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Children's Knowledge, Teachers' Knowledge: Implications for Early Childhood Teacher Education.

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A recent explosion of research on young children's knowledge raises issues for early childhood educators with regard to the extent to which early childhood programs incorporate the knowledge base that children bring to their learning. Recent psychological work on children's domain knowledge reveals early competencies that contribute to subsequent conceptual learning. Studies of learning in early childhood settings suggest further that sociocultural mechanisms (or constraints) of learning are important factors in children's knowledge construction in the early years. These studies also indicate the interface of content and processes in young children's knowledge construction. It is argued that the professional knowledge base of early childhood teachers should incorporate greater awareness of subject content knowledge. Implications for early childhood teacher education are discussed.

INTRODUCTION

Early childhood teachers' perspectives on the acquisition of knowledge have been strongly influenced by the predominant developmental philosophy that underpinned the play-based programs in early childhood education during the 1970s and 1980s. This approach reflects the influence of Piaget's cognitive-developmental theory which promoted the view that children learn most effectively through interaction with the physical environment. Accordingly, early

childhood teachers were trained to plan stimulating environments that would challenge children to find out about their world. During the 1990s, this constructivist view has been challenged by several trends. Firstly, the emergence of early childhood curriculum statements began to direct teachers towards specific bodies of knowledge deemed to be appropriate content for early childhood programs. For example, a 1980s statement on content from Western Australia's Health Education Syllabus specified an objective for community and environmental health as "students discuss relevant road safety rules" and the associated content as "importance of seatbelts; road sense for pedestrians; rules for riding bikes on footpaths" (Education Department of Western Australia, n.d.). More recent trends to couch curricula in terms of learning outcomes of a more generic nature, as in Western Australia (Curriculum Council, 1998) and New Zealand (Ministry of Education, 1996), arguably leave teachers uncertain about the specific knowledge base of these programs or how to incorporate this knowledge into programs. An outcome statement such as "children develop a relationship with the natural environment and a knowledge of their own place in the environment" in New Zealand's early childhood curriculum guidelines (Ministry of Education, 1996) provides little specific direction

as to how the processes and content embedded in the statement are to be identified and achieved.

Secondly, the increasing adoption of sociocultural theories of development and learning as a basis for an early childhood curriculum (e.g., Bodrova & Leong, 1996; Smith, 1996) has challenged the non-interventionist approach to early childhood teaching promoted by developmental philosophies. As sociocultural theories gain credence and challenge the normative base of developmental theories, such as Piaget's, early childhood educators have become less certain about the status of the child development knowledge that guided their teaching. Along these lines, an early challenge from the North American context (Spodek & Saracho, 1990) referred to the need to make the content of early childhood education programs more explicit in terms of their educational worth and cultural and community appropriateness, instead of relying, on developmental theory.

Furthermore, Cullen (1994) has queried the rationale for the developmental focus of early childhood programs in Australasia, while in the United Kingdom, Drummond (1989) argued that early childhood programs are typified by a conceptual vacuum. In a 1996 issue of the prestigious North American journal, *Early Childhood Research Quarterly*, which included a special collection on the relationship of child development knowledge and teacher preparation, Goffin, as special collection editor, proposed that a newly configured relationship between

childhood development and early childhood teacher preparation must emerge.

The following, section reviews research on an area of child development research, young children's domain knowledge, which brings a new perspective to the professional knowledge base of early childhood teachers.

DOMAIN KNOWLEDGE

Domain knowledge refers to a coherent, interrelated network of information and principles about a particular area which is distinguishable from a multiple of discrete 'bits' of knowledge. In a major review of research on knowledge acquisition in foundational domains, Wellman and Gelman (1998) examine the renewed interest in knowledge, how it is organised, and how it changes over time. Wellman and Gelman define foundational knowledge as "those concepts or bodies of knowledge that en-ender, shape, and constrain other conceptual understandings" (p. 523). They propose that in contrast to earlier research on children's knowledge, such as Piaget's major studies of children's concepts which emphasised *domain-general structures* and *processes*, recent research has focused on the knowledge itself, as the *content* on which the mind works. Much of this work has involved the study of what sorts of knowledge children have, and the mechanisms that account for this knowledge. Numerous studies are now indicating that young children possess early *domain-specific knowledge* that conforms to the criteria of "a core of systematic beliefs and distinctions" that

characterise a knowledge domain (Wellman & Gelman, 1998, p. 554).

