University Students Working with Performance Support Systems (PSSs) to Learn Complex Tasks

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Abstract

This paper is concerned with the design, implementation and evaluation of a Performance Support System (PSS) to enhance lesson planning skills in first year teacher education students. A PSS is interactive software that is intended to both train and support both the novice and experienced user in the performance of complex tasks. The concept of a PSS allows instructional designers to consider both instruction and performance of a task, within a single environment—whereas much conventional software has been criticised for its failure to acknowledge the cognitive processes involved in the task. This paper will focus on certain instructional design issues in creating PSSs that support the performance of complex tasks, consider a model of evaluation relevant to PSSs, and also report on the evaluation of the Lesson Planning System (LPS), as a PSS. The presentation of the paper will demonstrate the LPS.

Keywords

performance support system, EPSS, hypermedia, lesson planning, evaluation methodology

1. Introduction

This paper will primarily report on the design and evaluation processes for a Performance Support System (PSS) to enhance lesson planning skills in first year teacher education students. The paper will discuss the instructional design issues that emerged in the creation of a PSS, as well as the methods used to evaluate the system and some of the outcomes of evaluation in terms of task performance and strategies employed by students when interacting with the PSS.

2. Aims of the Research

The aims of the research project are to:

- develop a highly interactive, hyper-media learning environment to facilitate enhanced lesson planning skills in first year Bachelor of Arts (Education) students;
- investigate the effectiveness of the PSS in comparison with current methods and practices of teaching lesson planning;
- identify the cognitive strategies that students employ as they interact with the PSS; and
- assess students' use of, and responses to, the PSS.

To date, we have produced a number of prototypes and released a beta version of the PSS for use by a sample of the target population. Evaluation methods and analysis of data obtained from this sample provides a focus for part of this paper.

3. Performance Support Systems

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

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

There exist slightly different perspectives of PSSs, each moulded by small shifts in emphasis. For example, Barker and Banerji (1995) stress the problem–centered 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; that is, they comprise hypermedia reference and instructional sequences, together with open–ended software tools, and context-sensitive supporting information (Gery, 1995). Such software have been developed in training situations in medicine (e.g. medical diagnostic systems), engineering (e.g. computer-assisted design systems) and management (e.g. decision support systems). More recently, the concept of performance support has been applied to mainstream and generic software tools, such as Microsoft Excel; and further, the nature of supporting functions in current and future designs of PSSs has been reconceptualised by Gery (1995), to allow for increasingly diverse applications and types of performance support functions of PSSs.

However, these later developments in the design, application and theory of PSSs have not altered their main purpose, 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 just–in–time resources (instructional, supporting 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 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 that the uses and types of PSSs are likely to diversify in their future manifestations, when the nature of any particular PSS will be defined largely in terms of its target application, its users and the related domain.

In this light, a PSS has been developed for use by first year Education students in the academic setting and in the classroom. This PSS is intended to facilitate the development of student skills in the area of lesson planning. The Lesson Planning PSS (LPS) is:

- instructional software that teaches students the skills involved in lesson planning; and,
- provides support in the concurrent and subsequent performance of the lesson planning task.

To date, instructional materials based on interactive technologies have tended to focus on only the instructional aspect of task performance (Brown, 1991; Jih and Reeves, 1992). It is contended that student use of the LPS in the school and university setting will facilitate the transfer of cognitive strategies and minimise the distinction between ‘learning and doing’, thereby improving students’ lesson–planning performance.

4. Design of the LPS

The LPS incorporates the model of lesson planning required by Edith Cowan University and wider afield. It addresses essential components of the lesson planning task such as writing learning objectives, developing learning experiences and planning evaluation. Each component is supported by activities that instructs the user about the task (e.g. provision of information relating to reasons why objectives are necessary, criteria for quality objectives), and which also assists the user in performing the task (e.g. 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.

