PEDAGOGICAL CONTENT KNOWLEDGE - FOUR HIGH SCHOOL TEACHERS REFLECT ON THEIR TEACHING

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ABSTRACT

In this study an exploration of teachers' pedagogical content knowledge (PCK) was undertaken through case studies of four experienced teachers in relation to the nutrition content that they taught to Years 8, 9, 10 and 12. The case studies adopted a participant-centred, dialectical approach involving reflection-on-action (Clandinin, 1986; Smyth, 1991). Patterns and themes which emerged in relation to the nature of teachers' PCK aggregated around four issues: the domains of knowledge for teaching; teacher experience; teacher beliefs; and, the observable forms of PCK. Tentative propositions which arose from these qualitative data are posed: that PCK is 'intersectorial' in nature; that PCK is personally idiosyncratic in its expression; that context and beliefs are powerful mediators in the expression of PCK; and that, in its traditional forms, the expression of PCK is relatively rare.

INTRODUCTION

Nearly nine years ago now, Lee Shulman (1986a) coined a title for what he saw as an important and discrete section of a teacher's knowledge base, namely, pedagogical content knowledge (PCK). In 1990 a special issue of the Journal of Teacher Education was devoted to the topic of PCK and a large body of research now exists on this aspect of teacher knowledge. Almost all the research to date focused on the traditional subject areas of math, science, English and social studies, but the exact nature of PCK as a generic teaching phenomenon, remained somewhat elusive.

Pedagogical Content Knowledge - What Is It?

As the meaning of the words - and the grammar thereof - indicated, PCK was seen as a type of content knowledge particular to teaching. Whilst some maintained that all knowledge was pedagogic in one way or another (McEwan & Bull, 1991), such an argument was not very useful within the forum of educational research. The crux of the enquiry around PCK was to establish how the content knowledge of the teacher - as presented by the teacher - was made comprehensible to the student. What representations, if any, took place? And how could this PCK be codified, recorded and used, perhaps, by others?

Shulman (1986:9) stated that PCK included "the most useful forms of

representation ...the most powerful analogies, illustrations, examples, explanations, and demonstrations". In his subsequent article Shulman (1987:8) outlined what he condidered to be categories of the knowledge base for teaching. Fourth in his list of seven was pedagogical content knowledge, "that special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding."

Pedagogical content knowledge, then, was akin to and had elements of what variously was called "practical knowledge" (Calderhead, 1987; Elbaz, 1981), "knowing-in-practice" (Schon, 1983), "personal practical knowledge" (Clandinin, 1986; Day, Pope & Denicolo, 1990), "craft knowledge" (Leinhardt, 1990; McNamara & Desforges, 1978; Zeichner,

Tabachnick & Densmore, 1987), "language of practice" (Yinger, 1987), and "content specific cognitional knowledge" (Peterson, 1988). The exact nature of knowledge for teaching was crucial but, despite all the aforementioned attempts to capture its essence, it remained somewhat elusive.

Domains of Knowledge for Teaching - Where Does PCK Fit?

Elements which comprised the professional knowledge base for teaching were a natural, if neglected, part of the educational research enterprise (Shulman, 1986b). Shulman (1987:8) deemed PCK as a distinct entity within the knowledge base. That position was reiterated, naturally, in Wilson, Shulman & Richert's (1987:113) components of the professional knowledge base of teaching. In later analyses of the place of PCK, Reynolds (1992:5) proposed that it "contextualized" the other knowledge domains and Cochran, King & DeRuiter (1991:12) viewed PCK as "synthesized knowledge" which was formed from other knowledge domains but which was unique in itself.

As the investigations about PCK grew in number through the late 80s and early 90s, the totally distinct, cognitive nature accorded to PCK by Shulman and his co-researchers, became less tenable. Valli & Tom (1988) argued against Shulman's schema and its separation of principles and norms, and Sockett (1987) claimed that Shulman's focus on content embodied a relative lack of attention to context and ignored the moral dimension of teaching. Further, Sockett claimed that Shulman ignored the professional status of teachers and "his researchers seem to work on teachers rather than with them" (1987:217 his emphases).

Other criticisms were expressed by McEwan (1989) in relation to the universal requirement for all knowledge to be "interpreted" for an audience and the classroom was only one, not very unique, site for this to occur. Although the notion of 'content knowledge for teaching', or PCK, was not denied, exactly where and how it fitted into the

professional knowledge base, remained contentious.

Teacher Experience - A Corollary to PCK?

Although concensus about the location of PCK in the knowledge base for teaching was not evident, there seemed, at least, tacit concensus about the experiential flavour of PCK. Because, perhaps, of the links between PCK and the 'wisdom of practice', there was an implicit expectation that experienced teachers would have more of 'it' than novice teachers.

Although one cannot presume that experience leads to expertise, the idea of experience engenders an expectation of development and improvement. Researchers who worked within the novice/expert paradigm found that beginning teachers lacked PCK (Feiman-Nemser & Parker, 1990; Grossman, 1988; McDiarmid, Ball & Anderson, 1989), wheras expert and/or experienced teachers were marked by their ability to form repesentations of their subject matter (Gudmundsdottir, 1988; Marks, 1990; Wilson, 1988). Inadequate subject matter knowledge was a pre-cursor to limited PCK (Smith & Neale, 1989; Tobin & Garnett, 1988; Wilson & Wineburg, 1988) and this finding held for teachers who were classroom-wise but who were teaching unfamiliar topics or subjects (Hashweh, 1987; Carlsen, 1988).

The role of teacher education in the development of PCK was equivocal in the research. Some inquiries found that pedagogical training

assisted beginning teachers to form appropriate representations of their content and to reason pedagogically about their subject matter (Anderson, 1989; Barnett, 1991; Tamir, 1988; Wilkes, 1994), but others were unconvinced of the effects of pre-service courses to address PCK (Feiman-Nemser & Buchmann, 1986; Grossman & Richert, 1988; Lampert, 1988). In a study of veteran teachers, all five subjects claimed what was missing in their pre-service education was akin to "what Lee Shulman calls pedagogical content knowledge" (Cohen, 1990:24), and there was one study which claimed success, at least in the short term, for an in-service program which aimed to improve teachers' PCK (Smith & Neale, 1989).

Whilst experience was seen to be a type of correlate of PCK, its development curve was never scrutinised. Whether linear growth matched years of service, or whether variety of experience punctuated growth spurts, or whether growth in content knowledge (or,even, growth in outside-content knowledge) were related to the development of PCK, or whether affective and/or contextual constraints were involved in the interplay of experience and PCK, remained unchartered issues in the research.