Wellman and Gelman's (1998) review focuses on the substantial body of research on the foundational domains of biology, physics, and psychology, but the concept of domain knowledge also applies to other diverse areas such as social understandings, literacy, or mathematics. Such examples could include early understandings about family relationships, ideas about the meaning of print, and the ability to differentiate between different shapes. A recent review of categories in young children's thinking (Gelman, 1998) draws upon the large body of research on this one aspect of domain knowledge to consider implications for early childhood education. Gelman (1998) states that even young children are able to make sense of their world by using categories, or groupings of things that differ in some way, and that such categories are the foundation for later learning in school. As Gelman points out, young children's early inferences on the basis of some categories, such as boy or girl, can be inaccurate as well as accurate, suggesting that educators need to have more than a superficial awareness of children's knowledge in order to build upon it in educational contexts. Australian studies that have highlighted the informal musical knowledge children bring to the early childhood setting (Dilkes, 1998) and the mismatch between young children's home technological experiences and an early childhood technology curriculum (Fleer, 1996) support this conclusion.

To work with children's cognitive understandings educators also need to consider the mechanisms of cognitive change in the early years. Wellman and Gelman (1998) posit three mechanisms of cognitive change, reflected in the domain knowledge research. *Expertise* theories suggest that with practice and experience novice learners become more expert in a variety of domains (Sternberg, 1998). This is a commonsense explanation, but it does not adequately account for variation in expertise across domains for the very young child. *Modular* explanations (Carey, 1991) hold that innate conceptual modules, shaped by evolution, can account for very early knowledge, but are, according to Wellman and Gelman, less successful in explaining conceptual restructuring, particularly the role of cultural learning. The third explanation views conceptual structures as domain-specific theories. *Theory* explanations (Hatano & Inagaki, 1994) have the potential to explain the evolving nature of children's knowledge as theories are modified on the basis of evidence and experience although they are less specific about how conceptual revision takes place.

The theoretical and methodological ramifications of the psychological work on domain knowledge are specialised and beyond the scope of this paper. Nevertheless, the substantial evidence of young children's domain knowledge raises several issues with regard to the place of content knowledge in early childhood education. Inagaki's (1992) work on early childhood science education is one of the first applications of the psychological research on

domain theory to the field of early childhood education. The explicit recognition of sociocultural mechanisms of cognitive change in this analysis has the potential to enrich the various interpretations of cognitive change, described by Wellman and Gelman (1998).

Inagaki (1992) has proposed that the process of knowledge construction is constrained internally (by innate structures and acquired domain-specific knowledge) and externally (by cultural artifacts and human interactions). Inagaki's use of constraints encompasses conditions that both facilitate and restrict knowledge construction. The presence of innate or early cognitive constraints is inferred from evidence on young children's early competencies such as understanding of the counting principle (Gelman & Gallistel, 1978) and Inagaki's own research on recognition of body-mind distinctions (Inagaki & Hatano, 1993). Acquired domain specific knowledge is illustrated by Chi, Hutchinson and Robin's (1989) study of young children who were able to use their specialised knowledge of dinosaurs to make deductive inferences. Recent interest in the significance of cultural artifacts and human interactions for cognitive development has been generated by the resurgence of interest in Vygotsky's sociocultural theory during the 1980s. According to Inagaki (1992), cultural constraints encompass artifacts such as physical facilities and tools, symbols, and beliefs that are shared by a majority of people in a community-. social constraints to the behaviour of others, interactions with them and social contexts created by them.

