*Australian Journal of Educational & Developmental Psychology*. Vol 1, 2001, pp 10-21

# Prior knowledge in student and experienced nurses' clinical problem solving

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## ABSTRACT

This study reports an investigation of student and experienced nurses' use of prior knowledge in clinical problem solving. 30 experienced and 30 student nurses were asked to verbalise their thoughts while undertaking a simulated clinical problem solving task. All verbal protocols were coded for use of prior knowledge based on a coding scheme developed for the study. The theoretical basis of the coding scheme was derived from the knowledge-driven models indicating that the development of expertise is strongly linked with the evolution of sophisticated knowledge structures. Repeated measures MANOVA were used to examine group differences across the coding categories. Results indicated that the experienced nurses were more likely to have available a more readily accessible and highly structured knowledge base, allowing for rapid recognition of highly significant clinical data and the transformation of that data into highly relevant clinical schemes. The student nurses relied on a less accessible and less structured knowledge base, and was only able to identify and interpret less significant clinical data at a surface level. The results suggest an important role for prior knowledge in explaining clinical problem solving performance. Implications for nurse education are discussed.

## INTRODUCTION

Nurses are confronted with many clinical problems daily and their ability to competently deal with these problems is critical for safe and effective nursing practice. The question of how best to develop more successful clinical problem solving among nurses has become an issue of major importance to nurse educators and a prime educational objective in most nursing schools (Cholowski & Chan, 1994; Corcoran-Perry & Bungert, 1992; Girot, 2000; Kitson, Harvey, Hyndman & Yerrel, 1993; Kramer, 1993). A major theme in the study of clinical problem solving has been differences in performance between expert and novice problem solving. Much of this research has examined the effects of clinical experience (e.g. Deber, & Baumann, 1992; Norman, Trott, Brooks, & Smith, 1994; Tanner, Padrick, Westfall, & Putzier, 1987), the structure and use of knowledge for problem solving (e.g., Bordage & Lemieux, 1991; Cholowski & Chan, 1992, 1994; Rikers, Schmidt & Boshuizen, 2000), and the reasoning processes used processing clinical data (Hassebrock & Prietula, 1992; Leprohon & Patel, 1995; Patel, Groen, & Arocha, 1990). This research has indicated that differences in problem solving performance are explained not only by problem solving procedures but also by the quality and structure of related prior knowledge brought to the task.

**Prior knowledge in clinical problem solving**

Using a verbal protocol method Boshuizen and Schmidt (1992) were able to discriminate between the structure and quality of the prior knowledge used by physicians at varying levels of expertise. They found the recall of case relevant information to be non-linear, with both experts and novices recalling less information than intermediates. Expert explanations, however, were clearly characterised by higher-level propositions than were those at the novice and intermediate levels. Boshuizen and Schmidt (1992) suggest that where experts encapsulate clinical details within broader clinical concepts, novices and intermediates differ in the degree of elaboration of detailed information. In a sense, experts are concerned with data reduction while novices and intermediates are concerned with data acquisition and elaboration.

Bordage and Lemieux (1991) argued that competence in problem solving goes beyond data acquisition, hypothesis generation and breadth of knowledge. They argued that it is the relationships between elements of information that will discriminate between good and poor diagnosis. Using verbal protocol data analysed on the basis of their coding (Bordage and Lemieux, 1986) they found that the most successful diagnosticians, either students or specialists, included a larger array of semantic axes in their protocols, reasonably independent of the length of the response. Conversely, unsuccessful diagnosticians included fewer semantic axes, again independently of length. Bordage and Lemieux (1991) concluded that the difference between more successful and less successful diagnosticians is based on the ability to restructure and transform clinical data into more abstract clinical concepts and to generate coherent relationships among these concepts, therefore generating a deeper representation of the clinical problem.