Teacher Beliefs and PCK

Whilst the impact of affective components on the interplay of experience and PCK was not scrutinised, the role of teacher beliefs and PCK was the focus of eight located papers.

To separate knowledge and beliefs (and, even, behaviour) is, in some sense, an artifact of the research process. Beliefs do not emanate in a vacuum and one's teaching experiences, surely, mould and shape what are termed one's educational beliefs. As well, congruence between teacher action and teacher beliefs, cannot be presumed. These anomalies, in part, were resolved in Clark & Peterson's (1986:257) seminal review of the research on teacher thinking where they depicted thought processes and action as multi-directional.

In the areas of English and Social Studies, researchers reported that teachers' beliefs about the subject were encapsulated in their conceptions of the discipline and were characterised in the teachers' choices of content, textbooks, teaching strategies and the needs of the students (Grossman, 1988; Gudmundsdottir, 1988). For secondary science teachers, Brickhouse (1990) found a congruence between the personal philosophies of an experienced teacher and his classroom content actions, but a discontinuity for the inexperienced teacher's beliefs and content actions. Amongst experienced primary teachers, Smith & Neale (1989) found that a lack of (physics) content knowledge caused teachers' beliefs about science to be limited to didactic forms of knowledge.

Neither of the above science-teacher findings was of any surprise, nor were those of the researchers who investigated math teachers. Teachers who had very cognitively based views of mathematics (Peterson, Fennema, Carpenter & Loef, 1989), or who believed in mathematical discourse (Lampert, 1990) reflected those beliefs in their PCK. Studies which attempted to widen math teachers' PCK and, hence, their beliefs about the subject, reported success (Carpenter, Fennema, Peterson, Chiang & Loef, 1989), and some concerns as to the persistence of that success (McDiarmid, 1990).

One other study examined the belief patterns of teacher candidates and experienced and novice teachers. Through responses to statements about

what it meant to be good at Writing and Mathematics, Schmidt & Kennedy (1990:7) found less variation in the belief patterns of experienced teachers. This led to their proposition that "as teachers gain more teacher education and more experience teaching, their beliefs become more refined." 'Refined' could be replaced therein, however, by 'expedient' or 'narrowed' or 'rationalised'.

All of the above studies about teacher beliefs and PCK were in relation
to beliefs about the subject matter. Teacher beliefs about broader
educational issues in relation to PCK, were not the specific focus of
any located studies despite the, now, large corpus of literature about
teacher thinking.

As well, even though the literature on teacher thinking is vast, there
appeared to be little work on the mental scaffolding or metacognitive
structures that seemed intrinsic to PCK. Only one located study
addressed this issue. Borko, Bellamy & Sanders (1992:67) stated that
"experts' knowledge structures include stores of powerful explanations,
demonstrations and examples for representing subject matter to
students" and the study gave some credence to the concept of content
specific pedagogical expertise.

Forms of PCK

The study mentioned above by Borko et al. (1992) highlighted the
centrality of the various forms of PCK. Shulman (1986a:9) set a
pattern for the accepted forms of PCK when he elaborated on the types
of representation of subject matter which he deemed as evidence of PCK.
 To repeat those ... "the most powerful analogies, illustrations,
examples, explanations, and demonstrations".   In this initial article,
Shulman's description of PCK included, too, the oft forgotten phrase of
"and what makes specific topics easy or difficult" (1986a:9). His
focii were, overall, on a teacher centred environment and, largely, on
teachers' verbal behaviours.

In his subsequent article about knowledge and teaching, Shulman
(1987:15) added words such as "metaphors", and "simulations" to his
list of forms of PCK, and, by his phrase "and so forth", indicated that
the list was not exhaustive. In fact, along with their model of
Pedagogical Reasoning which became the focus of some later resesarch,
Shulman and his co-researchers further added "activities" and
"assignments" (Wilson, Shulman & Richert, 1987:120) to the forms of
PCK.

Perhaps, as an outcome of these indeterminate descriptions, the concept
of PCK remained a little murky, and its forms varied in emphases with
each researcher. Some researchers used, even if tacitly, the general
list of representational forms offered by Shulman, but extended the
classification of PCK by denoting 'areas' in which it was evident
(Grossman, 1988; Marks, 1990a; Wilson, 1988). There were other
researchers who refrained from listing their forms of representations
as such and who saw their teachers' PCK and content knowledge as
indistinguishable (Cochran et al., 1991; Gudmundsdottir, 1988), wheras
others retained the differentiation between content knowledge and PCK,
but gave no indication of their forms of PCK (Tamir, 1988; Meade &
McMeniman, 1992). Still another researcher cited earlier 'modes' of

representation (such as Bruner's, 1970, concrete, ikonic and symbolic) and adapted those to their subject area of enquiry (Ball, 1988).

There were some related enquiries which attempted to classify 'target areas' of PCK. For instance, Kromrey & Renfrow (1991) worked at the

development of teacher test items for PCK and identified four target areas in which a teacher's content knowledge could be tested for its pedagogical appropriateness: error diagnosis; communicating with the learner; organisation of instruction; and learner characteristics.

There were yet other related research areas which, whilst not about the forms of PCK in specific terms, were about the lingustic and epistemological bases of representations and explanations. The value of metaphors and analogies in teaching and learning was the field of endeavour for many researchers (Chi, Feltovich & Glaser, 1981; Davidson, 1976; Gabel & Sherwood, 1980; Ortony, 1975; Simons, 1984; Vosniadou & Ortony, 1989; Williams, 1989) and teacher explanations held the attention of many educational experts in past decades (Berliner, 1986; Gage, 1971; Rosenshine, 1968). Good teacher explanations were the focus of many years' work for Roehler & Duffy (1986) and, in an Australian context, Siregar & Evans (1989) developed a method for analysing the explanation structure of teachers' verbal expressions. Of late, educational enquiry used metaphor as a tool to explain the bases of teachers' behaviours and beliefs (Morine-Dershimer, 1987; Munby & Russell, 1989; Tobin, 1990).