The dual contributions of cognitive and sociocultural constraints to knowledge construction are illustrated in Inagaki's analysis of early childhood science education. Inagaki's analysis suggests that early childhood science education can work with the four constraints by (a) beginning with domains where early constraints are evident in children's competencies, (b) basing the content goals of science education on the domain-specific interests and knowledge that children have already gained, and (c) guiding children's knowledge construction through the use of sociocultural constraints. In view of the burgeoning interest in sociocultural perspectives on the early childhood curriculum, the explicit acknowledgement of sociocultural mechanisms of change in Inagaki's analysis is a welcome extension to the large body of post-Piagetian research on young children's domain knowledge that has emerged from a cognitive constructivist framework.

TWO RESEARCH TRADITIONS

Inagaki's (1992) discussion of the cognitive and sociocultural constraints on domain knowledge illustrates the potential of combining theoretical approaches for educational purposes. Both the interface and limitations of cognitive constructivist and sociocultural interpretations of knowledge construction have been noted by Hatano (1993), an internationally recognised expert on the development of domain-specific knowledge and thought in young children, in an aptly titled article "Time to merge Vygotskian and constructivist conceptions of knowledge

acquisition". Theories of domain knowledge and sociocultural theories of knowledge have largely developed as separate lines of inquiry with differing methodologies. A recent exception to this pattern is an article by Astington and Olson (1995) that examines relationships between the two approaches in the study of children's understanding of mind. The research area known as "theory of mind" reflects the cognitive focus of domain knowledge research by focusing on the development of children's discovery of the mind. This work has been largely based on laboratory studies and has accumulated an impressive body of findings regarding young children's abilities to attribute mental states to other people. In contrast, researchers such as Dunn (1988) have studied young children in natural home settings and observed how social understandings are acquired through everyday experiences of humour, arguments, and negotiations with siblings and parents. Dockett's (1995) Australian studies which demonstrate young children's theory of mind "in action" in the context of play in early childhood settings also demonstrate the value of a more naturalistic approach to the investigation of children's knowledge.

Astington and Olson (1995) suggest that acquisition of critical concepts permits increasingly complex understanding of social interactions which in turn lead to more advanced conceptual structures. Leaving aside the theoretical issue of causality, this type of explanation does help to explicate the view of cognitive researchers that young children apply

their increasing store of knowledge to problem-solving and reasoning (Catherwood, 1994). In the case of theory of mind acquisitions, the ability to recognise another's intentions makes possible the ability to engage in more complex collaborative play, which in turn provides further opportunities to participate in socially constructed learning,. The insights gained from the use of qualitative methodologies in natural settings thus highlight further the need for educators to acknowledge the knowledge base that children bring to early education settings.

The coalescence of cognitive and sociocultural perspectives on research on domain knowledge is in accordance with contemporary theoretical debate that is beginning, to challenge simplistic distinctions between individual and social interpretations of the origin of cognition (e.g. Cole & Wertsch, 1996; Glassman, 1994). However, the task of translating theoretical debate and research advances into educational practice remains a substantial challenge for early childhood teacher educators. The following sections draw upon the author's work on road safety education in order to illustrate ways in which a dual theoretical perspective can be brought together in a curriculum unit concerned with one area of domain knowledge, road safety.

THE INTERFACE OF CONTENT AND PROCESS

In a recent debate on the contributions of developmental psychology to science education, Kuhn (1997) has drawn attention to the increasing

work on the interface of domain-specific knowledge and cross-domain strategies. Kuhn applies this perspective to the area of science education, reviewing studies that demonstrate the importance of metastrategic, metacognitive, and epistemological dimensions of competence in scientific thinking. In the early childhood field, a cluster of studies inspired by phenomenographic interpretations of young children's learning (Pramling, 1990, 1995) provides considerable support for Kuhn's view. Each of the studies incorporates a metacognitive teaching condition in which teachers participate in reflective conversations with children about their learning experiences on a particular topic in order to increase their awareness of their learning. The epistemological base to the phenomenographic approach to learning is "that how children experience (understand, distinguish, see) different aspects of the world around them is considered to be more basic than skills and knowledge" (Pramling-Samuelsson & Mardsjo, 1998, p. 75). The educational principles underpinning the approach are threefold: (a) to get children to think and reflect; (b) to use their ideas as the base for the content of activities; and (c) to create situations in which children can gain an awareness of aspects of specific content (Pramling, 1995, p. 139). These situations could involve play, field trips, problem solving and other activities which actively enhance children with the content. A critical factor in these learning experiences is the teacher's interactions with the children in order to challenge them to think about and explain what is