Using a phenomenographic approach Ramsden, Whelan, and Cooper (1989) found that the ways in which students handle clinical data could be classified into two major categories of ordering and structuring. Students described in the structuring category, like Bordage and Lemieux's (1991) successful diagnosticians, looked for relationships rather than facts in order to gain meaning from the clinical data and therefore generated a deeper representation of the clinical problem. Students described in the ordering category, like Bordage and Lemieux's (1991) unsuccessful diagnosticians, tended to focus on the literal reproduction of clinical data. They were concerned with information largely isolated from the wider context resulting in poorer problem representations. While the research literature would suggest that the quality of prior knowledge would allow for explainable differences in clinical problem-solving performance little of this research has been extended to nursing. The major purpose of this study then, is to examine the prior knowledge used by experienced and student nurses in undertaking and completing a simulated clinical problem-solving task. In particular we aim to identify differential qualities in prior knowledge use that would allow for explainable differences in clinical problem solving performance

## METHOD

**Research design**

Using a mixed methods design first, a verbal protocol method was used to elicit data about the prior knowledge used by nurses in undertaking a clinical problem-solving task. Transcribed verbal protocols were then coded for quality of knowledge using a coding scheme developed for this study. Coded protocols were subjected to a frequency count and repeated measures MANOVA were used to examine group differences across coding categories.

**Participants**

Participants included 30 student and 30 experienced nurses. Following institutional ethical approval all participants gave voluntary and informed consent in writing. The 30 student nurses were second-year Bachelor of Nursing students. They were predominantly female (85%), ranging in age from 18 to 41 years ($\underline{M}$=21, $\underline{SD}$=2.1). The 30 experienced nurses were all mental

health nurses with a minimum of 5 years of clinical experience. They were predominantly female (60%), ranging in age from 28 to 55 years (M=38, SD=4.8). Their nursing experience ranged from 7 to 22 years (M=13**,** SD 3.1).

**Assessment materials**

Measures of prior knowledge were taken from nurses' verbal responses to a clinical problem task developed for the study. The task was based on a simulated clinical case of chronic low-grade depression (dysthymia). Nurses were asked to verbalise their thoughts at four stages of the problem solving task including: 1) written case history, 2) video-taped interview, 3) clinical summary, and 4) nursing diagnosis stages. All verbal protocols were transcribed and segmented into clausal units by the researcher. Segmented protocol data were subjected to detailed and exhaustive content analysis. This technique allowed for inferences about knowledge use by systematically identifying, categorising and classifying the content of the verbal protocols. In this way differential qualities of the type of prior knowledge used by nurses were identified and categorised. This process allowed for the development of a coding scheme that yielded seven coding categories.

The theoretical basis of the coding scheme was derived from the literature reviewed on knowledge-driven models indicating that the development of expertise is strongly linked with the evolution of sophisticated knowledge structures. Particularly important in this approach was the development of coding categories to operationalise the distinction drawn in the literature between different levels of quality in the structuring of prior knowledge. These included interpretation of clinical data at three levels of relevance (low, moderate and high), and transformation of clinical data at three levels of relevance (low, moderate and high). Still remaining to be clarified is the amount and frequency of knowledge use. Consequently a further two coding categories were developed namely explicit knowledge at three levels of relevance (low, moderate and high), and implicit knowledge at three levels of relevance (low, moderate and high). A further three coding categories reflected associated knowledge states including requests for further information, diagnostic hypotheses, and proposed treatment. In summary the coding scheme consist of seven coding categories and subcategories. Four coding categories reflected the use of prior knowledge namely explicit knowledge at three levels of relevance (low, moderate and high), implicit knowledge at three levels of relevance (low, moderate and high), interpretation of clinical data at three levels of relevance (low, moderate and high), transformation of clinical data at three levels of relevance (low, moderate and high). A further three coding categories reflected associated knowledge states namely requests for further information, diagnostic hypotheses, and proposed treatment.

All verbal protocols were then, coded blindly by the researcher. Twenty percent of the protocols were also coded blindly by a trained independent rater achieving inter-rater agreement of 83%, 78%, 85%, and 82% for the written case history, videotaped interview, clinical summary, and nursing diagnosis stages respectively. Disagreement was resolved by discussion. These data were analysed using MANOVA techniques from within Statistica V5.1 (Statsoft, 1995). Full details of participants, the problem solving task, study procedures, and the coding scheme including coded examples are available from the first author.