The value of content knowledge representations in a single teacher's repetoire of knowledge and skills, or the proportion of classroom time that the various forms of PCK should, or did, comprise, remained undetermined. Kagan (1990:427) stated that she "could find no studies that examined relationships between teachers' metaphors and student outcomes" and Marks (1990b:11) claimed that "two of the prototypical forms of PCK cited in the literature - teachers' awareness of student misconceptions and their use of analogies and representations - hardly appear in the data from this study." No located studies ascertained or estimated the proportion of classroom life that PCK assumed.

The forms of PCK, then, were partly established by Shulman, but variously interpreted in a number of studies that offered any elucidation of what they saw as forms of PCK. The role of PCK was presumed positive but its proportion in classroom events was never mentioned in the research.

There were many issues, then, that the literature raised but which remained unresolved. A few of these were: the location of PCK in the knowledge base for teaching; the path of teacher experience in the development of PCK; the interplay of teacher beliefs and PCK; and the accepted forms of PCK as evidenced in teacher behaviour. These issues

were the focus of the present enquiry into the PCK of teachers in
relation to the nutrition subject matter that they taught.

THE STUDY

An exploration of PCK, in relation to the nutrition content taught in
NSW high schools, was planned in order to:
a) further examine the nature of PCK;
b) discern PCK's characteristics in relation to an, as yet,
unresearched curriculum field; and,
c) accumulate grounded evidence of the nutrition concepts being
addressed by high school teachers which involved PCK.
To this end, intensive case studies which kept close to the language of
the participants were formulated through a small number of teachers
during the school year of 1993. The present researcher 'lived' in the
four classrooms; was an 'outsider' to the State of NSW and so held no
evaluative or competitive role; and was an 'insider' in terms of
subject and professional knowledge and affect.

THE STUDY MEMBERS

The four teachers who speak in this paper were nominated by their
superiors and peers as leaders in their teaching field and, after
contact by letter and a group meeting to explain the purposes of the
enquiry, agreed to take part in the year-long study. All four teachers
held the Head Teacher position of the Technical and Applied Studies
Department or the Home Economics Department of their school. Each was
active in professional associations, curriculum writing, subject
examining and professional development course organisation, within
their content expertise. There was no specific measure of expertise in
teaching, apart from subjective reports, and none was presumed. Three
teachers held Bachelors degrees whilst the fourth was qualified at the
Associate Diploma level. Each of the four teachers had more than
twelve years experience in country and metropolitan high schools in
NSW. During the study period one teacher was working in an inner city
selective girls' high school and the other three were situated in
metropolitan, comprehensive, high schools in, largely, middle income
suburbs. The teachers adopted the pseudonyms of Ms Robin Strand, Ms
Terri Needham, Ms Chris Hollows and Ms Kim Bishop.

DATA COLLECTION AND ANALYSIS

Profiles of the four teachers were formed through: classroom documents;
professional life histories; classroom observation; stimulated recall

of classroom activities (audio and video); and teacher belief interviews. The period of the study was over one calendar year.

Observation
The data comprised, firstly, classroom observation for a minimum period of twelve lessons for each teacher. In some appropriate instances observation became participant observation. The grade level, subject and lesson length of the classroom observation data were as follows:

Ms Robin Strand
Year 9Food Technology(6x40 mins.+6x80 mins.)

Ms Terri Needham
Year 10Home Economics(6x40 mins.+6x80 mins.)

Ms Chris Hollows
Year 8Design & Technology-Food(12x38 mins.)
Year 12Home Science(12x38 mins.)

Ms Kim Bishop
Year 8Design & Technology-Food(6x40mins+6x80mins)

Reflection
Secondly, two one-hour, reflection-on-action sessions were held with each teacher. The bases for these were (i) transcripts of audiotaped classroom discourse, and (ii) an agreed-upon videotaped lesson. Thirdly, a further three audiotaped interview sessions were held with each teacher throughout the year. (The final one of these was in the following calendar year.) The interviews focused on the professional background of the teachers; teacher beliefs and personal theorising; and teacher discussion of identified content topics and identified PCK.

Documentation

Fourthly, relevant teacher-designed documents such as Term plans, classroom worksheets, assignment outlines, tests, handouts and the like, were collected throughout the year.

Analysis
The classroom observation, reflection-on-action sessions, and interviews were transcribed and presented to the teachers for reading and editing purposes. The Ethnograph (Seidel, Kjolseth & Seymour, 1988) was used for the management of the coding of these transcripts and the coding process followed the procedures for text analysis as detailed in Strauss & Corbin (1990).

The background literature about PCK was instrumental in the initial application to the data of codes and categories. As the coding process was refined the codes were renegotiated until those listed in Appendix

A were decided upon as 'best-fit' for the data. These codes resulted from the present writer's alternating engagement in both open and axial coding.

The traditional verbal forms of PCK were extended to the eight PCK-extension codes listed in Appendix A. The code, PCK (with no extension), was applied to other forms which became apparent through the reading and re-reading of the data and the verification of patterns and themes. These other non-verbal forms included assignments, activities, plans, error prediction (unstated in the classroom) and worksheets. These latter, non-verbal forms will not be discussed in this paper.

DATA PRESENTATION

In the interests of conciseness, the data which are relevant to this paper will integrate the stories of the four teachers and will be presented under the four issues mentioned earlier.

PCK and the Knowledge Base for Teaching

The most distinctive theme that emerged with regard to the location of PCK in the knowledge base of each of the teachers was its intersectorial nature. In other words, the content that teachers selected to use and how they represented it was guarded by their Knowledge of the Curriculum (K CURR), their Knowledge of the Learners (K LRNRS), their General Pedagogical Knowledge (GPK) and their Knowledge of Educational Ends, Values and Purposes (K EVP). In the case of Robin, she melded her knowledge of the structure of the subject with her knowledge of the selected nature of the students. In a discussion about the subject matter used in class, Robin commented;

"We discuss a lot of things ...the lesson might start off on Topic 1, but somehow it drifts all over the gamut of Food Technology ...nutrition, psychology, sociology ...and, you know ...they're fairly aware ...you have to adjust really quickly in that they can just chew through the work ...it puts more pressure on you in a content sense."

The instance, quoted above, of content presentation in view of the market was, perhaps, no more than good sense, but it reflected the teachers' knowledge of the students and her ability to use her own subject knowledge. Robin's PCK was formed here by the intersection of her Content Knowledge (CK), General Pedagogical Knowledge (GPK), and Knowledge of the Learners (K LRNRS). For all four teachers this 'intersection' was apparent as they talked of their classroom lives.

In the case of Ms Terri Needham, her Knowledge of the Curriculum (K

CURR), GPK and K LRNRS were obvious components in her talk about a new
Year 11 course that she had taught in Term 1.