happening. Pramling's (1990) research on Swedish preschool children learning about the shop, and her subsequent studies on topics relating to the ecological cycle, reading and writing, aspects of society, and mathematics, illustrate how children's learning can move beyond an activity-based concept on of learning that shapes their understanding of the content towards a coherent understanding of a body of knowledge that integrates knowing about (content, or declarative knowledge) with knowing how to learn (process, or procedural knowledge). Similar demonstrations of cognitive change encompassing the dual components of content *and* process have been obtained in Western Australian studies of road safety education with preprimary children (Cullen, 1995) and of mathematics teaching with year I children (Allen, 1993). New Zealand studies of an environmental curriculum unit with four-year-olds (Prince, 1995) and road safety at the junior primary level (Cullen, 1998a) draw similar conclusions about the effectiveness of talking with children about their learning experiences. An important aspect of these studies is that the focus of teacher-child interactions on a particular topic includes both children's incidental learning (e.g. experiences with garbage) and planned learning experiences that extend understanding (e.g. making a composting box) (Pramling-Samuelsson & Mardsjo, 1998).

A key feature of the metacognitive approach which underpinned these studies is that teachers' interactions with children about their content learning did not focus simply on increasing

children's knowledge but aimed to increase their metacognitive awareness of their learning and how they had learned it. In accordance with the phenomenographic perspective, teaching also explicitly drew upon children's early conceptualisations, or from the perspective of domain knowledge theory and research, their foundational domain knowledge. This approach is revealing with regard to influences on children's knowledge (Cullen, 1998b). For example, conversations with preprimary children about their road safety knowledge prior to a curriculum unit on road safety indicated that young children hold a considerable body of declarative knowledge about the conventions of road safety (e.g. "the sign says you can walk") and that they can modify this knowledge on the basis of their experience. An interesting feature of this process is that reconstructions are sometimes more realistic for young children than the original road safety 'rule'. One child suggested that bikepaths can be dangerous because "a bike might come and they might get run over", a realistic assessment of recreational bikepaths which are shared with adult cyclists travelling at speed. Another child, talking about the use of pedestrian crossings, stated "if there's a green person you can cross, if there's a mum". This response extends the conventional knowledge about pedestrian crossings to incorporate a belief about young children's inability to cross roads alone. Such conceptions probably reflect parental instructions while using crossings and suggest some of the mechanisms through which children's theories

about safety are constructed on the basis of their everyday experiences.

In the preprimary study, all children were introduced to the same road safety content through planned learning experiences comprising real and simulated experiences with traffic, symbolic materials and activities in the indoor and outdoor learning environments. Two groups of children subsequently participated in a learning centre condition using resources and play materials related to road safety (the block area and outdoors). Only one of these groups participated in reflective (metacognitive) conversations with the teacher about their road safety play during play and in group discussions on the mat. A third group participated in a free play condition in which road safety resources were available but were not organised as thematic learning centres. Interviews with children after the three-week curriculum unit indicated that the quality of their learning about road safety had been enhanced by the opportunities to engage in adult-child discussions about road safety learning experiences. Children who had participated in reflective dialogues with adults were able to conceptualise their learning about road safety in a coherent, integrated way that revealed their understanding of roads and traffic as a system while the other children were more likely to report discrete pieces of information. For example, two children talked about a children's crossing in this way: "There was made a crossing outside, we crossed it" (free play) versus "There's a children's crossing sign. we go when the lady (warden) says

it's safe. She knows when cars come; there's some lights round the corner. We saw them when we went for a walk with Mrs M." (reflective dialogue). The difference between these two statements is not simply a matter of verbal fluency; the second child is able to link separate ideas together to demonstrate understanding of how traffic flow can affect safety on a children's crossing.