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## ANALYSIS AND RESULTS

**Prior knowledge**

To examine group differences in prior knowledge use (explicit knowledge, implicit knowledge, interpretations, transformations) by experienced and student nurses across the four stages of the problem-solving task, a 2 (group) x 4 (stage of the task) x 4 (knowledge category) x 3 (level of relevance) MANOVA with repeated measures on the last three factors was computed. The mean scores and standard deviations are presented in Table 1. Results indicated a significant four-way interaction between group, stage, category and level of relevance, *F(*18,

1044)=5.92, $p<.001$. This suggests that while experienced and student nurses did not differ in the total number of instances of knowledge used, differences were evident in the type of knowledge category used and in the level of relevance of that knowledge at all four stages of the problem solving task. A summary of the MANOVA results is presented in Table 2. The pattern of differences is illustrated in Figure 1.

*Across four stages of the task.* Very few instances of explicit knowledge were evident across all four stages of the task but the little explicit knowledge found among experienced nurses was highly relevant. Instances of implicit highly relevant knowledge were more evident among experienced nurses, while instances of implicit less relevant knowledge were more evident

**Table 1** Means and standard deviations (in parentheses) of the four knowledge use categories at the three levels of relevance across the four stages of the task for experienced and student nurses (n=60)

| | Student nurses | | | Experienced nurses | | |
|---|---|---|---|---|---|---|
| Stage and prior knowledge category | Level of relevance | | | Level of relevance | | |
| | Low | Moderate | High | Low | Moderate | High |
| Written case history stage | | | | | | |
| Explicit | 0.27 (0.52) | 0.30 (0.61) | 0.03 (0.18) | 0.03 (0.18) | 0.37 (0.85) | 0.80 (2.06) |
| Implicit | 4.80 (5.80) | 2.00 (2.74) | 0.00 (0.00) | 1.37 (1.67) | 4.87 (4.60) | 2.83 (4.70) |
| Interpret | 2.80 (3.92) | 3.03 (2.63) | 0.00 (0.00) | 0.77 (1.48) | 2.30 (2.17) | 0.43 (1.01) |
| Transform | 0.10 (0.31) | 2.20 (2.17) | 0.03 (0.18) | 0.07 (0.25) | 4.73 (3.45) | 2.87 (3.74) |
| Video-taped interview stage | | | | | | |
| Explicit | 0.00 (0.00) | 0.00 (0.00) | 0.03 (0.18) | 0.00 (0.00) | 0.00 (0.00) | 0.33 (1.12) |
| Implicit | 0.77 (2.05) | 0.77 (1.25) | 0.13 (0.35) | 0.07 (0.37) | 0.83 (0.99) | 1.47 (2.03) |
| Interpret | 2.40 (2.95) | 7.70 (4.79) | 1.60 (1.48) | 0.37 (1.33) | 1.60 (1.73) | 2.17 (1.76) |
| Transform | 0.13 (0.57) | 2.50 (2.32) | 2.47 (2.19) | 0.00 (0.00) | 2.83 (2.79) | 7.73 (4.97) |
| Clinical summary stage | | | | | | |
| Explicit | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.00 (0.00) | 0.30 (1.06) |
| Implicit | 0.23 (0.63) | 0.27 (0.64) | 0.13 (0.57) | 0.00 (0.00) | 0.27 (0.64) | 1.70 (2.15) |
| Interpret | 0.73 (1.57) | 1.63 (2.17) | 0.13 (0.43) | 0.03 (0.18) | 0.13 (0.43) | 0.13 (0.35) |
| Transform | 0.00 (0.00) | 1.27 (1.41) | 0.90 (1.09) | 0.00 (0.00) | 0.53 (1.33) | 3.63 (2.98) |
| Nursing diagnosis stage | | | | | | |
| Explicit | 0.33 (1.83) | 0.03 (0.18) | 0.00 (0.00) | 0.00 (0.00) | 0.03 (0.18) | 0.10 (0.31) |
| Implicit | 0.27 (0.83) | 0.53 (1.17) | 0.17 (0.46) | 0.07 (0.25) | 0.60 (1.07) | 1.87 (2.33) |
| Interpret | 1.37 (3.07) | 2.70 (2.95) | 0.47 (0.97) | 0.03 (0.18) | 0.47 (1.28) | 0.27 (0.52) |
| Transform | 0.07 (0.25) | 1.37 (1.45) | 0.97 (1.77) | 0.00 (0.00) | 0.70 (1.21) | 3.50 (3.00) |

among student nurses, particularly at the written case history stage. Instances of highly relevant transformations were more evident among experienced nurses, while instances of less relevant interpretations were more evident among student nurses, particularly at the video taped interview stage (see Figure 1).