"I have no choice to change the content but I have the ability to
approach it in a more learning centred way. Being the first time that
I taught it, some parts were good because I've taught that many times
before ...my background knowledge and resources are good ...I'm going
to have to put in a lot of effort to get the information together (for
the new sections) ...and also to present it in a student centred way,
because I know that I can look forward to many lessons when they won't
cooperate."

For this teacher of recalcitrant students, her knowledge of them (K
LRNRS), the extant curriculum constraints (K CURR) and her knowledge of
teaching methods (GPK), and, perhaps, knowledge of self, influenced the
classroom content. There was recurring evidence throughout the data of
this intersectorial nature of the content knowledge for teaching (PCK).
 Content knowledge was reconstituted in terms of the learner and made
pedagogical. The nature of this amalgam was very different from the
content knowledge from whence it came. When talking about what was
important for students to learn about nutrition, Ms Chris Hollows
commented on society's interest in things nutritional being of some
assistance.

"There is an interest in food and diet now that supports what I'm
trying to do ...you virtually can't pick up a newspaper these days that
hasn't got an article (on nutrition) in it ...there is recognition for
the need for people to understand their food intake ...but it is in the
syllabus in a way that it's like a mad dog's dinner ...an itty bit here
and an itty bit there ...and the kids do not have the skills to pull it
all together into a cohesive body of knowledge ...and so we have to try
to do that in what we do in class ...and it's no good even just giving
them a cohesive body of knowledge ...if we don't also give them the
strategies for doing something about their own eating patterns."

In the above excerpt there was indication of Chris' general
dissatisfaction with a less than rigorous body of knowledge being part
of school offerings (CK), her knowledge of the curriculum (K CURR), her
concerns about the transfer of learning (GPK) and the purposes of
nutrition education (K EVP). Each of these domains of the knowledge
base for teaching played its part in the formation of her PCK about
what was responsible nutrition education.

For Ms Kim Bishop this sense of responsibility about nutrition content
was voiced in a different way. This teacher was in the throws of
adopting the design process into her thinking about teaching and
learning. There was some flux in her implementation of this but the
PCK of this teacher was still a phenomenon of the intersection of the
other domains of the knowledge base for teaching. In talking about the
process orientation, Kim explained;

"I'm trying to crystallize in my mind what I mean ...what I teach obviously is in a content area ...but as I've indicated to you, I keep on adjusting it ...to be sensitive to the age group that I'm dealing with ...and each class ...that's the only way that I can really get my nutrition message across ...I have to be sensitive to what is able to be delivered realistically ...particularly with this approach ...but I'm not setting out to teach nutrition ...I'm teaching them learning ...and the content is an aside ...I'm a facillitator ...I'm totally committed to the approach ...I think it is the only way to teach ...they learn far more than they ever did before."

Kim's enthusiasm for 'process' learning was unbridled and the factual content presented in lessons was, indeed, less than in the other observed Year 8 class who addressed the same curriculum profiles. Nevertheless, Kim's observed PCK was at the crossroads of her other domains of knowledge for teaching. In the above excerpt, the content was best conveyed, according to this teacher, through students applying the design process to food problems. This resulted in 'better' learning. Kim's content knowledge for teaching (PCK) derived from her K LRNRS (age, class) and K CURR (profiles, time) her CK and her GPK (method).

It could be construed from the above four excerpts that not only was PCK a phenomenon of the intersection of the domains of knowledge for teaching, but that there were individual differences in its formation which reflected beliefs about teaching and learning and which reflected situational demands and self-perceptions of ability.

PCK and Teacher Experience

There was an implicit notion in much of the literature that PCK was a type of corollary to experience in the classroom. Rovegno (1992:8) claimed that "it was evident that PCK included experiential dimensions." In this study the theme of 'experience' occurred and recurred throughout the data. Each of the sub-categories was further defined by this theme and its presence was evident across all the data sources.

The obvious areas where experience at teaching was most relevant to the content, were: firstly, in the plans for what was to be taught; secondly, in the selection and use of strategies that were deemed most effective for conveying that content; and, thirdly, in the prediction, diagnosis, prevention and/or solution of student errors or difficulty with content.

None of the experienced teachers in this study was in the business of

detailed lesson plans. At the second meeting of the present writer and
Ms Robin Strand, the latter waved a piece of paper with the weeks of
the term listed on it and a major topic heading for all but the last
few weeks. In explanation, Robin commented;

"Well, I mean ...really, my plans for the Year 9s for the term
...that's it!! ...I'll try things out with the Year 11s and then I'll
pick out bits that I think will work well with this group ...'cos, you
know, the curriculum's changing so much ...you can't be ...you just
don't have the time."

The above may be interpreted as 'less than desirable' but, in
enactment, each lesson was highly structured and full of relevant
activity. This was the case for all four teachers but the bare bones
of the courses were all that were committed to paper. Similar
expressions of experience were made by Ms Terri Needham in relation to
her Year 10 course.

"I mean, I've planned that course many times ...for many years ...and
I've taught it a lot ...and you adjust it on the run having done it
many times before."

The content for teaching was reviewed as appropriate or inappropriate
and adjusted 'on the run' in the light of the teachers' previous
experiences with that content. As Clandinin (1986:3) remarked, it

would be absurd to imagine that teachers could be divorced from their
experience as they made new decisions. In this study, the data
indicated that pedagogical content knowledge was formed through the
teachers' experiences with particular content, in particular
classrooms.

This PCK was formed, too, in part, by a knowledge of what strategies
were most suited to making that content comprehensible to students. In
relation to this aspect of PCK, experience had a voice. Ms Robin
Strand explained that there were certain topics which were best
understood if the practical application preceded the theoretical
explanation.

"In actual fact it is something that I've learned during my teaching
career ...to sometimes just let students do something completely
without really having a lot of understanding of the nuts and bolts
...and then to go back later ...they listen better then because they
can remember what happened."

The experience with different teaching strategies had caused Ms Kim
Bishop, also, to re-evaluate content.

"Yes, I have changed ...in the last three years particularly since I've

done this Design & Technology ...I'm no longer the only person who knows everything ...to let the students go ...and to let them take charge of their learning."

On the other hand, Ms Chris Hollows made adjustments to the content because she felt that the very strategies implicit in 'letting the students go' were unsatisfactory in their learning outcomes.

