their performance in the lesson planning task; and it is likely, these students transferred their learning and their level of skill-performance in the task, achieved by their use of the LPS, to the same type of task, without the use of the LPS.

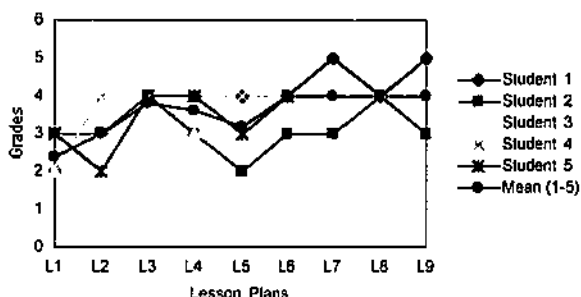


Figure 7.2.1. Students 1—5 (Study 2): Grades for lesson plans 1—9 (where 1—6 corresponds to F—A).

There are both similarities and differences between the outcomes for students here, in the second part of the main study (MS/2), and those in the first part (MS/1). In general terms, the students in MS/2 rapidly obtained higher grades in their lesson plans, and maintained or bettered these grades over subsequent lesson plans produced by use of the LPS. Further, the students in MS/2 were, on average, performing the task of lesson planning at a higher level of competency over all the lesson plans produced, by means of LPS and 'pen & paper', than those students in MS/1—but only by an overall average difference of 0.29 of a grade point (see Table 7.4.3, below). In general terms, both sets of students improved their grade assessments over the entire span of lesson planning tasks;

and also maintained or continued to better their assessments for lesson plans subsequently produced by means of 'pen & paper'.

Table 7.4.2. Students 1–5 (Study 2): Grades for lesson plans 1–9 [where 1–8 corresponds to F–A].

Lesson plans	Lesson plan grades					
	Student 1	Student 2	Student 3	Student 4	Student 5	Mean (1-5)
L1	2	3	2	2	3	2.4
L2	3	3	3	4	2	3.0
L3	4	4	3	4	4	3.8
L4	4	3	3	4	4	3.6
L5	4	2	3	4	3	3.2
L6	4	3	5	4	4	4.0
L7	5	3				4.0
L8	4	4				4.0
L9	5	3				4.0
Mean (L1-L9)	3.9	3.1	3.2	3.7	3.3	3.4
St. Dev.	0.9	0.6	1.0	0.6	0.8	0.6

Table 7.4.2, above, reveals the range of average grades achieved by students in this study, for all nine lesson plans, together with the mean grades, calculated over all lessons (L1-L9) and for all students (1-5). Whilst the grades achieved by each student do not, in the majority of cases, follow a continuous path of improvement, the similarity in the standard deviations for the range of lesson plans, L1-L9, for at least students 1, 3, 4, and 5, suggests that similar degrees of growth were achieved in lesson plan quality by all but one of the students.

Table 7.4.3. Students 1–4/5 (Studies 1–2): Average grades for all lesson plans over Main Studies 1-2

Study	Average Grade Assessments					Average
	Student 1	Student 2	Student 3	Student 4	Student 5	
MS 1	3.4	2.9	3.4	2.9		3.14
MS 2	3.9	3.1	3.2	3.7	3.3	3.43

Discussion

There are a number of significant points that emerge from the interview, interactions and product assessment data, concerning the cognitive strategies that individual students put into place in their use of the LPS. For example, despite the external imposition of the task of lesson planning, as part of the requirements to complete a professional practice exercise, all of the students responded in

different ways to it, working in the task to develop learning about the task, and about themselves as learners and lesson planners (ie. where lesson planning is the task). Clearly, the learning achieved is task specific and task linked. So although the media used to perform the task is changed, when the task remains unchanged, performance related learning continues.

Whilst there are no formal evaluation processes built into the instructional components of the LPS (ie. in the form of test questions, case problems, etc.), in the manner of PSS design advocated by Puterbaugh (1990), Milheim (1997) and others, the analysis of the interview data in this study (MS/2) leads one to question the value of including such a feature. In a PSS, where the means for users to formally evaluate their skills and knowledge are included, the benefits are to be found in the feedback offered by the system. But as with traditional instructional contexts, where learning to perform a task and actually performing it are distinct and separate, the value of this feedback must be held in question. Any such feedback is limited to an abstraction of the task, and is not likely to help the learner transfer learning to the performance of that task. Furthermore, the provision of such feedback, being based on abstractions of the real task (eg. test questions about various aspects of the task), are likely to have a negative or negligible impact on students' motivation to learn and to perform the task: to paraphrase Carr (1994), feedback in instructional contexts can be useful but only in terms of that instruction—it can do little to help to transfer learning to the performance of the task, and is 'notoriously unreliable' at motivating performers. However, it should be noted that in this study (MS/2), all students are seen to have improved their performances in lesson planning tasks. Where students might not experience such improvements, feedback on task abstractions might play a limited role, to perhaps point to those aspects of the task that might be misconceived or misunderstood, lending support to students in their conscious development of more appropriate cognitive strategies. Essentially however, both learning and assessment of that learning needs to be grounded in real tasks, and not abstracted from them.

There are fundamental elements in the design of PSSs, that find their basis in well-grounded arguments mapping out the benefits of real-world learning and denigrating 'traditional or formal classroom' learning. These arguments can be most easily traced in, although not limited to, the work of educationalists that expound the theoretical perspectives of situated cognition, cognitive

apprenticeship and 'communities of practice' (Brown et al., 1989; Cognition and Technology Group at Vanderbilt, 1990; Collins, 1989; Collins et al., 1987; Lave, 1988; Lave & Wenger, 1990; Wenger, 1991). A theme common to these learning theories, and these theorists, is that learners experience difficulties with what is variously called 'fractionated instruction' and 'fragmented learning'. Indeed, it is often proposed in this context that learners, both children and adults, construct knowledge from active participation in holistic, complex meaningful environments organised around long-term goals; and that fractionalised instruction maximises forgetting, inattention and passivity (Gery, 1993). Of course, a similar perspective can also be found in mainstream cognitive psychologies, such as information processing (Corrie, 1995; Miller, 1956), where issues such as familiarity, associations, meaningfulness, mental scaffolding, etc., are considered important in achieving learning via cognitive functions such as attending, encoding, working memory processing and long-term memory storage and retrieval. Successful learning is meaningful learning and is embedded or integrated; unsuccessful learning is likely to be disembedded, without context and entirely abstract.

However, typically in PSS design, as in the LPS, much of the instructional information, declarative and sometimes procedural, is contained in a hypertext format and navigation system. For at least two students in this research programme, the third student (3) in MS/1 and the second (2) in MS/2, this created initial difficulties, with the former student (MS/1/3) preferring external information resources structured in a linear framework (ie. a text-book) when it came to accessing instructional components of the LPS; and the latter (MS/2/2) printing much of the same information resources from the LPS directly before using it. Thus, despite the theoretical principles upon which PSSs are based, instructional information when structured, and thereby fragmented, within a hypertext navigation system may well mitigate against successful learning for some students, particularly in its transfer to new applications.