*Written case history stage.* **V**ery few instances of explicit knowledge were evident among either experienced or student nurses, but the few instances of explicit knowledge evident among the experienced nurses were highly relevant. Instances of implicit moderately relevant and some highly relevant knowledge were more evident among experienced nurses, while instances of implicit low relevant knowledge were more evident among student nurses. Highly and moderately relevant transformations were more evident among experienced nurses, while low and moderately relevant interpretations were more evident among student nurses (see Figure 1).

*Clinical interview stage.* Very few instances of explicit or implicit knowledge were evident among either experienced or student nurses. The very few instances of implicit knowledge evident among experienced nurses were highly relevant. Highly relevant transformations were more evident among experienced nurses, while moderately relevant interpretations were more evident among student nurses (see Figure 1).

*Clinical summary stage.* Very few instances of explicit or implicit knowledge were evident among either experienced or student nurses. The few instances of implicit knowledge evident among experienced nurses were highly relevant. Highly relevant transformations were more evident among experienced nurses, while moderately relevant interpretations were more evident among student nurses. However, fewer interpretations and transformations were evident in the clinical summary stage than in the previous two stages (see Figure 1).

*Nursing diagnosis stage.* **V**ery few instances of explicit or implicit knowledge were evident among either experienced or student nurses. The few instances of implicit prior knowledge evident among experienced nurses were highly relevant. Highly relevant transformations were more evident among experienced nurses, while moderately relevant interpretations were more evident among student nurses. However, fewer interpretations and transformations were evident in the nursing diagnosis stage than in the first two stages (see Figure 1).

The overall pattern of results for indicates that instances of explicit and implicit highly relevant knowledge and highly relevant transformations were more evident among the experienced nurses. On the other hand, instances of explicit and implicit less relevant knowledge and less relevant interpretations were more evident among the student nurses (see Figure 1).