"But this is what we find with this course ...we get kids in ...I mean you have them for a third of the year ...and we start off on a context and they haven't got a clue ...so you have to go back to formal instruction before you can get them to come to terms with what it is that they're supposed to be doing in a design brief ...and then when you've got that started they have no skills ...so I've changed things quite a bit."

The professional judgements of these teachers were thoughtful and intelligent in structuring the learning opportunities of the students in their charge. Whilst each made different decisions, their reasonings were logical and were made with the objective of maximal student learning, but with an element of their individual peronalities. It seemed that the theme of 'experience' formed a filter for all the teachers' thoughts and actions. In the axial coding process, experience was both a causal condition and, at times, an intervening condition.

The third hallmark of experience with the content for teaching was stated earlier as being witnessed in a teacher's error diagnoses, and in a teacher's predictions of what was easy and difficult for students within the subject matter.

These four teachers all had extensive experience in the subject area. All had taught food and nutrition courses throughout their teaching careers. When speaking about the course that was the focus of the enquiry, three of the four teachers identified many 'pet' areas of student difficulty with content. Ms Terri Needham's Year 10 class were often involved in decision-making in terms of menu selection. The appropriateness of those decisions was then tested in a practical, albeit simulated, situation. The teacher, however, was attuned to the

usual mistakes of students in terms of time allocation, more so than in skill estimation.

"Mostly, kids choose things that are way beyond the time level ...and ...occasionally, I suppose, something beyond their skill ...but ...it's more to do with time ...and that's probably the most common error ...in not keeping within their time ...that's set."

Similar instances of error prediction occurred throughout Terri's data.

 The instances resulted from familiarity with the content in a
pedagogical sense. Students were protected from major errors by the
experience that Terri had of the common mistakes that students made.
She felt, too, that to prevent irrevocable misjudgements was not in
breach of the enquiry method that was being used. Guidance, based on
experience of the content, was offered to students.

In a similar way, Ms Chris Hollows' long exposure to the teaching of
nutrients alerted her to common student misunderstandings with some
central concepts. Chris commented on the almost, inevitable student
confusion between nutrients and food groups.

"The reason is the way the Food Groups are presented. They (the
students) get the nutrients fine if you set them out ...clearly ...then
you categorise food ...and when you get to the meat group ...you will
say, 'they're mainly protein foods', and so all of a sudden the two
start to get entwined and you don't really want them to ...and yet you
do ...somehow we have to combine them and keep them separate ...it's
not a great problem if you make the kids aware of this at the start
...when we're talking about the nutrients, we're talking about the pure
form ...and when we're talking about the Food Groups we're talking
about foods that have a combination of those nutrients ...in all sorts
of proportions."

The incidence of error prediction was frequent in the data from three
of the teachers. The fourth teacher was concerned with students' being
exposed to the 'process' of learning and there were infrequent
occurrences in the data from her of Content Knowledge as a caterory per
se. This may have caused a concommitant rarity of error diagnosis. As
this anomaly appeared in the data, later interview probes were directed
at this issue, but no clear answers were evident in subsequent data.

PCK and Teacher Beliefs

The literature about teacher beliefs and PCK focused on beliefs about
the subject, rather than beliefs about teaching and learning, or wider
teacher beliefs about the place of education in the social order.
Because this study was about a subject area not the focus of previous
known research, namely nutrition, the data presented here reflect the
four teachers' beliefs about the subject of nutrition.

A common belief across the four teachers was the importance of linking
the practical nature of food with the more theoretical study of
nutrition. This theme recurred throughout the discussions and was a
maxim for the classroom actions of these teachers. A typical statement
on this issue came from Robin as she talked about her own approach;

"To me the nutrition goes hand in hand with the food preparation and so
you've always got that linking of it with what they actually do ...it's

such a challenge ...it's not easy ...even sitting here thinking about
what I do ..."

This belief was reiterated and extended by Kim as she spoke about her
perspective on the subject;

"Food is a cultural and psychological phenomenon ...and food has many
functions ...when we are experiencing anger ...happiness ...we use
foods in other ways ...and for social purposes ...so I think that you
have to expose students to the whole spectrum because you don't just
use food for nutritional purposes."

The interdisciplinary nature of the subject was outlined above and
recurred, for example, in a statement by Terri as she discussed how her
own views on the nature of the subject had changed over time;

"It's hard for teachers who have taught a very factually based subject
to deal with different approaches ...I think that we probably have felt
in the past that you don't understand it if you can't explain the
structure and the composition and the physiological functions and so on
...of the nutrients ...which is what it's always been tied to ...I
think I'm probably less stratified now ...I think I'm seeing it more in
a social way than in a chemical way."

These themes of 'practice-theory links' and the 'interdisciplinary
nature' of the subject were part of the conversations from all four
teachers. The discussions then, often extended into the common belief
that the subject needed to be presented in an holistic way rather than
as a study of individual nutrients. As Chris said about a lesson on
fibre;

"To me, the more that you reinforce the idea of it as a whole ...rather
than 'this is fibre' ...separately ...you've got a little bit of
information on fibre and that brings it into relationship with the
other nutrients ...and it makes what we did at the very beginning
relevant ...because of this linking back and forth that I do with the
nutrients."

In relation to beliefs about the subject, the teachers focused on the
substantive aspects of the content. Very, occasionally they touched on
the syntax of the subject but they were not really absorbed with how
nutrition knowledge becomes established. Nor, to any great degree, did
their conversations reflect the philosophical and/or historical bases
of the subject matter.   However, there was almost no conversation
about the content for teaching, that was devoid of some aspect of the
teachers' beliefs. Very frequently these beliefs were about teaching
and learning and schools and society and politics and ethics and more.
It was of no great surprise, perhaps, that the teachers' personal codes
and tenets were ever-present in their reflections about content for

teaching.

Forms of PCK

As mentioned earlier, the traditional forms of PCK were identified as, mostly, teacher-verbal representations of content material. Shulman cited metaphors, analogies and the like, as examples of tools which helped student comprehension. In this section, the forms of PCK-extension listed in Appendix A and derived from the classroom observation data, will be discussed. Other forms of PCK which emerged from the data (PCK-no extension) will be addressed elsewhere.