It is a basic tenet for the design of PSSs as well as a manifestation of the principle of just-in-time learning, that instructional information is made available at the point of need, and that time lags between task instruction, task practice and task performance are minimised or at best, removed. Furthermore, characteristics of various theories in cognitive psychology, share the same tenet—this is true of information processing, situated cognition and cognitive apprenticeship.

Certainly, as Harmon and King (1979) point out, if learners are provided with information as they need it, they are more likely to make connections between the information and the context in which it is to be used. But of course, not all students will necessarily make meaning, particularly in complex aspects of tasks such as lesson planning, at the point of completing the task—or at least, not straight away. In one case here, for example, a student (2) imposed a learning strategy that she had used repeatedly in other learning situations, of re-reading instructional information so that it might be better understood, feeling more secure away from the task, when she has time to reflect more fully on the information. It seems that for this student, being too close to the performance of the task is a barrier to being able to appropriately reflect on related information.

Furthermore, the same student also showed some difficulties in transferring what she knew, or had learnt, to a new situation; and when it came to a new task or where there was a new element in a known task—in this case, for example, planning for groups in a Science lesson—the student needed to return to the instructional materials to search for an approach to solve the problem. Thus, whilst the conditions and functions in the LPS might encourage *substantive* transfer across media, where learning transfer occurs because tasks and environments are similar, or because the skills needed in two settings are alike, they may not encourage *procedural* transfer, which calls for mental effort and deliberate thought, to take a concept from one context and apply it to another (Salomon & Perkins, 1989). Although, in this example, for this student, the mental effort or cognitive load imposed in learning transfer from one task to a similar yet new task, might also be explained by reference to standard novice-expert studies (Berlach & Hattie, 1993; Chi et al., 1988), and the fact that this student had not transcended her novice status in the task of lesson planning. In other words, she wasn't able to bring to bear on the new problem a schema, or abstract representation of the problem, that adequately addressed the variation in the task she faced—quite simply, she hadn't yet developed the necessary schemata from only limited experience in lesson planning, to allow her to solve variations in lesson planning tasks; and she was not able to decontextualise one strategy so to apply it to the demands of a slightly different task.

Of course, the difficulties shown in transferring performance learning across media by this student (MS/2/2) is not evident in the data obtained for other students in this part of the study (MS/2), or in the first part (MS/1). For many

students here, the lesson planning tasks completed off the computer and without the support of the LPS, were simply identical or very similar to those completed whilst using the LPS. Familiarity of task and situation is probably enough to provide for substantive transfer (Salomon & Perkins, 1989), allowing students to maintain or even improve their performance in the task where the skills required remain essentially the same. We can see this occurring for many of the students in this study—the third student in the second part of the study (MS/2/2) is a very good example. In this case, she didn't see a need to access the instructional components in the LPS to confidently construct even her early lesson plans. However, she was still able to improve her performance assessments. Indeed, this might be explained by reference to a limitation in the data, since this and perhaps other students, especially in the second part of the study (MS/2), might be assumed to have already moved away from their novice status in lesson planning, by virtue of the fact that this was their second professional practice experience, therefore having begun to accumulate skills and knowledge in the task. Probably a more likely explanation, however, will be found in the similarity of the tasks being undertaken by these students, and the shallowness of the learning transfer being effected. If these students were to attempt a task which required new skills or presented them with a new problem to solve, it is perhaps likely that they would perform the task poorly, and/or need to access additional instructional information related to the problem being faced.

It would seem that to encourage transfer in learning over different media, as between the use of the LPS and 'pen & paper' to create lesson plans, it is necessary to provide the extended experience required for novices to build robust schemata to apply to new yet different problems or sub-problems; and also to provide the means for them to abstract rules and principles from experience, to use in a variety of both like and unlike task situations. In this sense, the difficulties of effecting learning transfer are not mitigated by the use of a PSS such as the LPS, unless, perhaps, there are specific instructional strategies employed in the PSS that might aid novices to retain their learning more efficiently. Such strategies would need to help learners build functional conceptual (mental) models of the domain, as well as abstract fundamental rules and principles from experience and practice in the task, amongst other things. The design principles of PSSs may, in fact, actively prevent some students transferring their learning, simply because the cognitive requirements necessary to perform the task as well as to make meaning from the instruction, are

immediate and excessive when combined in close proximity, hindering the need to reflect and abstract, without specific measures on board to help students undertake these higher-order cognitive acts. Indeed, the LPS does contain a Reflection Tool but this is limited to encouraging the student to reflect on the nature and relationship between a lesson plan's objectives, teaching methods and evaluation processes—it does not prompt or scaffold reflection on other instructional information.

Part of a more general problem here can also probably be traced to the notion that learning or effective training in a task, is not always best achieved in small chunks or steps, as tends to be promoted and designed in PSS technology. Clark (1992) reminds us that learners need a framework within which to build their knowledge—and this is even more so in complex knowledge domains. If learning is not explicitly tied to an overarching framework, the learner will not develop what Desrosiers' (1996) calls 'the big picture'.

A number of students in both parts of this study (MS/1, MS/2) drew attention to a further concern in the use of the LPS and PSSs more generally, as tools for learning. As Mauldin (1996, p. 37) states, PSSs place an emphasis on 'knowing how, rather than knowing what or knowing about'. That is, they demand the learner or user of the system attend to largely procedural matters concerned with completing the task at hand, and provide for declarative and metacognitive knowledge only in support of task performance. Indeed, Clark (1992) warns that learners might be encouraged within the PSS to ignore instructional information and work primarily to develop greater performance and not independent knowledge—users might be content to complete a task satisfactorily rather than attempt to understand the nature of the task and their completion of it, more deeply. However, whilst a number of students in this study, in both MS/1 and MS/2, did develop this approach to the LPS, others did not. In particular, in MS/2, two students, (MS/2/2, MS/2/4), demonstrated how they developed preferences to work with a cognitive strategy that is premised on a comprehensive review of relevant information and used to construct understanding rather than simply to enable performance. This strategy is characterised by accessing the same instructional support information repeatedly and not only when it was appropriate to task performance, but more so when it was thought to be relevant to understanding the full nature of the task.

Furthermore, another student in MS/2, (MS/2/5), provides evidence of developing a cognitive strategy that is based on exploiting the value, and refining the use, of two types of performance support functions in the LPS—the explicit and immediate support offered by the Verb database, which reduces the need to hold and manipulate in memory an array of data; and the Work pad and Reflection tool, that can be used to encourage deeper and higher-order cognitive processes, such as reflection, critical review and metacognition. This student clearly reported how her use of the LPS ‘made me realise what I knew and what I don’t know’; and how various functions in the LPS prompted her to review her way of writing lesson plans, encouraging her to adopt higher and metacognitive cognitive processes in this task than she might have done without the use of the LPS.