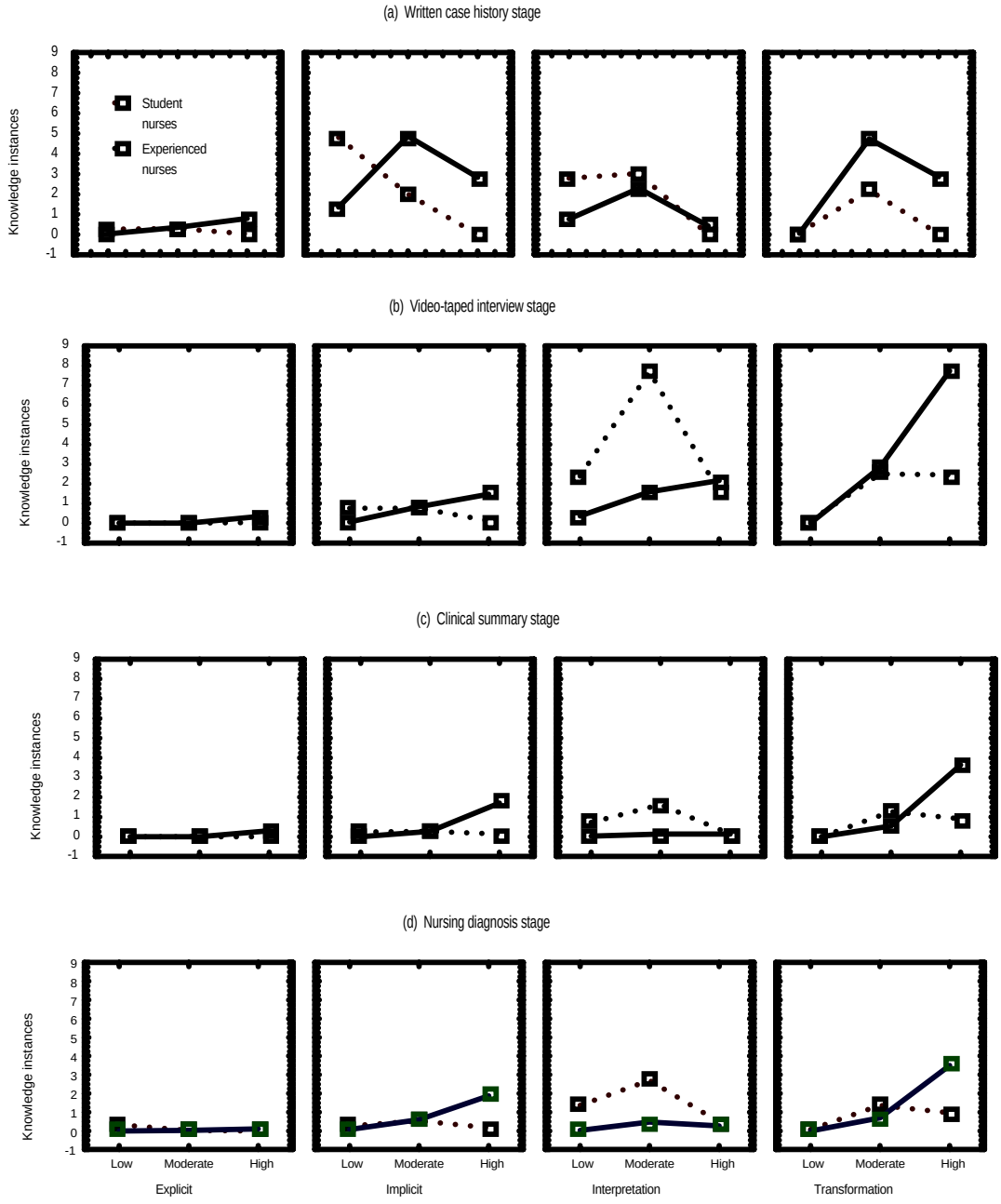
**Knowledge states**

To examine group differences across the four stages of the task for the three coding categories of request for further information, diagnostic hypothesis and proposed treatment, three separate repeated measures MANOVAs were undertaken. The means and standard deviations for each category are presented in Table 3. A summary of the three MANOVA results is presented in Table 4.

*Request for further information.* A 2 (group) x 4 (stage) MANOVA with repeated measures on the last factor was computed on the request for further information data. The only significant effect was the main effect for stage, $F$ (3,174)=3.32, $p$<.05. Examination of the means indicated that both experienced and student nurses overall made more requests for further information at the written case history stage than at the other three stages of the problem solving task.

*Diagnostic hypothesis.* A 2 (group) x 4 (stage) MANOVA with repeated measures on the last factor was computed on the diagnostic hypothesis data. No significant main effects or interactions were evident in this analysis. Examination of the means seems to suggest that experienced nurses made more diagnostic hypotheses during the first three stages and the student nurses made more diagnostic hypotheses during the final stage of the problem-solving

**Figure 1** 4-way MANOVA interactions for Group x Stage x Knowledge Category x Relevance Level using stage as the constant variable (n=60)



task. However, the Group x Stage interaction approached but did not attain statistical significance ($p<.1$).

*Proposed treatment.* A 2 (group) x 4 (stage) MANOVA with repeated measures on the last factor was computed on the proposed treatment data. A significant interaction between group and stage for proposed treatment was found, $F$ (3,174)= 4.79, $p<.01$. Examination of the means indicates that experienced nurses made a significantly higher number of proposed treatment statements in their clinical summaries than student nurses, but very few statements of proposed treatment were made in the other three stages by either experienced nurses or student nurses. This pattern of results is illustrated in Figure 2.

**T**he results of the separate repeated measures MANOVAs indicated differences between experienced and student nurses in the number of diagnostic hypotheses and proposed treatments stated. Experienced nurses stated more diagnostic hypotheses during the first three stages of the problem-solving task, while student nurses stated more diagnostic hypotheses in the final nursing diagnosis stage. Further, experienced nurses stated more proposed treatments in the clinical summary stage than student nurses did, but very few statements of proposed treatment were evident in the other three stages.