The most significant feature of the data was the 'infrequent' appearance of nearly all of these sub-categories. Apart from the category PCK REP, which contributed (on average for the four teachers)

about 15% of the classroom observation data, the other sub-categories each contributed less than 1% of the classroom observation data. The only exception to that was
the sub-category of PCK STOR which made up just over 1% of classroom observation data.1

The relatively higher contribution of PCK REP was due to the nature of the subject presentation and the frequent use of food demonstrations as part of the lesson sequence. The relatively low contributions of the other language devices were, perhaps, in keeping with the average person's spoken English. And classroom life cannot poetry be.

Metaphors which were used to help in the explanation of content material were scattered throughout the data. They comprised 0.66% of the classroom observation data. Some instances were judged by the researcher as 'better' than others but such evaluations remained subjective and untested. As an example of this form of PCK one teacher, at one stage, used a number of metaphors within a short period of class time. The following extract is taken from a lesson in which Robin demonstrated the preparation of a fruit platter and then students, in groups, prepared a platter to their own design.

Teacher: What's this deadly weapon? (holding up an apple corer) ...while I'm peeling this orange I hope you've worked out your groups...Van Dykes...where are all the artists in here? ...they can be done on the melon ...or you can do crescents or balls ...you'll have to decide ...and Year 9 Food Tech does not squabble ...you can see as the pineapple is cut that it is a little brown ...it is a bit sad. (silence in the room). Some people are plotting what they'll be doing.

In the above instance, Robin maintained the interest of students by using language that was both explanatory and motivating. When asked

why she had used the term 'deadly weapon', the teacher explained it as a semi-humorous approach which would allow students who had not seen one before, to declare their ignorance without feeling at risk amongst their peers. By ascribing sad emotions to the pineapple, too, the atmosphere of the demonstration was kept informal and students were free to offer their comments during its enactment.

Other references to the process of forming Van Dyke serrations on melons included brief reference to the students as 'artists', to assist in explanation of the process, and as a possible motivator and personaliser to students. So, too, referring to students as 'plotting' during the period of silence set them, by way of light humour, to the task. The whole exercise was 'metaphoric' in a sense as students were later encouraged to become "commercial food sculptors".

Similes, as well as metaphors, were part of the teachers' representational repetoire and contributed 0.58% of the classroom observation data. They were often brief and sometimes consisted of the one-word lead up, "like ...". For instance, Terri gave a quick explanation of a term;

Teacher: Dextrinization ...dextrinization is a big word for browning ...like the browning that takes place when you cook your toast ...it's due to dry heat acting on starch ...

In strict language terms the above may be interpreted as an explanation rather than the pure form of a simile but wherever the explanation included a 'like' or 'as' in the data, it was coded in this study as PCK SIM.

The use of analogies to assist student understanding of content material was made in varying amounts by the four teachers. Across the total classroom observation data analogy use was in about the same order as that of metaphors and similes. The approximate proportion of the classroom observation data that was given to analogies was 0.63%. Given that an analogy usually takes more lines of text to develop than a quick metaphor or simile, it would be presumed that the number of times that analogies were used in classroom talk in this study was less than that of the former mentioned figures of speech. One brief analogy was used by Chris when trying to revise a definition of food with her Year 8 students;

Teacher: Snack, what? ...snack foods. ...What did you decide food was on Monday?
Student: Something that we can chew.
Student: Consume.
Teacher: Something that we can chew? ...You said consume? ...Yes, but we can consume shoes, we can consume cars, are they foods? Does it

have a purpose?
Student: Gives us nutrients.

In the above excerpt, Chris drew on the characteristics of consumption
as applied to some goods and compared those characteristics with
consumption in relation to food. Whilst the analogy was brief and
could have been developed further, the pace of the revision questions
was fast and their place in the total lesson was small. Throughout the
data this property was typical of many analogies: the rapid interaction
of classroom talk often forced the abbreviation of analogy development.

As mentioned earlier, the sub-category of PCK REP was much more
extensive in its appearance within classroom observation data than the
other forms of PCK. In total, it contributed 14.7% of the classroom
observation data. The coding process led to a grouping of what seemed
to be sensible associations of like-type instances. Hence, those
knowledge representations which used demonstration, maps, charts,
photograghs, blackboard daigrams and the like, were classified as PCK
REP.

Because of the nature of the subject, the sheer amount of
demonstration, for instance, was greater - one would presume - than for
a subject such as English. Its amount would, probably, be more akin to
that present in the laboratory teaching of science subjects.   A brief
example of PCK REP which occurred in the data recorded Chris taking
advantage of a commercial form of knowledge representation.

Teacher: We now look at how foods are put together ...Karen spoke a
while ago about it when she said fruits and vegetables ...so we don't
talk about foods in terms of vitamins and minerals do we? ...we have
foods in other clusters ...have a look up the back there (a chart on
the back wall of the classroom)
Student: What about tomatoes? (not pictured)
Teacher: Well, that is the fruit of the plant ...but we often classify
it as a vegetable ...OK ...that forms part of one group ...how many
groups are there?

The teacher chose here to refer to a wall chart as a
convenient visual representation of the 5 Food Groups. Quick reference
to such tools was made by some of the teachers at various times but,
overall, the use of commercial forms of representations was far less
than teacher-created representations.

The sub-category of PCK STOR was not suggested specifically in any of

the literature, however, it was a significant feature that emerged in
the data which added to the teachers' repetoires of representations.
These stories were, mostly, of a semi-personal nature and were allied,
it seemed, to interest and motivatory aspects of classroom management

as well as to content understanding. One such 'story' included reference to Terri's young son. The Year 10 class were discussing the pros and cons of Kelloggs Frosties:

Teacher: What's a disadvantage? ...are you listening?
Student: They're unhealthy.
Teacher: They're unhealthy because?
Student: They've got too much sugar.
Teacher: And if you don't need that energy ...and it's refined carbohydrate ...but there might be another disadvantage ...anyone been shopping lately for breakfast cereal?
Student: They're expensive.
Teacher: They really are ...and if you look at the ingredients ...the second top ingredient is sugar and the third top ingredient is salt ...you're paying over $3 a box ...I know, because it's just what we like when we're seven and a half ...so that's a disadvantage.

The teacher very occasionally referred to the antics of her son in order to give impetus to the content. In a later discussion of the use of stories in the classroom, Terri, in a typical moment of self-abnegation, be-moaned her own story-telling abilities and explained her reticence;

"I'm not very good on stories ...I think, ...though some people are and I think that makes wonderful teaching ...as long as it's relevant ...I'd like to be able to tell better stories ...for kids to see things come alive ...when I do it, it's an attempt on my part to remove barriers which are there between student and teacher ...but I won't let them in too close ...because, especially kids who don't treat you right ...and they don't, and they haven't ...but that's kids ...probably if I did it more, then they would be more ...who knows ..."