A tangential aspect of this issue, concerns the influence that students’ predetermined styles of learning have on their strategic use of PSSs such as the LPS. For example, some students are seen in both parts of this study (MS/1, MS/2), maintaining a cognitive strategy that is based on a clear distinction between learning about the task and completing the task. That is, they tended to spend separate periods and interactions, reviewing largely declarative information concerned with the general domain in which the task sits, even developing metacognitive strategies such as thinking aloud and writing related notes (sometimes in the Work pad) at the same time. This approach was also characterised by spending a lot of time and interactions in comprehensively exploring all the information available. Only afterwards it seems, do these students attend to the task itself, and then without returning for any significant amount of time, to the instructional support information. Such a strategy is undoubtedly borrowed from more traditional approaches to teaching and learning, where students experience learning and performing separately. It seems for some students at least, it is not easy or apparently necessary, to shed this practice and adopt strategies which are probably more suited to the use of a PSS. Further, the experience of simply using the LPS does not evidently cause students to adopt a particular way of working in a task.

Interestingly, the students who did impose more traditional cognitive strategies in their use of the LPS did not suffer in terms of their performance, actually improving or consolidating performance measures in lesson plan assessments during and following their uses of the LPS. It might be concluded from this then,

that traditional approaches in training and learning, where instruction and task performance are separated, remain effective and preferred ways of working for some students. However, it should be remembered that in most of these cases, for students using the LPS, the time lapse between the instruction and performance in the task of lesson planning is minimised since they are undertaken at the same session. Although there is an example in MS/2, of one student (MS/2/2) going to some considerable lengths to purposefully destroy the proximity of task learning and task performance—she spent a long time printing almost all instructional information to study away from the task, preferring the linear and continuous format of printed information as opposed to fragmented instruction coded in hypertext form, and also preferring to access this information away from the pressures of task performance.

Of course, in light of these concerns about the cognitive strategies developed by students in their use of the LPS, it is possible to surmise that PSS technology may not suit complex knowledge domains, where learning and knowledge transfer are important criteria for their implementation; nor may they suit all types of learners, especially those that prefer to use cognitive and metacognitive strategies that entail a separation of the acts of learning and performance. However, especially in terms of the latter issue, it may be necessary to account for external and what Clark (1992) labels as environmental factors, and what Tessmer and Richey (1997) have more recently described as 'contextual elements', as being key in determining the nature and value of use of PSSs. That is, outside the pressures of producing a lesson plan in a given space and limited time slot (such as in pre-determined time periods, at a central resource room, and during an assessed professional practice period), where the differential cognitive loads of task performance and task learning are perhaps overwhelming, novices in this task might perform the task differently, developing more efficient cognitive strategies and perhaps to better effect. However, whilst this may be the case, it might not be possible to identify the best contexts for use of the LPS or any PSS, since 'context is not the additive influence of discrete entities but rather the simultaneous interaction of a number of mutually influential factors' (Tessmer & Richey, 1997, p. 87).

Issues related to performance outcomes for students using the LPS have not been well resolved in either this part of the study (MS/2), nor in the first part (MS/1). There are indeed strong pointers and a convergence in the data obtained, that

suggest most students do improve performance measures in the task of lesson planning whilst using the LPS. Some researchers in PSSs have thought that simply by automating support in task performance (Geber, 1991; Gery, 1991; Leighton, 1996), users are bound to improve in performance outcomes in directed tasks. However, in this study, the improvements in task performance are generally maintained or even bettered, after students have stopped using the LPS to construct their lesson plans. Indeed, whilst the numbers of lesson plans assessed for students in MS/2 (2–3, per student) and in MS/1 (1, per student), are not extensive, the aggregate for all students and over MS/1 and MS/2, provides a relatively sound indicator of a positive trend, which should be more rigorously investigated in a future research programme.

Conclusion

Both the pilot and the first part of the main study, presented in Sections 5 and 6, respectively, provided outcomes which (i) demonstrated by use of the LPS, novice student-teachers developed and sustained a marked level of expertise in their production of lesson plans relatively early on (ie. at or near the third task observed); and, (ii) spotlighted cognitive strategies that were commonly and increasingly used by these students in their development of expertise in the task, such as templating lesson plans (ie. using early lesson plans as templates for later ones), automating approaches to sub-tasks and concentrating on higher-order sub-tasks, and finding motivation in a conscious bid for self-improvement in the task.

The second part of the main study, reported in this section (Section 7), found that, in students' use of the LPS to learn and perform lesson planning as a complex task, the following was true:

- (i) Novice student-teachers achieved gains in learning and performance by their adopting a diverse range of cognitive strategies using the LPS. Whilst these strategies had common elements when viewed across all students, when they were mapped as 'cognitive strategy profiles' for individual students, they were richly different.
- (ii) Learning and performance in students was transferred substantively across media, so that when the LPS was removed as part of the task environment, learning and skill-performance in the same task continued.

- (iii) Non-contextual feedback on task performance was likely to be of limited or no value in enhancing either performance or learning in students.
- (iv) Not all students learnt or performed effectively in a hypertext environment; and at least one student appeared to be specifically disadvantaged by the embodiment of instructional resources in a hypertext or hypermedia format in the LPS, as a task-based performance environment.
- (v) At least one student in this study was hindered in achieving meaningful and deep learning, by the design of the task environment in the LPS—where learning and performance was intended to be completed simultaneously or at very close proximity, (as in the philosophy of just-in-time learning).
- (vi) Learning in a task-focused environment, such as that provided in the LPS, did not appear to promote cognitive strategies in students that were primarily guided by the motivation to perform the task better. Students were just as likely to form strategies guided by the motivation to obtain better understanding in the task.
- (vii) Students' learning styles or preferences appeared to be the primary factors influencing their adoption of cognitive strategies in learning and performing in a task. This was despite the fact that these strategies were not necessarily suited or optimised to the cognitive tools available for use in the LPS, or to the task-based environment in which they were applied.
- (viii) The context of use provided for the LPS in these studies, was a contributing factor influencing the type and diversity of strategies adopted by novice student-teachers in their completion of lesson planning tasks.
- (ix) The LPS provided strong cognitive support to novice student-teachers in their completion of lesson planning tasks.

These findings, and their significance, are discussed in the concluding section to this thesis (Section 8), in the context of crafting direct responses to the original orientations that guided this research programme.

SECTION 8

Conclusion

Introduction

Whilst all parts of this research programme have provided a number of findings concerned with the design, application and use of PSSs for complex tasks, it is necessary to address the original research orientations and to sculpt the findings of this research programme into coherent and credible responses to the tasks undertaken to investigate these orientations. Also, it is necessary to use this final section to address wider issues—for example, to determine the implications this research has for the design, implementation and use of PSSs for complex tasks; to describe the limitations to this current work; and to outline implications this current work might have for further research.

Research orientations addressed

There were four orientations originally posed, to guide the methods and frame the outcomes of this research programme:

1. To identify the critical components of a PSS to support the completion of a complex task (lesson planning).
2. To design and construct the LPS based upon those critical components considered to be relevant to lesson planning.