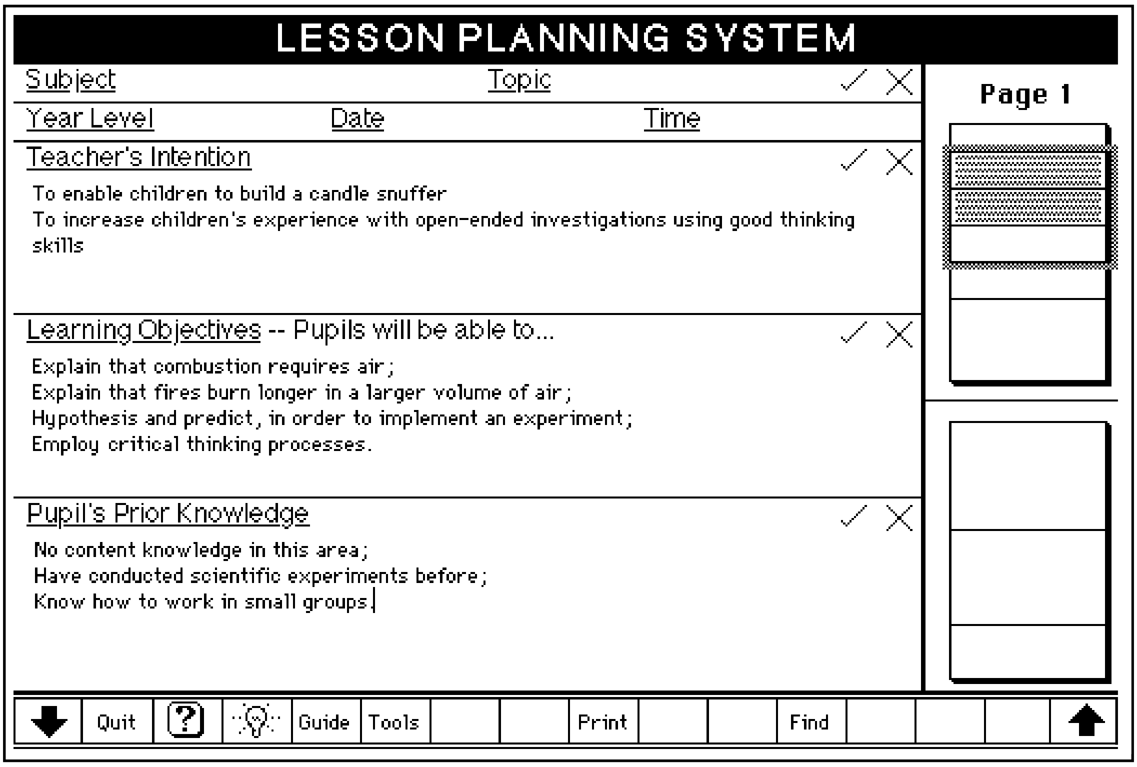

Figure 1. A performance function of the LPS.

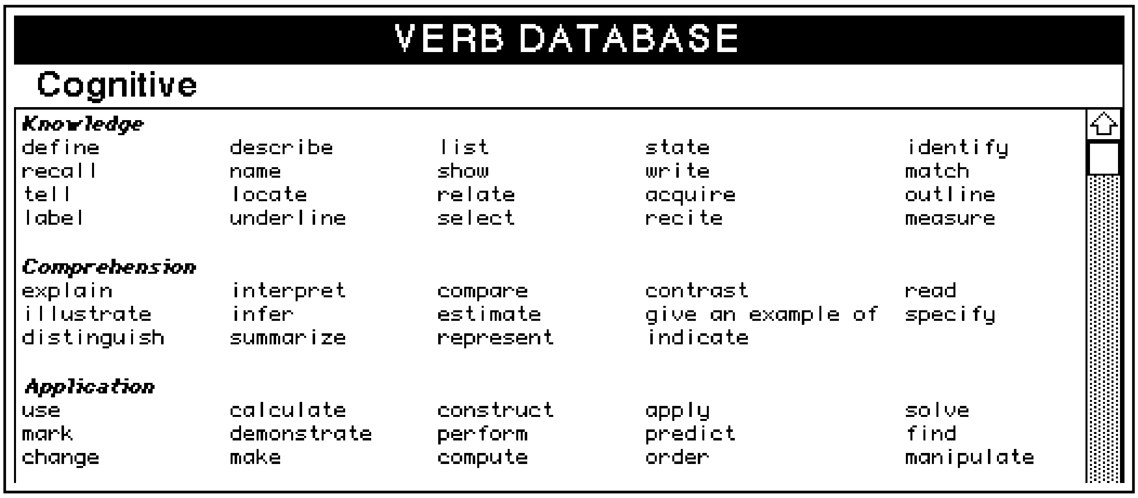

Figure 2. A support function of the LPS – Verb database.