In this case where the Year 10 class was less than cooperative, the teacher's expression of PCK STOR was promoted by her beliefs about teacher/student relationships, but curtailed by the context. Despite all of this, Terri used stories which appealed to students as a form of PCK. Their use, however, was fairly sparse in comparison with that of both Robin and Chris, but was more frequent than Kim's use of this form of PCK.

A further figure of speech which was identified as a form of PCK was that of mnemonics. On rare occasions teachers used sound with sense to assist in the interpretation of content matter and, of course, as an aid to memory. This form of PCK constituted only 0.16% of the classroom observation data. Most of the instances were, seemingly, unplanned and depended on the quick thinking of the teacher in question. One such example of this occurred when a teacher was reviewing a test in which one of the questions was about the different forms of Vitamin B. A class member's name happened to rhyme with part of the correct answer.

Teacher: The final one (question on the test) has to do with vitamins ...one of the B group ...
Student: Thiamin.
Teacher: Thiamin, Siamon ...well done!
Students: (laughter at the teacher's adulteration of Simon's name)
Teacher: There are others in the B group ...
Student: ...riboflavin ...niacin ...

Teacher: Yes, they are examples

When asked about this incident, Terri refrained from claiming any glory;

Researcher: What was going on in your mind at the time? Did you plan that one?
Teacher: No, (laughs), of course not! ...I've no idea what was going on in my mind. It would be nice that I thought "Ah-hah, this will help them to remember the name" ...but I don't remember thinking that.

There were some planned instances of PCK MNEMON in the data, but their occurrence was more often as a result of clever, quick reactions to opportunities, and even then, they occurred on a very infrequent basis.

The total amount of PCK GEST was, also, a small contributor to classroom observation data and comprised only 0.16% of the text. This may seem surprising given that most people make gestures as they speak. This sub-category was reserved, however, for those instances where the gesture was, actually, representational of the content. This happened rarely although, as mentioned earlier, the researcher may have missed some visual instances whilst making notes. As an example of this form of PCK, one teacher indicated the approximate serving size of a particular weight of food.

Teacher: And how much is a serving?
Student: Um ...125 gram?
Teacher: And how much does that look like?
Student: Not much.
Teacher: Not that much. About that much. (Indicates with thumb and index finger a part-circle of about 6cm diameter) ...Yes, a piece like that ...or if it's a tiny little eye fillet you could have it thicker ...that's around about 120 grams.

Another occasion offered a non-example of PCK GEST. During the lesson this same teacher made meaningful gesture which was related to the content but which was not considered representational. A student offered an incorrect response to a question and the teacher - who was standing behind him at the time - merely pulled his shoulder-slung jumper up over his head. This indicated to the class, in a fun way,

that the response was incorrect and no words were necessary. Whilst
the gesture was related to the content, it did not tell the content.

The final verbal form that became a sub-category of PCK was that of PCK
ERR which constituted 0.75% of the classroom observation data.
Examples of this form were presented in the earlier section on 'PCK and
Experience' and so further examples will not be given here as
illustration. The discussion offered earlier, too, stands as
indication of this form of PCK across the data.

Summary - Forms of PCK

The four teachers were quite different in their uses of these tools of
representation. Their "armamentarium" (Shulman, 1986:9) were distinct
in some ways. Robin's conversational language was peppered with humour
and colour and her use of PCK MET, and PCK SIM was higher than any of
the other three teachers. Robin's use, however, of PCK ANLGY was very
low and this form was used by Chris with her Year 12 class more than
twice as much as any other teacher. As well, Chris' use of PCK ERR was
far higher than that of the other teachers and was also concentrated in
the Year 12 class. The occurrences of PCK MNEMON and PCK GEST were

very infrequent and possible patterns were not considered because of
their rarity.

On the other hand, PCK REP contributed a significant proportion to the
classroom observation data, but its pattern across teachers was linked
to the emphasis in each teacher's classroom on food demonstrations.
For instance, in Chris' Year 12 class, where there were almost no
demonstrations, the proportion of PCK REP was only 4.4%, yet in her
Year 8 class, PCK REP constituted 27.7% of the classroom observation
data. Despite a distaste for PCK STOR, Terri used this form of
representation as much as two of the other teachers, but Robin's
emphasis on story telling (3.53%) was far higher and was related to her
use of humour in the classroom. The incidence of all forms of PCK
(other than PCK REP) in the data from Kim, tended to be somewhat lower
than the other three teachers and was in concert with a lower emphasis
on CK and a higher emphasis on process.

FINDINGS AND CONCLUSIONS

The conversations of these four teachers as they talked about their
teaching, as well as their classrooom talk with students, gave some
insights into what they did with, and how they felt about, the
nutrition content matter that they taught.

1. Decisions about nutrition content that made it pedagogical were

directed, consistently, at maximising the learning process. Few
pedagogical content decisions were made, it seemed, on purely expedient
grounds. Some caution would be invested in this interpretation of the
data, given that to think about teaching is a lot easier than to do
teaching (McNamara, 1990). And some individuals reflect very well.
Nevertheless, the classroom actions bore out these teachers' reflected
concerns about the learning of their students.

2. Decisions about nutrition content that made it pedagogical were
multi-faceted in their knowledge base origins. The intersection of the
categories which emerged from these data - and which represented the
domains of knowledge for teaching - was the place where PCK was
embedded. The categories waxed and waned in their presence and power
on PCK. As well, other themes of context and experience and beliefs
and self-perception, were seen to mediate the decision making process.
The findings, however, were not quite like Cochran et al's. (1991:13)
chocolate mousse(!), or Marks' (1990:9) "neighbourhoods in San
Francisco" (!), but were somewhat akin to Reynolds' (1992:5)
"contextualization".

To record and codify what happened at this intersection was possible
and was seen in this paper. The findings of this study would support
the proposition that a thorough knowledge of content is the sine qua
non for the expression of PCK (Hashweh, 1987; Kennedy, 1990; Lampert,
1988; Tobin & Garnett, 1988). For these four experienced teachers the
expression of PCK was, also, a mixture of the various domains of the
professional knowledge base, with the weightings dependent upon the
situation and the individual. This finding is of relevance in terms of
nutrition teacher education and nutrition teacher development.
Particularly in this country at a time of national nutrition curriculum
development which is to include national teacher development
strategies.