3. To investigate how novice student-teachers engage these components in the LPS to produce a lesson plan.
4. To investigate the effectiveness of the LPS as a PSS to support the completion of lesson planning.

The following discussion addresses each of these orientations, in terms of the findings from, and actions taken in, this research project.

To identify the critical components of a PSS to support the completion of a complex task (lesson planning)

There were two principal ways in which this research orientation was addressed, and both were furnished by review of relevant literatures. The first approach centred on identifying components of the LPS so that it might function as a PSS but also satisfy specific requirements of the lesson planning task environment. The second approach concerned the development of a theoretical rationale and framework for the operational functions of the LPS, so that the software was optimised not only for performance but also for learning.

There were a number of considerations made in designing the LPS, so that it functioned as a PSS in the manner described by a broad consensus of those represented in the PSS literature. These considerations included:

- electronic support for job task(s);
- support on demand;
- integration of performance and support functions; and,
- appropriate use of technology.

These considerations are fully explored, and the corresponding design features provided in the LPS described, in Section 2.

The second way in which research orientation was addressed was of a more inventive nature, and required the adoption and adaptation of theory. Given that traditionally, PSSs have not been designed for complex educational tasks, there was little material directly relevant to building a model of learning and performance in the LPS.

A consideration of learning theories provided the means to construct an informed and coherent model of instructional support to the learning and performance tasks in the LPS. It became clear, in a wide-ranging review of pertinent learning theories, that the role of such theories in optimising performance and learning in the LPS, was multifarious. Indeed, since all theories of learning were evidently partial in their explanation of student learning, they needed to be employed collectively to help inform the design task. Furthermore, since these theories had been grown independently, they did not enjoy a natural relationship with each other (Duchastel, 1998). It was therefore necessary to provide a cohesive and coherent overarching framework within which they could be made to operate. The framework chosen was based on a discursive model of teaching and learning, and is described in Figure 2.3, in Section 2. The elaboration of, and reasons for, adopting this model and its implementation in the LPS, is described in Table 2.5, again to be found in Section 2.

So, in this context, the LPS was designed to possess certain pedagogical characteristics in the form of both tools and information resources, all of which were predicated on the notion that learners needed to conduct dialogue in order to learn effectively, and that this dialogue should be centred on a process of reflection, adaptation and interaction—with knowledge, actions or behaviours and the task environment. Of course, whilst the notion of dialogue was central to the instructional and performance support model built into the LPS, it was not *assumed* there would be real dialogue in the use of the LPS, between two or more learners (although this might occur); yet the possibility for developing dialogue *within* a learner did exist. The LPS, then, was designed to provided an operational model for a dialogic process which could be seen as a mediation process between the known and the unknown or between the learner and the object of learning.

On reflection, the LPS invoked a design model that was centrally founded in cognitivism but also acknowledged the need to look beyond information processing theories concerned centrally with memory, to provide an inclusive, eclectic and multi-dimensional approach to the design process. However, it was not intended in this research program, to test any one of these theories, but rather at a more general level, to develop a holistic rationale for the development and application of performance support tools for learning in complex knowledge domains. The basic design strategy adopted, then, was to think in terms of what

the learner must do (performance) and how the teaching should support the them (instruction)—and to describe this within a system.

Arguably, this system, in the embodiment of the LPS, found an entirely appropriate expression in the theory of cognitive tools and in performance centred design methodologies.

To design and construct the LPS based upon those critical components considered to be relevant to lesson planning

The response to this research orientation can be found in Section 3, which provides an account of the process of development of the LPS and in particular, how its features were identified, how these features were then iteratively designed and developed within a coherent software model, and finally how the LPS was formatively evaluated to determine the behaviour of the component parts in the context of use in 'real-world' lesson planning tasks.

The process of design and construction of the LPS was achieved by adopting two complementary approaches: the first involved using relevant literatures to help predict the cognitive processes that are necessary to the completion of a complex task, such as lesson planning, and then outlining the nature of the software tools and information resources that might best support these processes. The second approach utilised focus group interviews of both novices and experts in lesson planning to determine the most efficient ways and means of creating lesson plans, together with identification of the shortcomings in lesson plans presently constructed by first-year (novice) undergraduates in the local setting.

As a result, the LPS was constructed in line with those critical components considered to be relevant to lesson planning; and these were then fitted within the design model created for the LPS (see the response to Research Orientation 1, above).

As in any standard design for a performance support system, there were two major types of components created for the LPS: the first were support or performance tools (also classifiable as task-support tools); the second, instructional sequences or items. In addition, a 'help' facility was created, which can be classified as an instructional aid (see Figures 3.1–3.4, Section 3). The primary difference between performance-support and instructional-support

components in the LPS, is one of operation. For example, performance-support functions provided dynamic access to information, templates and generic tools, to allow users to implement information directly or indirectly into their lesson plans. Alongside and in addition to these dynamic tools, was the provision for a standard series of other tools (such as 'save' and 'print') that allowed for the manipulation, in various ways, of students' work. Conversely, the instructional information was not primarily intended for students to embed into their work, but rather to inform both their performance and understanding of lesson planning.

The components provided in the LPS, together with their relationship to desirable knowledge types and their corresponding means of representation, are fully described in Tables 2.3.1–2.3.4, in Section 2.

From the analysis of the focus group interviews, it was decided to amend the LPS, so that it provided for greater access to more diverse information about lesson planning, particularly different models of lesson planning; and to provide for greater availability of use. To implement both these provisions, it seemed to be appropriate to provide an on-line version of the LPS. An on-line version of the LPS, with dynamic links provided to more, and more diverse, information on lesson planning, should increase accessibility at more vantage points, for use in and outside school classrooms. However, for the purpose of this research, the amendments to the LPS based upon the focus group evaluation, was provided for use on the 'static' or disc version of the LPS. Specific changes to the LPS, based on this formative evaluation, included:

- refinements and additions to information made available, particularly that which informs student teachers of the available range of lesson planning approaches;
- sound provided for 'copy' and 'paste' actions in the notepad, to better indicate an action had occurred to the user;
- a greater range of lesson plans were added to the LPS, as exemplars of peer-generated lessons planned in all major subject areas that student teachers might be expected to teach in, in both primary and secondary schools.

To investigate: (i) how novice student-teachers engaged the components in the LPS to produce a lesson plan; (ii) the effectiveness of the LPS as a PSS to support the completion of lesson planning.

These two investigations account for the two remaining orientations (ie. Research Orientations 3 and 4) adopted for this research programme. Two approaches were taken in response: the first sought to examine students' cognitive strategies in their use of the LPS; and the second analysed the outcomes of student's use of the LPS. The full accounts of these parts of the research programme are given in Sections 5 (Pilot Study), 6 (Main Study, Part 1) and 7 (Main Study, Part 2).