Lesson planning is an essential performance skill for teachers and student teachers. It is also a complex task. 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 must 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 lesson planning process can be viewed as an exercise in problem solving where success is largely dependent on a domain specific comprehension of the problem and possible strategies towards solution. Glaser (1984) has suggested that 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. Thus, the transition from novice to expert performance is largely provided for by the acquisition of a suitable knowledge base (Glaser, 1982), comprising both descriptive and heuristic components. Descriptive knowledge is the shared knowledge of experts and practitioners that is usually retrievable from various information sources, while the heuristic component includes the knowledge of good practice and judgement constructed over years of experience. The description of expert performance embedded in the performance support functions of the LPS includes these two related aspects: the information structures and declarative knowledge that are required for performance and the cognitive strategies and procedural knowledge that is required by the task.

The LPS is based on the premise that students, by using the LPS, will come to understand the processes involved and be able to plan lessons effectively both through their use of the LPS and also by other means (e.g. pen and paper). 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, transfer is more likely (Child, 1981). To facilitate transfer of learning in this case, the metaphor that guides the design of the human-computer interface is provided by traditional lesson planning: the LPS environment in which students plan their lessons makes use of identical terms and elements to those encountered in the paper and pen process. It is expected that students will undertake the performance aspects of the lesson planning task using similar methods, whether they are working with the LPS or pen and paper. 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) is intended to approximate to that between learner, lecturer and other supports (e.g. information sources) in a traditional context.

It is also of value to conceptualise the LPS as a modelling environment, where students are given opportunities to explore, test and refine their model of the lesson planning process; and by such interactions students might be expected to move from their own mental model of lesson planning to the conceptual model of that process required by an expert. 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 expert knowledge and it must facilitate learner predictions (L.M.M.G., 1988). 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.

5. Evaluation

Implicit to the aims of the research programme is the need to evaluate the LPS in terms of its role in students' performance of the lesson planning task. Indeed, a hypothesis central to this work is that the use of the LPS will result in students creating better quality lesson plans, and more efficiently, than they do by traditional means. Furthermore, it is relatively simple to obtain measures to test this hypothesis (the consideration of such measures will be the focus of a subsequent paper). However, as Collis and Verwijs (1995) maintain, 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. However, once this fact is recognised, it is relatively easy to account for the strategies that students employ in making use of the system; again, this is something planned for in the research programme, the results of which will be published elsewhere.

What is perhaps of more immediate interest is evaluation of the nature of the task the LPS is directed towards, the experience of the students in the task and the context in which students use the LPS to help perform that task. This is what Collis and Verwijs conceptualise, in a protracted description, as user orientated evaluation. Barker and Banerji (1995), perhaps more elegantly, suggest something similar, namely that evaluation of a PSS should take 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.

As part of the iterative evaluation processes employed in the life–cycle of the LPS, a quasi–experiment was conducted, after an approach followed by Barker and Banerji (1995), to assess the potential usefulness of the LPS in terms of context of use, types of user and system resources made available. Two groups of users were identified—an expert and a novice group; both groups of users were asked to make use of the LPS at university, in preparation for professional practice (where lesson planning is a required and assessed performance skill of the students), and in the field (i.e. at schools, over the period of the two–week professional practice). The expert (E) and novice (N) groups were differentiated by students' experience with lesson planning and, partially, by their own perceptions of their lesson planning skills. Thus, expert students were described as students who had completed 2 years of an education degree course, whereas novices were those who had completed only 6 months; expert students were those who perceived themselves as 'very capable' in lesson planning; novices were students who considered their lesson planning skills as 'poor'.

Each of the students in the expert and novice groups (4 students per group) were asked to undertake the lesson planning task twice (after initially being made familiar with the system), at their own pace. There is, of course, no control over the products generated as a result of task completion (i.e., the lesson plans); however, it is assumed that they will be applied to the student's own teaching. Data were collected using independent checklists for each student. These data included the number of student interactions with both instruction (support) and performance (tools) components of the LPS

(Figure 3), as well as the time taken for each student to complete the tasks (Figure 4). For purposes of analysis, the data collected for students working in the two different contexts (i.e., at university and in the field) have been presented as means.