3. Decisions about nutrition content that made it pedagogical were
guided by each of the teacher's experiences with that subject material
in relation to particular groups of students. Each of the teachers

spoke of the number of times that they had taught certain courses and
how new content required 'time-in-teaching'. As Borko & Livingston
(1989:489) stated "any teacher will think and act like a novice, to
some extent, the first time he or she attempts to teach a particular
body of knowledge."

The representations of content material that these teachers used were
developed over time and with revision, and all four teachers concurred
on the 'three runs' rule of thumb before 'comfort' with a course was
achieved. This was somewhat briefer than Berliner's (1987:78)
sugggested "five years or more" but may be attributable to the many
years of experience with the content that these four teachers held.

The experiential flavour of PCK was seen, too, in teacher plans which
were decidedly skeletal but which, in enactment, showed an "ability to
manage complexity and solve practical problems" (Clark & Yinger,
1987:98, after Schon), and the brevity of which suggested that
"teachers' plans are seldom fully reflected in their written plans".
(Morine-Dershimer in Clark & Yinger, 1987:8) The role of experience
with certain content was not only as a cognitive filter, but, as
suggested by Rovegno (1991:74), "there appeared to be a strong
affective component to PCK development." The teachers in these
discussions reported that they felt at ease when appropriate PCK was in
their control.

Because this study was retrospective, career histories of PCK relied on
teacher memory. Longitudinal studies of teachers' PCK development in
relation to specific topics - or the meaning of the subject - would be
of distinct interest.

4. Decisions about the nutrition content that made it pedagogical were
inextricably entwined with the teachers' beliefs about the subject
matter. A note of caution should be made in that the method of the
study included reflective modes of data. There was, perhaps, an
inevitable emergence of teachers' beliefs and values and these were
described within an experiential frame. As one reflects, one is
inclined to question the larger picture and to contemplate one's
beliefs.

Nevertheless, for these four teachers, there were a couple of common
and firmly held beliefs about nutrition content. Especially in
relation to its interdisciplinary nature and to its interdependence of
theory and practice. There were elements of the meaning of the subject
in their discussions, but their views were, mostly, about the
substantive aspects of the subject. There have been pleas in the past
for "critical attention to be given to PCK in teacher education
programs in the form of the meaning of the subjects that they are
teaching" (Clark & Lampert, 1986:30), and this plea could yet apply.

Beliefs about wider issues were embedded, too, in the teachers'
discussions. There was some evidence in the teachers' talk, of
conflict between pedagogical beliefs and actions and the power of
context to define beliefs. There was, also, evidence of a confluence
of beliefs and experience but this may have been an artifact of the
mode of enquiry which asked teachers to think about their professional
experiences.

5. Decisions about the content that made it pedagogical were expressed
in different forms of PCK. In this paper, the traditional forms of PCK
were reported and were found to be used by teachers on very individual
and idiosyncratic bases. Although Marks (1990b:11) reported that in
his study "they hardly appeared in the data" there was no reported
calculation or estimation with which later studies could be compared.

How much PCK is enough? Is more necessarily better?

There has been some related work which yielded insights into the
 possible negative aspects of analogies and metaphors (Davidson, 1976;
 Gabel & Sherwood, 1980; Simons, 1984), and Shulman (1990:308) visited
 this notion when he stated, more recently, that "in trying to simplify
 something we often provide such a powerful analogy that it washes out
 everything that comes afterward."

The judgement and evaluation of PCK - in its traditional forms - still
 requires much examination. For these four teachers, their interest in
 thinking about how they represented their content opened doors of
 meaning for themselves and the students in their care, now and in the
 future.

The main finding of this study was that PCK formed the grist of
practical knowledge about nutrition content by which these teachers
transformed and enlivened their subject matter. The total picture for
PCK has yet to be drawn, but studies which keep close to the language
of teachers and which focus on specific subject areas, must contribute
insights into the nature of knowledge for teaching.

IMPLICATIONS

The nature of PCK is fully realised in its specificity. This study of
an unresearched content area which forms part of the curricula in all
Australian high schools, showed that when teachers make decisions about
the content - which represent that content in pedagogical terms - they
need to know their subject well. Then, the specific instances of
pedagogical content make sense to the newcomer. This is crucial at a
time of large financial investment in a National Project in Nutrition
Education which seeks to address curriculum and teacher development. A
related implication bears on other aspects of teacher education. If
the meaning of the subject is not addressed in tertiary content courses
(as, often, it seems not to be) then, perhaps, the subject-specific
method courses in faculties of education could address this issue in
the name of richer, and more grounded, pedagogical content knowledge.

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APPENDICES

APPENDIX A

ETHNOGRAPH CODES

1. Content KnowledgeCK
2. General Pedagogical KnowledgeGPK
PlanningGPK PLANG
ManagementGPK MANGMT
StrategyGPK STRAT
3. Curriculum KnowledgeK CURR
4. Knowledge of LearnersK LRNRS

5. Pedagogical Content KnowledgePCK
MetaphorPCK MET
SimilePCK SIM

AnalogyPCK ANLGY
Representation/DemonstrationPCK REP
StoryPCK STOR
MnemonicsPCK MNEMON
GesturePCK GEST
ErrorPCK ERR

6. Knowledge of Educational Ends,
Values and PurposesK EVP

1. Caution must be applied with the interpretation of these percentages. Some twenty thousand lines of classroom observation data were collected for the four teachers over four school terms.

Transcripts of audiotaped classroom life (supplemented with handwritten notes) were almost a complete record of all spoken classroom life. Nevertheless, teachers could not always be heard; student utterances were not the focus of the study and were not always recorded; and some class activities were recorded by paraphrase and their verbal detail not recorded. A further caution is placed on the notion of percentage comparisons. As the data were coded for all the domains of the knowledge base for teaching as listed in Appendix A, of course, the coded categories overlapped. In some cases, PCK - of one form or another - overlapped with the codes which represented the other domains of the knowledge base. The Ethnograph can extract up to seven 'nested' or 'overlapping' codes and so where this occurred the common area was counted as PCK. Also, in some instances, the form of PCK started or ended mid-line and the Ethnograph identified text only by whole line. Percentages were calculated by line of text and there was overlap of codes, so there is a small element of under/over estimation within the reported percentages. Neither of the above difficulties would make the mean percentage profile of PCK distorted to a great degree, but the proportions must be held, merely, as a broad guide.