The pilot and the first part of the main study, presented in Sections 5 and 6, respectively, provided outcomes which:

- (i) demonstrated by use of the LPS, novice student-teachers developed and sustained marked level of expertise in their production of lesson plans relatively early on (ie. at or near the third task observed); and,
- (ii) spotlighted cognitive strategies that were commonly and increasingly used by these students in their development of expertise in the task, such as templating lesson plans (ie. using early lesson plans as templates for later ones), automating approaches to sub-tasks and concentrating on higher-order sub-tasks, and finding motivation in a conscious bid for self-improvement in the task.

The second part of the main study, reported in this section (Section 7), found that, in students' use of the LPS to learn and perform lesson planning as a complex task, the following was true:

- (i) Novice student-teachers achieved gains in learning and performance by their adopting a diverse range of cognitive strategies using the LPS. Whilst these strategies had common elements when viewed across all students, when they were mapped as 'cognitive strategy profiles' for individual students, they were richly different.
- (ii) Learning and performance in students was transferred substantively across media, so that when the LPS was removed as part of the task environment, learning and skill-performance in the same task continued.
- (iii) Non-contextual feedback on task performance was likely to be of limited or no value in enhancing either performance or learning in students.

- (iv) Not all students learnt or performed effectively in a hypertext environment; and at least one student appeared to be specifically disadvantaged by the embodiment of instructional resources in a hypertext or hypemedia format in the LPS, as a task-based performance environment.
- (v) At least one student in this study was hindered in achieving meaningful and deep learning, by the design of the task environment in the LPS—where learning and performance was intended to be completed simultaneously or at very close proximity, (as in the philosophy of just-in-time learning).
- (vi) Learning in a task-focused environment, such as that provided in the LPS, did not appear to promote cognitive strategies in students that were primarily guided by the motivation to perform the task better. Students were just as likely to form strategies guided by the motivation to obtain better understanding in the task.
- (vii) Students' learning styles or preferences appeared to be the primary factors influencing their adoption of cognitive strategies in learning and performing in a task. This was despite the fact that these strategies were not necessarily suited or optimised to the cognitive tools available for use in the LPS, or to the task-based environment in which they were applied.
- (viii) The context of use provided for the LPS in these studies, was a contributing factor influencing the type and diversity of strategies adopted by novice student-teachers in their completion of lesson planning tasks.
- (ix) The LPS provided strong cognitive support to novice student-teachers in their completion of lesson planning tasks.

In essence, then, these findings reveal that the novice students employed a diverse set of cognitive strategies to complete their lesson planning tasks using the LPS; and that the strategies they adopted were principally influenced or determined by, (i) the context of use of the LPS; (ii) their preferred learning styles; (iii) their previous learning experiences; and (iv) their motivations.

In terms of outcomes of use, the study showed that the novice student-teachers achieved gains in learning and performance as a result of their use of the LPS; and learning and performance in students was transferred across media, so that when the LPS was removed as part of the task environment, learning and skill-performance in the same task continued. In this context, the LPS was found to provide strong cognitive support to novice student-teachers in their completion of lesson planning tasks, and to their learning in this task.

Significance of findings

At the highest level of interpretation, the findings from this study demonstrated that the LPS provided novice student-teachers with strong cognitive support in their completion of lesson planning tasks. Furthermore, learning and performance in students was transferable across media, so that when the LPS was removed as part of the task environment, learning and skill-performance in the task continued. A significant implication in this frame, is that PSS technology, does offer a viable, non-traditional, option for engaging students in both learning and performance in complex task domains, such as lesson planning.

However, the LPS did not appear to offer an optimal environment for all students. Whilst these students did not appear to suffer adversely in their performance in lesson planning tasks as a result of using the LPS, there were indications that the cognitive strategies they developed in their interactions with the LPS, did not align well with the features of the 'just-in-time' PSS environment in which they were working. More particularly, there was some evidence that they had difficulties in transferring their learning from one type of task to a variation of that task. For example, some students appeared to be cognitively disadvantaged by the fragmentation of instructional resources and information by their inclusion in a hypermedia format; others were similarly disadvantaged by the proximity of task and learning environments. A significant implication in this, is that users of PSSs need to be guided towards the development of appropriate cognitive strategies, thereby maximising the potential advantages of the PSS to both learning and performance.

It was also apparent that students' cognitive strategies were principally influenced or determined by, (i) the context of use of the LPS; (ii) their preferred learning styles; (iii) their previous learning experiences; and (iv) their motivations. A significant implication from this understanding, is that where all or any of these elements, for individual students, do not align well with the PSS environments being used, learning and performance is likely to suffer.

The extent to which the design of the LPS was of significance is an interesting issue, principally because whilst this was not the subject of this research programme, there were indications in aspects of the data analysis, that were pertinent. For example, whilst the value of feedback in any learning system, and

indeed, in PSSs, is well known and accepted, there appeared to be little value to the inclusion of non-contextual feedback based on abstractions of the real task—such as test questions or case problems. In dealing with PSSs, where the design of the software systems are predicated on authentic tasks, feedback would also seem to need to be authentic and grounded in real tasks, rather than abstracted from them. This does not accord with much of the PSS literature, especially that regarding the nature and implementation of feedback in PSS design advocated by Puterbaugh (1990), Milheim (1997) and others. A significant implication in this observation, would appear to be that where PSSs are designed to enhance learning and performance in complex educational task environments, the feedback provided in assessment and evaluation processes, embedded in the software, needs to be grounded in real tasks and not abstracted from them.

More generally, this research programme suggests that there is benefit to be had from the design and implementation of PSSs to operate in complex task domains in educational contexts.

Implications for future research

In line with the rationale for conducting appropriate types of research offered in Salomon's seminal paper (1991), this work was concerned to explore and identify the possible value of designing and applying PSSs for use by students in educational contexts to learn and to perform in complex tasks. In its exploration, this work has revealed a number of possible variables, whose presence and strength might be tested in future experimental studies, across larger populations and greater periods of time, to optimise the possibility for generalisation and prediction in the findings. The focus of such studies might include:

1. Design of PSSs for complex educational tasks:
 - The role of contextual and non-contextual (or authentic and non-authentic) feedback in PSSs developed for complex tasks.
 - The correlation between performance and instructional resources used in a PSS developed for complex tasks, and learning and performance outcomes in users.

2. Application of PSSs to complex educational tasks:

- The nature of the relationship between students' learning styles and approaches (Biggs, 1987) and their development of appropriate cognitive strategies, in their use of PSSs to perform and learn in complex tasks.
- The extent of the learning and performance gains for students working with PSSs developed for complex tasks.
- The extent to which PSSs hinder or support substantive transfer in learning and performance, between like and unlike tasks in complex task domains, across media (ie. from using a PSS, to using traditional means of performing and learning in specific tasks).
- The preferences of students representative of a range of different learning styles and approaches, to use either PSSs or traditional means of learning and performing in complex educational tasks.