Another insight from the road safety studies (Cullen, 1995, 1998a,b) is the significance of peer interactions about road safety situations for helping to make explicit the content of learning. Video recordings of the preprimary children's play revealed that children who had experienced reflective dialogues were more focused on road safety play in the learning centres, used more complex language, and played more collaboratively with peers both indoors and outdoors, on safety themes. Language such as "Watch, there's a stop sign coming up" and "Check the crossing first" also indicate that children were engaging in strategic monitoring and planning processes characteristic of metacognitive activity. Further, only these children showed evidence of increased skills, assessed on the basis of videorecordings of each child crossing the road outside the preprimary centre. These findings illustrate how social mechanisms (interactions with adults and peers) can evoke processes of learning (metacognitive strategies and awareness of the content of learning) in ways that promote understanding of content knowledge.

Interestingly, no differences were found in performance on a symbolic task (a feltboard story) which approximated the type of symbolic learning typical of many road safety materials for preschool children and which had formed part of the direct teaching in the curriculum unit. In this regard, the study also provides considerable support for the view that children's domain knowledge is enhanced through authentic learning experiences (Toyama, Lee & Muto, 1997). Walks in the local neighbourhood to practise road safety skills and child-initiated play on safety themes gain authenticity by relating meaningfully to children's everyday lives. The authenticity of adult-structured symbolic learning activities such as cartoon-based games and stories is more problematic.

SOCIALLY ORGANISED SETTINGS OF LEARNING

The above studies support the views of Vygotsky that children's learning is embedded in social contexts and processes. Specifically, the teaching-learning processes involved in the reflective conversations parallel concepts proposed by researchers from the sociocultural school of thought, in that the concepts of scaffolding (Wood, Bruner & Ross, 1977), guided participation (Rogoff, 1990), and co-construction (Valsiner, 1988) all invoke the key component of social interaction. Additionally, the use of resources such as child-sized road signs, in the road safety study, illustrates how the explicit use of cultural tools can evoke both content and learning processes within the road safety domain

of knowledge. The road signs involved children in such cognitive and metacognitive processes as planning the best place to locate the signs, following, directions from peers, negotiating uses, and other forms of thinking that enabled play to proceed. The experience of manipulating the use of signs to convey meaning about traffic and pedestrian behaviour enabled children to construct a holistic understanding of traffic as a system, assisted by the cultural tools of their community. Moreover, by collaboratively designing their own play settings, such as networks of roadways and pedestrians crossings, the children who experienced reflective dialogues participated in socially-constructed thinking which moved them beyond the simple repetitive levels of play observed in children's use of the road safety resources in the free play condition. In accordance with cognitive constructivist explanations, children also reworked conventional road safety rules and practices on the basis of their specific experiences. The dual contributions of sociocultural and cognitive interpretations of knowledge construction in the road safety area of domain knowledge parallel those proposed by Inagaki (1992) with regard to science domain knowledge. In the following sections the implications of this theoretical *rapprochement* for the field of early childhood teacher education are considered.

THE KNOWLEDGE BASE OF EARLY CHILDHOOD TEACHER EDUCATION PROGRAMS

The components of an early childhood curriculum have been described by Bruce (1989) in terms of the child, knowledge, and the environment. Bruce attributes a key role to the teacher in linking the child and knowledge through the environment. I have suggested elsewhere (Cullen, 1996) that this type of educational philosophy places heavy demands on early childhood teachers to match learners' interests with curriculum content. Early childhood teacher education programs have traditionally included a strong emphasis on child development and pedagogy (learning through play, planning environments) as the professional knowledge base of early childhood teaching. A more recent trend to include subject content areas (mathematics, science, literacy) under the influence of external curriculum requirements has been received somewhat uncomfortably by an early childhood profession concerned about the downward press of primary curricula (Anning, 1995; Curtis, 1998; Moyles, 1996). In contrast to this nervousness about the presence of subject studies, I argue that subject studies warrant greater consideration in early childhood teacher education programs. It is difficult to see how teachers can acknowledge and extend young children's foundational domain knowledge if teachers themselves are not comfortable with the knowledge base of those domains. Research on young children's use of domain knowledge in early childhood programs supports this argument.