**Table 2** Summary of the MANOVA results for the four knowledge use categories of explicit knowledge, implicit knowledge, interpretations and transformations (n=60)

| Source of variation | *df* | *MS* | *F* | *p* |
|---|---|---|---|---|
| Between subjects | | | | |
| Group (A) | 1 | 9.68 | 1.08 | .30 |
| Within subjects | | | | |
| Stage (B) | 3 | 213.99 | 55.75 | .00 |
| Category (C) | 3 | 308.16 | 59.01 | .00 |
| Relevance (D) | 2 | 213.02 | 25.66 | .00 |
| A x B | 3 | 12.64 | 3.29 | .02 |
| A x C | 3 | 205.22 | 39.30 | .00 |
| B x C | 9 | 80.47 | 28.75 | .00 |
| A x D | 2 | 323.26 | 38.93 | .00 |
| B x D | 6 | 68.70 | 19.79 | .00 |
| C x D | 6 | 159.92 | 43.41 | .00 |
| A x B x C | 9 | 13.94 | 4.98 | .00 |
| A x B x D | 6 | 43.53 | 12.54 | .00 |
| A x C x D | 6 | 49.25 | 13.37 | .00 |
| B x C x D | 18 | 23.72 | 9.81 | .00 |
| A x B x C x D | 18 | 14.29 | 5.91 | .00 |

## DISCUSSION

Overall the results indicated that relative to student nurses, the experienced nurses' prior knowledge seems more readily accessible and more highly structured, as reflected in the greater number of highly relevant explicit and implicit references to prior knowledge and highly relevant transformations evident in the experienced nurses' verbal protocols. The results suggest that at the initial case history stage, experienced nurses had available a readily accessible and highly relevant prior knowledge base for making sense of the clinical data. This was reflected in

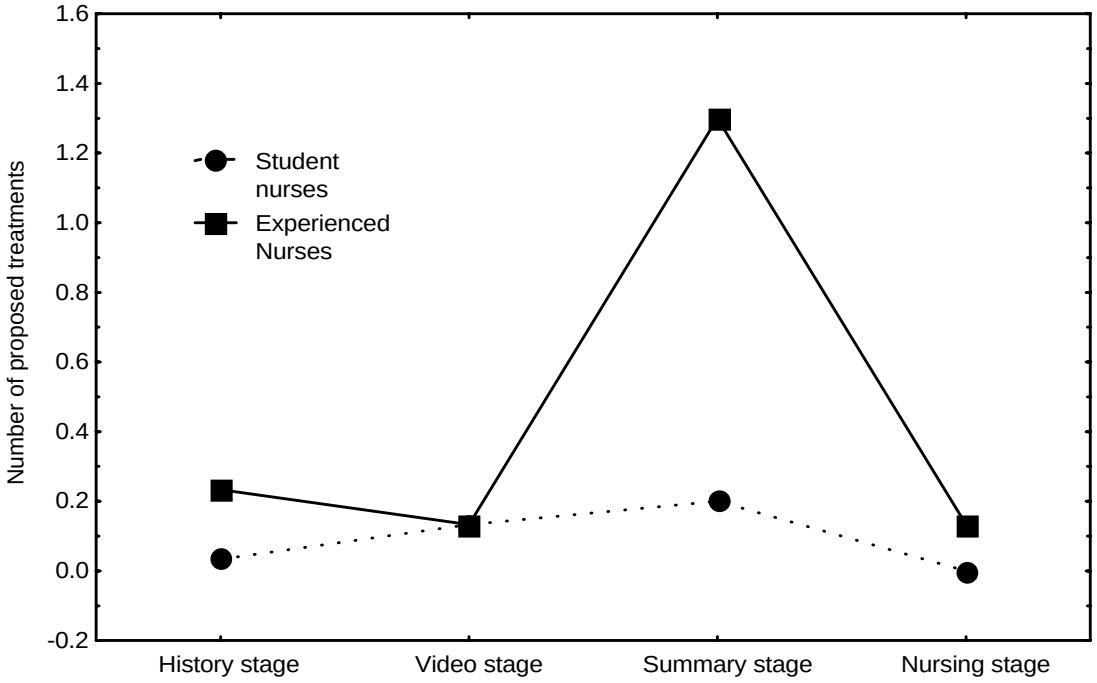
**Table 3** Means and standard deviations (in parentheses) for the three knowledge state categories across the four task stages for experienced and student nurses (n=60)