In addition, there is clearly a need to investigate, in non-experimental studies, a number of other issues, including:

3. The role of communication (one-to-one, one-to-many) in dynamic and on-line PSSs developed for complex tasks⁴⁷.
4. Developing appropriate cognitive strategies in novice students using PSSs in complex tasks.
5. The nature of collaborative (ie. group) use of PSSs developed for complex tasks.

In more general terms, there is a need and an opportunity, to follow this research programme and design new PSSs for other complex tasks, based upon the same design model implemented in the LPS, and to investigate their roles in mediating students' learning and performance. Such work would serve to verify and extend the findings made here, and help strengthen the contributions made by this research programme, to the PSS, instructional design, teacher education and information and interactive technologies literatures.

⁴⁷ Whilst this issue has not been generated directly by the findings of this research programme, it seems that in an instructional design model predicated on dialogue (see Section 2), such as that appropriated for the LPS, there is an obligation, built into this model, to implement technologies that support both synchronous and asynchronous communications between learners or users, and between learners and lecturers in an educational setting. Indeed, this type of research is currently being conducted by Laffey and Musser (1997).

Limitations

While this research programme successfully developed and explored the use of a PSS in complex educational tasks, the capacity for the findings to be generalised to different contexts, tasks and populations is tempered by various limitations related to the design and implementation of the study. In particular, this research was limited by:

- The number of students studied. The nature of the design adopted for this study limited the number of students who could feasibly be monitored in their use of the LPS. It would, in future studies, be beneficial to observe a greater number of students, representative of both novice and expert student populations.
- The number of tasks completed by students. It would, in future studies, be desirable to observe the completion of more tasks, over a range of different lesson planning contexts, authentic and non-authentic.
- The time allowed and place provided for observing students in their completion of lesson plans using the LPS, during periods of professional practice (ie. in the main study, part two). It would be of value, in future studies, to observe students using the LPS in a range of situations, and particularly at places and times students would naturally choose to do their lesson planning.
- The fragility of the data used to analyse the nature of learning and performance transfer across media (ie. from LPS to traditional 'pen & paper'). It would, in future studies, be beneficial to strengthen the data collected to specifically test the extent of transfer, using such instruments as pre- and post-tests and student learning profiles (developed via student interviews).

Conclusion

This research programme demonstrated that performance support systems can be designed and applied to complex educational tasks, to the advantage of students' learning and performance in these tasks. It lends strength to the proposal that PSSs provide an exciting, alternative, model of teaching and learning relevant to a range of complex task domains in higher education.

SECTION 9

References

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Appendix A

Interview procedure and sample dialogue using talk aloud protocols

Present: Interviewer (Int); Interviewee (St)

Situation: Watching a video recording of the student-teacher's sixth lesson planning session using the LPS.

St: I did that (pointing to the screen), to make it easier to get to use

Int: How did it make it easier?

St: I got to know how it worked, how to use the functions. I find I always need to know everything about the way the software works before I can use it. That's why I'm playing around with just about everything—the objectives stuff, how to use those verbs. And also how to print the lessons when I wanted. I didn't use this system (the LPS) much, other than the times I came into uni, and I needed to get into the swing each time I used it. I forgot some of the what it could do.

St: I found here that I really only needed to use these functions, the verb database for the objectives, and the workpad, and also the examples of the objectives, the evaluation processes—this is what I found most useful after I got to know what I was doing with the software.

Int: You seem to have got into a rhythm with the software now. Do you agree?

St: Yes, the quickest way of working was to look at a sample of what I was doing, like creating the objectives or making sure I'd thought about the right sort of evaluations for the children and myself, to make sure I was evaluating the things I wanted the kids to learn, and then to sort of paste my own words and ideas into that format. It made things a lot easier for me. Although I found I couldn't do that for other lessons I wanted to do—the sample lesson plans weren't like the ones I always needed to do for my class at school. It would help if there were more sample plans and they were more varied over subjects as well as age groups.

Int: Can you say a bit more about how you were using the LPS by this stage (ie. this is the sixth and final lesson plan constructed by the student using the LPS)?

St: I sort of got into a pattern of doing things—I got quicker at it, at using the software and creating the objectives—I always find it difficult to start with the right words. But I didn't need to use hardly any of the explanations of how to do things, I just went and did them. The only things I needed to really think about for this lesson was to check I had evaluated the lesson in the right way, to make sure the kids, all the kids, had learnt what I intended.

St: I guess I didn't really need to use the computer (ie. the LPS) now, I could have done most of this by hand. And I did do a lot of planning at school, just before I was teaching, a few hours before I was teaching the lesson. I knew what I wanted to do, and the plan was just a way of writing out how I was going to do it. I had

most of it in my head. I could have used the computer (ie. LPS) to help do it, but by now (ie. by this stage), it was just as easy to do it by hand. I really didn't need the other functions, although it would have been nice to have been able to check I was doing it right, you know, using the help given on evaluation processes, just here (pointing to the screen and the relevant part of the LPS functions).

Appendix B

Student-teacher lesson plan assessment schedule

Grade	Criteria	Marks
Unsatisfactory	<ul style="list-style-type: none"> • Incomplete lesson planning, by omission of objectives, instructional methods and/or evaluation process. • Demonstrates an inadequate knowledge of planning for teaching a lesson. • Demonstrates poor understanding of the related processes in planning a lesson (ie. stating lesson objectives; creating methods by which these objectives can be met; evaluating learning). 	F
Competent	<ul style="list-style-type: none"> • Plans straight forward learning experiences thoroughly and clearly. • Attends to effective pre-lesson organisation. • Demonstrates an adequate knowledge of content in planning learning experiences. • Specifies objectives (cognitive, affective, psychomotor) in terms of what the students will learn. • Selects learning resources and structures the environment (eg. groupwork) to contribute to the achievement of learning objectives. • Plans appropriate teaching strategies for whole class or single group teaching. • Demonstrates appropriate timing in lesson plans. • Plans for evaluation in accordance with learning objectives, using basic techniques such as observation, questioning, discussion, supervision and teacher/student marking. 	E
Highly Competent	<ul style="list-style-type: none"> • Plans related learning experiences across more than one subject to develop a skill, topic or theme. • Plans more complex learning experiences. • Plans learning content to reflect multiculturalism, where this is appropriate. • Plans for teaching strategies which promote problem solving and creativity. • Allows for modifications to lesson as a result of lesson evaluation. 	D
Outstanding	<ul style="list-style-type: none"> • Plans for evaluation in accordance with learning objectives, using basic techniques such as observation, questioning, discussion, supervision and teacher/student marking. • Plans for coherent organisation and continuity of learning experiences over an extended period of time. • Structures objectives which reflect progression in learning over a series of learning experiences. • Planning reflects the special needs of individuals and/or groups. • Plans to use teaching strategies for multiple groups within a class. • Plans for multiple learning experiences within a single environment. • Plans for specific strategies to cater for students with special needs. • Plans for use of a variety of resources and media in a single learning experience. • Plans for evaluation in accordance with learning objectives, using advanced techniques such as rating scales, criterion assessment, diagnostic tests and student self-assessment. 	C B A

Student-teacher outcome statements in relation to lesson planning skills

Grade	Student Outcomes
Competent	Plans an appropriate and functional lesson, which is appropriately timed; displays an understanding of lesson content to be taught; has one or more objectives describing what students are expected to learn as a result of the lesson; and demonstrates an awareness of (i) checking for student learning, and (ii) checking for self-performance.
Highly Competent	Plans a lesson which may be one part of a wider learning experience; plans for use of more than one instructional technique in a single learning experience; uses a range of resources and media meaningfully; and demonstrates use of one or more evaluation techniques, formal and informal.
Outstanding	Demonstrates appropriate planning for a range of student abilities, progressive learning over a number of objectives, extended learning experiences and more complex lessons. Evaluation planning displays a personal belief system about how evaluation is an integrative part of the teaching/learning process. Specifies elements of teaching skills (as part of self-assessment) which will be given special consideration.