For example, in a study of preschool science in which teachers aimed to initiate children into one aspect of the natural world, gasification, Ravanis and Bagakis (1998) noted that preschool teachers had a problematic relation with the science content of the program. In the area of mathematics, Young-Loveridge, Carr & Peters (1995) found that children identified as 'experts' and 'novices' were virtually indistinguishable in their use of mathematical skills and purposes in kindergarten classes, suggesting that teachers were unaware of the competencies of experts.

The re-emergence of interest in project approaches and thematic teaching in the early childhood field during the 1990s also provides a strong rationale for a reconsideration of the place of subject studies in early childhood teacher education on programs. The project approach promoted by Katz and Chard (1990), international interest in the Reggio Emilia programs in Italy (Forman, 1996) and the concept of emergent curriculum (Jones & Nimmo, 1994) all encourage the view that young children should participate in extended sequences of learning about a topic. In order to do this, early childhood teachers require both an understanding of how to work with young children's foundational domain knowledge and confidence with the subject knowledge relating to children's interests.

There are encouraging signs from the professional development field that early childhood teachers' lack of confidence with subject matter can be modified. For example, Jordan (1999) has recently reported how teachers engaged in a professional

development program to assist them to scaffold children's learning voluntarily used an encyclopaedia database on the computer to increase their own knowledge of topics of interest to their children. In the preservice area, Maynard (1996) has documented how teacher mentors gradually altered their attitudes to subject (content) knowledge when they were asked to assist the student teachers on placement in their schools to focus on an aspect of subject knowledge during their teaching practice. These attitude changes to subject content knowledge have the potential to move teachers a long way from the superficiality which has beset much thematic teaching in the early childhood sector. It also moves them beyond the belief that child development should form the sole content of early childhood curricula.

CONCLUSIONS

In a recent review of research evidence relating to appropriateness or effectiveness in the early childhood curriculum in the UK, Anning (1998) included '*clarification of the nature and efficacy of 'subject' learning, for young, children' as one of the priorities for a research agenda for early childhood curricula. This paper has discussed one area of research, which illustrates the interface of child development and subject learning, and which holds implications for early childhood teacher education. These implications follow from several generalisations arising from the application of domain knowledge research to the early childhood sector.

1. The emphasis of domain knowledge research on authentic experience can help to guard against fears that an emphasis on a subject knowledge base will automatically lead to an uncritical acceptance by early childhood teachers of formal subject-based teaching methods and curricula. Further, authentic experience is also sensitive to cultural beliefs and practices (Butterworth & Candy, 1998).
2. The evidence that domain knowledge and learning processes are internally related challenges the common belief that early childhood programs should be predominantly process-oriented. Both content and process are important to constructing a coherent body of knowledge.
3. The recognition of social processes in the construction of domain knowledge emphasizes the important contribution of adult and peer interactions to learning, and is consistent with the increasing acceptance of socially constructed views of knowledge in the early childhood tertiary sector within Australasia (e.g., Dockett & Fler, 1999; Jordan, 1999).

The coalescence of the qualities of authenticity, active learning processes, and socially-constructed learning in the research on domain knowledge provides a sound model for learning in the early childhood curriculum. To achieve these qualities, early childhood teacher education programs need to ensure that subject studies are not experienced by students as prescription-driven static bodies of knowledge to be 'acquired' but correspond to the

essential qualities of domain knowledge. Accordingly student teachers also need opportunities to immerse themselves in a subject study which captures their personal interest. Sternberg (1998) argues that "instruction should be geared not just toward imparting a knowledge base, but toward developing, reflective, analytic, creative, and practical thinking with a knowledge base" (p. 18). This perspective applies as equally to the field of teacher education as it does to the area of subject learning with young children.

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