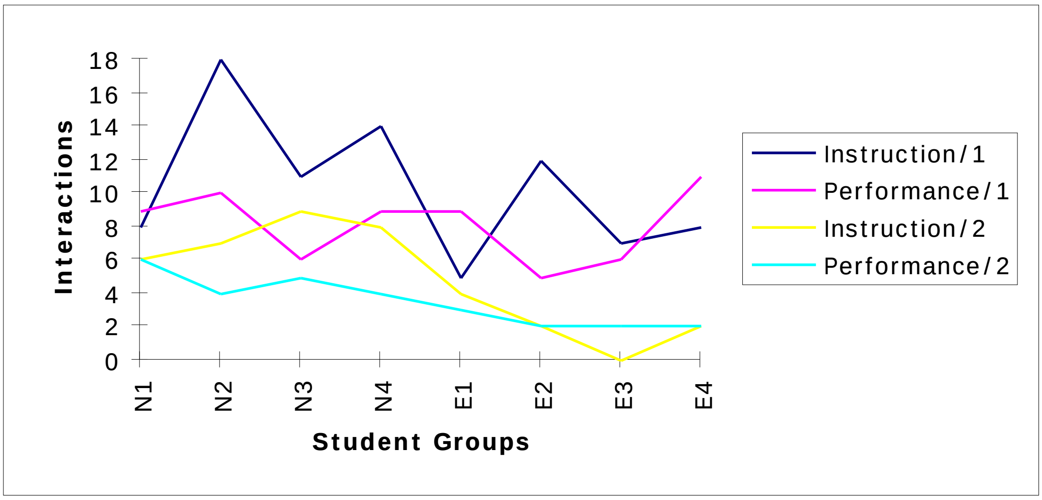

Figure 3. Task performance characteristics.

Although the combined population of the student groups was small (n=8) and therefore a limiting factor on the value of the findings, the results are of interest as part of the iterative evaluation process. For example, Figure 3 demonstrates how, for the second task (T/2) at least, the manner in which the novice students perform the task is closer to the manner in which the expert students perform the task; that is, the novice students make less use of the instructional components of the LPS, and the level of their use more closely resembles that of the expert students. Also, novice and expert students' use of the performance functions of the LPS converge, demonstrating comparatively consistent user behaviours across student groups. Furthermore, this pattern holds when the task performance time characteristics are accounted for (Figure 4). Here, despite a slightly erratic pattern for task 1 (T/1), novice and expert students are seen to take very similar amounts of time for completing the second task (T/2).

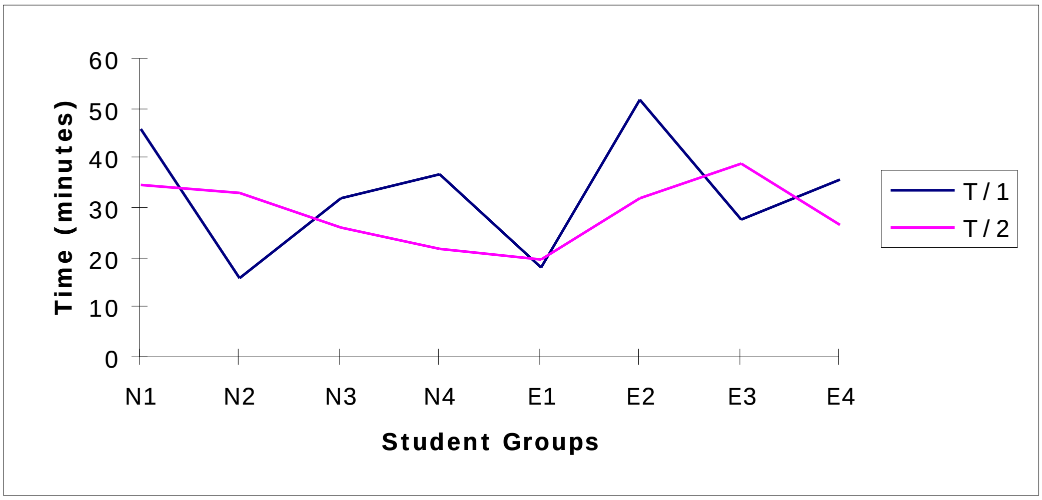

Figure 4. Task performance time.