Appendix C

Checklist for student use of LPS

Lesson Structure

Effective objectives

Evaluating learning outcomes

Preparation

Ways of writing the lesson plan

Evaluating self

What is a lesson plan?

What is a good objective

Planning methods

Using the LPS

How do I ensure my evaluation will be effective?

Reflection

Verb Database

Example Lesson Plans

Work Pad

Example Objectives

Example Evaluation Processes

Find

Print

Appendix D

Letters provided to students inviting participation



EDITH COWAN
UNIVERSITY
PERTH WESTERN AUSTRALIA

School of Information Science
Faculty of Science, Technology
and Engineering

Developing performance support systems for complex tasks: Lessons from a lesson planning system

I am a PhD student at Edith Cowan University, investigating the use of performance support systems in pre-service teacher education. The purpose of my study is to explore the potential value of building and applying these software systems to teaching and learning in higher education, and particularly, to students studying lesson planning as part of their undergraduate course in teacher education.

You can help in this study by consenting to participate in using the Lesson Planning System (LPS), a performance support system that is intended to help students enhance their lesson planning skills. If you do consent to being involved, you will be asked to use the LPS to plan a number of lessons (approximately 6) over a two week period (immediately prior to your second professional practice period), and to be observed and video-taped as you do so. You may also be asked to participate in an interview about how you went about completing the lesson planning tasks (ie. your thoughts and ideas whilst planning your lessons). The time you will be asked to spend using the LPS will vary, but as a general guide, amount to about 6 hours, plus 1 hour for the interview (if required). The interview questions will only be aimed at identifying the strategies you use to plan your lessons. No questions of a personal nature will be asked.

All participants can withdraw from the study at any time and for any reason.

All information provided by participants in this study will be confidential and viewed only by myself, the principal researcher. At the completion of the study, all video tapes of the interviews, together with the transcripts of the interview questions and answers, will be destroyed (by erasing the video tapes and shredding the transcripts). Whilst the data obtained by videotaping and questioning participants, will be used in the study, no participant will be identifiable by name or other personal details, in the report of the study.

My supervisor, Dr Ron Oliver (Tel: 9370 6372; email: r.oliver@cowan.edu.au), and myself (9273 8022; email: m.wild@cowan.edu.au) are available to discuss any part of the study or your participation in it. Alternatively, you can contact Edith Cowan University's Executive Officer for the Ethics Committee of the University (Rod Crothers: Tel. 9273 8170; email: r.crothers@cowan.edu.au).

Consent form

I _____ (full name) have read the information above.

Any questions I have asked have been answered to my satisfaction.

I agree to take part in this study, by making use of the Lesson Planning System (LPS) in the weeks preceding my second professional practice; by being video-taped whilst I use the LPS; and by answering questions concerned with how I used the LPS.

I know that I can change my mind and stop at any time, without prejudice to my courses of study as a student at Edith Cowan University, or my work in preparation for or during teaching practice.

I understand that all information I provide will be treated as confidential and will not be released by the researcher unless required to do so by law.

I agree that the data gathered for this study may be published provided my name or other information which might identify me is not used.

Participants name:

Signature:

Researcher:

Date:

(page 2 of 2)



EDITH COWAN
UNIVERSITY
PERTH WESTERN AUSTRALIA

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I understand that all information I provide will be treated as confidential and will not be released by the researcher unless required to do so by law.

I agree that the data gathered for this study may be published provided my name or other information which might identify me is not used.

Participants name:

Signature:

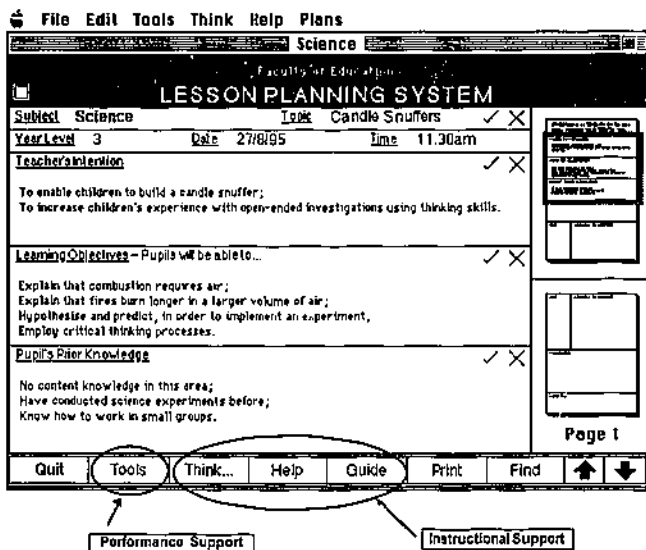
Researcher:

Date:

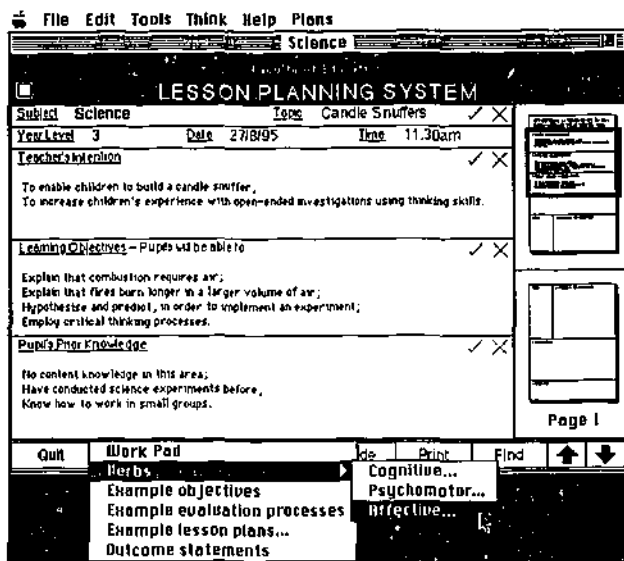
(page 2 of 2)