| | Student nurses | Experienced nurses |
|---|---|---|
| Category and stage | Total score | Total score |
| Need for further information | | |
| History | 0.10 (0.31) | 0.27 (0.69) |
| Video | 0.03 (0.18) | 0.00 (0.00) |
| Summary | 0.13 (0.51) | 0.00 (0.00) |
| Nursing | 0.00 (0.00) | 0.03 (0.18) |
| Diagnostic hypothesis | | |
| History | 0.20 (0.48) | 1.20 (1.85) |
| Video | 0.23 (0.77) | 0.80 (1.24) |
| Summary | 0.13 (0.43) | 0.93 (0.87) |
| Nursing | 1.30 (6.36) | 0.30 (0.65) |
| Proposed treatment | | |
| History | 0.03 (0.18) | 0.23 (0.57) |
| Video | 0.13 (0.43) | 0.13 (0.43) |
| Summary | 0.20 (0.48) | 1.30 (2.47) |
| Nursing | 0.00 (0.00) | 0.13 (0.43) |

**Table 4** A summary of the MANOVA results the three knowledge state categories of request for further information, diagnostic hypothesis and, proposed treatment (n=60)

| Source of variation | *Df* | *MS* | *F* | *P* |
|---|---|---|---|---|
| Need for further information | | | | |
| Between subjects | | | | |
| Group (A) | 1 | 0.00 | 0.04 | .84 |
| Within subjects | | | | |
| Stage (B) | 3 | 0.37 | 0.11 | .02 |
| A x B | 3 | 0.24 | 2.13 | .09 |
| Diagnostic hypothesis | | | | |
| Between subjects | | | | |
| Group (A) | 1 | 7.00 | 1.21 | .27 |
| Within subjects | | | | |
| Stage (B) | 3 | 1.27 | 0.21 | .89 |
| A x B | 3 | 13.15 | 2.18 | .09 |
| Proposed treatment | | | | |
| Between subjects | | | | |
| Group (A) | 1 | 7.70 | 6.12 | .02 |
| Within subjects | | | | |
| Stage (B) | 3 | 6.18 | 7.89 | .00 |
| A x B | 3 | 3.77 | 4.89 | .00 |

**Figure 2** Number of proposed treatments across the four stages for student and experienced nurses (n=60)




the large number of instances of implicit reference to highly relevant prior knowledge. On the basis of this readily accessible and highly relevant knowledge they were able to quickly and accurately identify significant clinical data as a basis for more accurate understanding of the clinical case (Schmidt & Boshuizen, 1993). Very early in the task they began transforming clinical data into highly relevant clinical concepts, suggesting the use of a highly structured prior knowledge base. This enabled them to more accurately represent the nature of the clinical problem and to deal with the problem less in sequential terms and more in terms of over-riding clinical concepts (Bordage & Lemieux, 1991).

As more clinical data were presented at the video-taped interview stage, the experienced nurses seem to focus less on making sense of the clinical data, as reflected in the very few instances of explicit or implicit reference to prior knowledge, and more on higher level clinical concepts, as reflected in the large number of highly relevant transformations. It seems that on the basis of their highly structured and highly relevant prior knowledge base, they were more likely to encapsulate lower level details and strengthen their conceptual knowledge of the clinical problem by systematically transforming clinical data into clinical schemes (Boshuizen, Schmidt, & Custers, 1995). In the clinical summary stage and the nursing diagnosis stage they continued to focus less on making sense of the clinical data, as reflected in the very few instances of explicit and implicit reference to prior knowledge, and more on transforming clinical data into highly relevant clinical schemes. On the basis of their highly relevant and highly structured prior knowledge they were able to generate a greater number of diagnostic hypotheses in the early stages of the task, and to propose more treatments than student nurses.