Obviously, the data collected have only limited functionality; but analysis does demonstrate that the LPS can effectively operate to improve the performance characteristics of novice lesson planners, aligning aspects of their performance more closely with that of expert lesson planners. There are, of course, a range of other issues and areas that need to be evaluated in terms, for example, of the context of use and the strategies of use employed by both novice and expert student lesson planners over longer time frames. More importantly, it would also be necessary to tackle issues of transfer of knowledge.

6. Further Research

As indicated above, research into the use of LPS is currently on–going; however, early results appear to confirm aspects of the evaluation data described above—that is, use of the LPS, at least over short periods of time (2–3 weeks), seems to be able to raise the task performances of novices in the domain of lesson planning, so that they more closely resemble those of experts. Incidentally, the research methodology being used for this study is described in full in an earlier paper (Wild and Kirkpatrick, 1995).

7. Conclusion

This paper affords an outline of the main instructional design issues arising from the development of the LPS, and importantly describes aspects of the iterative evaluation process being used in the production of a PSS for a complex task. Furthermore, it is implied that there are issues in both the design and evaluation of the LPS that are relevant to other PSSs, especially those focused on complex knowledge domains. In closing, it is perhaps worth noting that the concept of the LPS is concerned more with describing how the learner can interact with instructional and supporting resources in the performance of a task and less about creating the instructional conditions traditionally associated with learning (Gagne, 1977; Glaser, 1987). Indeed, this is in keeping with what Marton and Ramsden (1988) and other phenomenographic approaches to researching teaching and learning have revealed about effective instruction (Laurillard, 1993).

8. References

Barker, P. and Banerji, A. (1995). Designing electronic performance support systems. *Innovations in Education and Training International*, Vol. 32, No. 1, pp. 4-12.

Brown, M. (1991). An investigation of the development process and costs of CBT in Australia. In R. Godfrey (Ed.), *Simulation and academic gaming in tertiary education: Proceedings of the 8th Annual Conference of the Australian Society for Computers in Learning in Tertiary Education*, Launceston, Tasmania: University of Tasmania, pp. 43-54.

Child, D. (1981). *Psychology and the teacher* (Third ed.). London: Holt, Rinehart and Winston.

Collis, B. and Verwijs, C. (1995). Evaluating electronic performance support systems: A methodology focused on future use-in-practice. *Innovations in Education and Training International*, Vol. 32, No. 1, pp. 23-30.

Gagne, R. M. (1977). *The conditions of learning*. New York: Holt Rhinehart and Winston.

Gery, G. (1991). *Electronic performance support systems.* Boston, M. A.: Weingarten Publications.

Gery, G. (1995). The future of EPSS. *Innovations in Education and Training International*, Vol. 32, No. 1, pp. 70-73.

Glaser, R. (1982). Instructional psychology: past, present and future. *American Psychologist*, Vol. 37, pp. 292-305.

Glaser, R. (1984). Education and thinking: the role of knowledge. *American Psychologist*, Vol. 39, pp. 93-104.

Glaser, R. (Ed.). (1987). *Advances in instructional psychology*. Hillsdale, N. J.: Lawrence Erlbaum Associates.

Jih, H. J. and Reeves, T. (1992). Mental models: a research focus for interactive learning systems. *Educational Technology Research and Development*, Vol. 40, No. 3, pp. 39-53.

L.M.M.G. (1988). *Tools for exploratory learning* (Occasional paper No. InTER/5/88). University of Lancaster.

Laurillard, D. (1993). *Rethinking university teaching: a framework for the effective use of educational technology*. London: Routledge.

Marton, F., and Ramsden, P. (1988). What does it take to improve learning? In Ramsden, P. (Ed.), *Improving learning: new perspectives* London: Kogan Page.

McGraw, K. L. (1994). Performance support systems: Integrating AI, hypermedia and CBT to enhance user performance. *Journal of Artificial Intelligence in Education*, Vol. 5, No. 1, pp. 3-26.

Raybould, B. (1990). Solving human performance problems with computers. *Performance and Instruction* (Nov / Dec), pp. 4-14.

Raybould, B. (1995). Making a case for EPSS. *Innovations in Education and Training International*, Vol. 32, No. 1, pp. 65-69.

Wild, M. and Kirkpatrick, D. (1995). Issues of instructional design in the production of a user performance support system for a complex cognitive task. Paper presented at *World Conference on Computers in Education VI, WCCE95: Liberating the learner*, Birmingham, United Kingdom, 23-28 July, 1995.