Appendix E

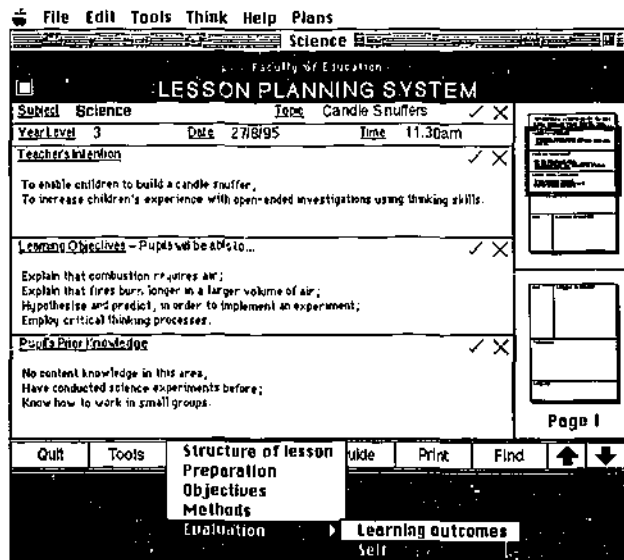
Screens showing the range of performance and instructional support in the LPS



The provision for performance and instructional support in the LPS



The range of informational tools provided in the LPS



The range of instructional sequences or items provided in the LPS

File Edit Tools Think Help Plans

Science

Faculty of Education

LESSON PLANNING SYSTEM

Subject	Science	Topic	Candle Snuffers	✓	✗
Year Level	3	Date	27/8/95	Time	11:30am
Teacher's Intention					
To enable children to build a candle snuffer, To increase children's experience with open-ended investigations using thinking skills.					
Learning Objectives – Pupils will be able to...					
Explain that combustion requires air; Explain that fires burn longer in a larger volume of air; Hypothesise and predict, in order to implement an experiment; Employ critical thinking processes					
Pupils Prior Knowledge					
No content knowledge in this area; Have conducted science experiments before; Know how to work in small groups					

Page 1

Quit Tools Think...

Using the LPS
What is a Lesson Plan?
What is a good objective?
How do I ensure my evaluation will be effective?

The provision for 'help' facilities in the LPS

Maths lesson

Faculty of Education

LESSON PLANNING SYSTEM

Subject Maths		Topic Shapes		<input checked="" type="checkbox"/> <input type="checkbox"/>
Year Level 2	Date 1/4/97	Time 9.30		
Teacher's Intention To get the children to begin to identify the attributes of different shapes				<input checked="" type="checkbox"/> <input type="checkbox"/>
Learning Objectives - Pupils will be able to... Recognise the difference between two or more shapes Identify 2-3 components of a shape that help define it Draw 3 different shapes				<input checked="" type="checkbox"/> <input type="checkbox"/>
Pupil's Prior Knowledge				<input checked="" type="checkbox"/> <input type="checkbox"/>

Page 1

Main interface of the LPS, showing use of the thumbnail views for feedback and navigation.

Verb Database

Cognitive Verb Database

Knowledge	define recall tell label	describe name locate underline	list show relate select	state write acquire realise	identify match outline measure
Comprehension	explain illustrate distinguish	interpret infer summarize	compare estimate represent		
Application	use mark change	calculate demonstrate make	construct perform compute		
Analysis	analyse differentiate diagram	classify breakdown discriminate	categorise compare relate		
Synthesis	create combine	develop compose	propose produce		

WorkPad

explai

Integration of separate support-tools in the LPS: the Verb Database and the Work Pad.

Appendix F

Refereed papers

Whilst involved in this research programme, the author has published a number of refereed journal articles and conference papers, that originated in and/or contributed to, aspects of this study. A sample of these are given here:

- Wild, M. (1995). *Issues of instructional design in the production of a user performance support system for a complex cognitive task*. Paper presented at the World Conference on Computers in Education VI, WCCE95: Liberating the learner, Birmingham, United Kingdom. 23-28 July, 1995.
- Wild, M. (1996). *Designing multimedia for instruction: The role of educational theory*. Paper presented at the Australian Society for Education Technology Annual Conference (EdTech96): Learning technologies—Prospects and pathways, Melbourne, Australia. 7-10 July, 1996.
- Wild, M. (1996). Designing multimedia as cognitive tools to enhance task performance. In S. Leong & D. Kirkpatrick (Eds.), *Proceedings of Higher Education Research and Development Society of Australasia (HERDSA) Annual Conference: Different approaches—Theory and practice in Higher Education* (pp. 953-959). Perth, Western Australia: HERDSA.
- Wild, M. (1997). Designing instructional multimedia: Creating a rationale based on performance rather than learning. In D. Dicheva & I. Stanchev (Eds.), *Proceedings of IFIP Working Group 3.3 Conference: Human Computer Interaction and Educational Tools (HCI-ET)* (pp. 100-112). Sozopol, Bulgaria: Virtech, Sofia.
- Wild, M. (1998). Designing a performance support system for teacher education. In T. W. Chan, A. Collins, & L. Jianxiang (Eds.), *Proceedings of ICCE98: The Sixth International Conference on Computers in Education*, Vol. 1 (pp. 638-642). Beijing, China: China Higher Education Press and Springer-Verlag.
- Wild, M. (1998). Investigating the instructional value of performance support systems. In R. M. Corderoy (Ed.), *Proceedings of ASCILITE98: Flexibility—the next wave? Fifteenth Annual Conference of the Australasian Society for Computers in Learning Tertiary Education* (pp. 663-672). University of Wollongong, Sydney: University of Wollongong.
- Wild, M. (in press). Creating a role for performance support systems in teacher education. *Journal of Information Technology for Teacher Education*, 6(3).
- Wild, M., & Kirkpatrick, D. (1995). University students working with performance support systems (PSSs) to learn complex tasks. In J. M. Pearce, A. Ellis, G. Hart, & C. McNaught (Eds.), *Proceedings of ASCILITE'95: Proceedings of The Twelfth Annual Conference of the Australian Society for Computers in Learning*

- in Tertiary Education* (pp. 550-556). University of Melbourne: University of Melbourne.
- Wild, M., & Kirkpatrick, D. (1996). Multimedia as cognitive tools: Students working with a performance support system. In C. McBeath & R. Atkinson (Eds.), *Proceedings of The learning superhighway—new world, new worries? Third International Interactive Multimedia Symposium* (pp. 412-418). Perth, WA: Promaco Conventions Ltd.
- Wild, M., & Quinn, C. (1997). Theoretical perspectives on the design of instructional multimedia. In D. Dicheva & I. Stanchev (Eds.), *Proceedings of IFIP Working Group 3.3 Conference: Human Computer Interaction and Educational Tools (HCI-ET)* (pp. 170-179). Sozopol, Bulgaria: Virtech, Sofia.
- Wild, M., & Quinn, C. N. (1998). Implications of educational theory for the design of instructional multimedia. *British Journal of Educational Technology*, 29(1), 73-82.
- Stoney, S., & Wild, M. (1998). Interface design and motivation: Maximising learning opportunities in instructional multimedia. *Journal of Computer Assisted Learning*, 14(2), 40-50.