The student nurses, on the other hand, did not seem to have available an adequate knowledge base for an accurate understanding of the clinical case. At the initial written case history stage, they did not seem to have ready access to relevant prior knowledge and seemed less able to identify significant clinical data, as reflected in the large number of instances of implicit reference to low relevance prior knowledge. From the very first stage, they only managed to

make interpretations of less relevant clinical signs and symptoms, reflecting the use of a less structured prior knowledge base. This limited them to a data-bound and symptom-by-symptom approach to the processing of clinical data, thus restricting their ability both to discriminate between more relevant and less relevant information and to draw on more conceptually based clinical concepts.

As more clinical data were presented at the videotaped interview stage, the student nurses also seemed to focus less on making sense of the detailed clinical data set, as reflected in the very few instances of explicit or implicit reference to prior knowledge. But they still only managed to focus on the surface meaning of given symptoms, as reflected in the large number of moderately relevant interpretations, rather than higher-level clinical concepts. Because of their less structured and less relevant prior knowledge base, they were less able to contextualise the clinical data. Rather, they only continued to interpret the elementary meaning of signs and symptoms (Bordage & Lemieux, 1991). At the clinical summary stage and the nursing diagnosis stage they continued to focus less on making sense of the clinical data set (as reflected in the very few instances of explicit and implicit reference to prior knowledge) and they continued to interpret less relevant clinical data. Because of the limitations posed by their less accessible and less structured prior knowledge base, they were less able to generate diagnostic hypotheses in the first stages of the task and less able to propose treatments than the experienced nurses.

Overall these results suggest an important role for the structuring and accessibility of prior knowledge in explaining clinical problem solving in experienced and student nurses. The experienced nurses were more likely to have available to them a more readily accessible and highly structured knowledge base, allowing for rapid recognition of highly significant clinical data and the transformation of that data into highly relevant clinical schemes. On the other hand, the student nurses seem to have to rely on a less accessible and less structured knowledge base, and were only able to identify and interpret less significant clinical data at the surface level.

**Implications for nursing education**

To improve clinical problem solving performance then, it would seem fruitful that nurses should be encouraged to develop a strong and well-structured knowledge base in the context of their discipline. Curriculum should make explicit reference to the knowledge base and provide organised instruction that will facilitate the development of a well-structured prior knowledge base, and hence a more readily accessible schema that can be used to process clinical data in the specific context in which the information is being studied (Prawat, 1991; Schmidt, 1995; Shuell, 1990, 1993; Swartz, 1991).

Particular learning environments, such as problem-based learning and anchored instruction, have been argued to be conducive to the development of a strong knowledge base and highly structured schema that may be applied to clinical problems (Schmidt, 1995). For example, one of the assumptions of problem-based learning is that where students are motivated by the perceptions that knowledge acquisition is important and challenging, the design of clinical nursing problems, the associated teaching processes, and the criteria for assessment must created an appropriate motivational and learning environment within which such knowledge is structured and applied for understanding. Asking students to generate questions about the clinical problems presented to them is likely to focus attention to critical data and force students to think about how these data relate together and to their own prior knowledge. This provides a useful strategy to clarify concepts and promote the construction of hierarchical structures and schemes from pieces of clinical data. Further, in responding to their own questions in an elaborated way, students are encouraged to engage in higher level integrative reasoning, thus forcing the student's attention away from surface details to more over-riding clinical concepts for understanding (King, 1992).

The research study, both through its limitations and its findings, raises a number of questions for future research. First, the question emerges as to how generalisable these findings are to other nursing populations. There is a substantial body of research suggesting that there are

various stages in the development of expertise and that prior knowledge is used in different ways at different developmental stages (Boshuizen & Schmidt, 1992; Schmidt & Boshuizen, 1993). As the experienced nurses in this study were not necessarily defined as experts in their field, it may well be worthwhile to examine the way experienced nurses with varying amounts of specialist academic and clinical experience use their prior knowledge to solve ill-structured nursing problems in their area of expertise. Similarly, it may be beneficial to examine how student nurses use their prior knowledge at various stages of their professional education and clinical experience.

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